Spring 2017

Mathematics & Statistics 2017 APR Self-Study & Documents

University of New Mexico

ACADEMIC PROGRAM REVIEW
SELF–STUDY, SPRING 2017

Department of Mathematics and Statistics
College of Arts and Sciences

Contents

Abbreviations.

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ALEKS   -- Assessment and Learning in Knowledge Spaces
AMS     -- American Mathematical Society
ASA     -- American Statistics Association
APR     -- Academic Program Review
CBMS    -- Conference Board of the Mathematical Sciences
College -- College of Arts & Science
CTL     -- Center for Teaching and Learning
CTLB    -- Collaborative Teaching and Learning Building
DA      -- Department Administrator
DARPA   -- Defense Advanced Research Projects Agency
DARS    -- Transfer Evaluation System
DMS     -- Division of Mathematical Sciences
DOE     -- Department of Energy
HSC     -- Health Sciences Center
IAS     -- Institute for Advanced Study
ICM     -- International Congress of Mathematicians
IMS     -- Institute of Mathematical Statistics
IT      -- Information Technology
JMM     -- Joint Mathematical Meetings
LANL    -- Los Alamos National Laboratory
MPM     -- Material-Point Method
MaLL    -- Mathematics Learning Lab
MCTP    -- Mentoring Through Critical Transition Points
MRN     -- Mind Research Network
NIH     -- National Institutes of Health
NOAA    -- National Oceanic and Atmospheric Administration
NNSA    -- National Nuclear Security Administration
NRC     -- National Research Council
NSF     -- National Science Foundation
NMAS    -- New Mexico Analysis Seminar
NM HED  -- New Mexico Higher Education Department
PARCC   -- Partnership for Assessment of Readiness for College and Careers
PDE     -- Partial Differential Equations
PI      -- Principal Investigator
PLF     -- Peer Learning Facilitators
RA      -- Research Assistantship
SBAC    -- Smarter Balanced Assessment Consortium
SIAM    -- Society for Industrial and Applied Mathematics
SLO     -- Student Learning Outcome
SMLC    -- Science and Mathematics Learning Center
SNL     -- Sandia National Laboratories
STEM    -- Science, Technology, Engineering and Mathematics
SUnMaRC -- Southwest Undergraduates Mathematics Research Conference
SCC     -- Statistics Consulting Clinic
TA      -- Teaching Assistant
UHC     -- Undergraduate Honors Committee
USNWR   -- U.S. News and World Report
WCOAS   -- West Coast Operator Algebra Seminar
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Introductory Section and Background Information

The section should provide a brief introduction to the self–study.

This self-study fulfills one requirement of the University's Academic Program Review (APR), with site visit scheduled for March 22-24, 2017. Following the format mandated by the sixth edition of the APR Manual (see `http://apr.unm.edu/assets/documents/apr-manual-2015.pdf`), this document describes our efforts, successes, and challenges in performing our duties in research, teaching, and service. In each section (or *criterion* in the parlance of the Manual), we have included in italicized font relevant directives from the APR Manual for each criterion.

The present introductory section summarizes the entire self-study, draws attention to salient issues, and provides context. Criterion 0.A includes the document summary and a quick view of our Department. Criterion 0.B is a short history of the Department and each of its programs. Criterion 0.C describes the Department's organizational structure and governance. Criterion 0.D is a placeholder for external program accreditations; there are none. Finally, Criterion 0.E describes the previous 2008 Academic Program Review, listing its resulting recommendations.

0.A. **Executive summary.** *An executive Summary that provides a one to two-page summary/abstract of the information contained within the self-study.*

0.A.1. *Summary of the self-study.* The organization of this document is as follows.

Criterion 1 focuses on the Department's program goals, as reflected primarily in our mission statement and student learning outcomes. Criteria 1.A and 1.B describe our Department's mission in relation to both our programs and the University's broader mission and vision. Criterion 1.C states goals for our undergraduate and graduate programs. This section only makes broad statements; it points to Appendix E for details. Criterion 1.D considers student awareness of expected learning goals. Criteria 1.E and 1.F respectively define our constituents and demonstrate how our program goals serve them. Criterion 1.G is an extensive list of our outreach and community activities.

Criterion 2 describes the curricula of our degree programs, our service in support of the general education core and other departments, and the procedures ("modes of delivery") by which our courses are taught. The descriptions in Criterion 2 are somewhat intricate. Indeed, as seen in the quick view below, we support 13 versions of 3 basic degrees (BS, MS, and PhD), an Undergraduate Honors Program, (undergraduate and graduate statistics) Minors, and a graduate Certificate Program in Computational Science and Engineering. Added to this complexity is the reality that we are a service department maintaining gateway courses taken yearly by thousands of undergraduates.

Criterion 3 describes our recent efforts toward program assessment. From the standpoint of guidelines set by the College's Assessment Committee, our Department's (undergraduate and graduate) program-level assessment mechanisms are admittedly embryonic. We do not imply that they are absent. Indeed, excellent internal metrics for evaluating both student performance and our programs have been in place for years, particularly for our graduate programs. Further evidence of internal undergraduate assessment appears in Criterion 4. Our current challenge is to ensure that these metrics comply with University guidelines. Criterion 3 starts with an overview of undergraduate assessment, describing recently codified Student Learning Outcomes (SLOs) and their use as assessment measures. Details are relegated to Appendix E. Criterion 3 also describes internal assessment mechanisms for the graduate programs (in mathematics and statistics). We have not yet documented how we evolve in response to program-level assessment.

Criterion 4 focuses on students. Among other considerations, it describes recruitment and admissions, enrollment and graduation trends, advisement, and support services. Criterion 4.A summarizes our recruitment and admissions efforts. Criterion 4.B is an account of enrollment, persistence, and graduation trends, with relevant conclusions highlighted graphically. Criterion

4.C describes advisement of students. For Criterion 4.D, a mandated entry on student support services, we point to Criterion 4.E where we also discuss student success and retention initiatives taken by the Department. It catalogs both support activities and other initiatives.

Criterion 5 considers our faculty. Criterion 5.A lists them and describes their credentials, with a compositional breakdown in terms of gender and ethnicity. It further documents their garnered recognitions and achievements. Among these are teaching awards, fellowships, and external grants. Criterion 5.B remarks on professional development, including mentoring, promotion, and University resources. Criterion 5.C provides select representative examples of faculty research. Finally, Criterion 5.D points to Appendices C and D for faculty vitae.

Criterion 6 treats resource allocation and planning. Criterion 6.A defines our resources, and accounts for their allocation. Much of this section focuses on the procedure by which we staff our courses and assign other duties. Criterion 6.B is a summary of budgets, mostly in tabular form. Criterion 6.C describes our staff, recounting recent upheavals in personnel. 6.D lists library resources. As its chief conclusion, this section describes our current human and financial resources as minimally adequate to inadequate in terms of their current numbers and allotment.

Criterion 7 describes the Department's facilities. Criterion 7.A reviews classroom and department space, the MaLL, and research facilities. Criterion 7.B considers our computing facilities, a subject of marked concern for faculty involved in computational research.

Criterion 8 compares our Department with peer institutions, and identifies meaningful peers. Among the attributes considered in these comparisons are external ranking, faculty honors, and PhD production.

Criterion 9 draws conclusions and considers future directions. It summarizes our strengths and challenges, and outlines strategic directions and priorities.

For some Criteria, the Provost's APR Committee has posed extra 'reflective' questions for the department. These are answered at the end of the Criterion to which they pertain.

Finally, six appendices (attachments) collect details not covered in the core document.

Quick view of the Department.

Degrees.

- BS, MS, and PhD degrees in Mathematics and Statistics. The Mathematics BS supports Concentrations in Pure Mathematics, Applied Mathematics, Mathematics Education, and Mathematics of Computation. The Department also supports an Undergraduate Honors Program, (undergraduate and graduate statistics) Minors, two tracks for the Mathematics MS, and a graduate Certificate Program in Computational Science and Engineering.

People.

- 29 tenure-stream faculty (Fall 2016), two are half-time (28 FTE). 9 in Pure Mathematics, 11.5 in Applied Mathematics, 7 in Statistics, 0.5 in Mathematics Education.
- 6 lecturers, 31 contingent faculty (11 term instructors, and 20 temporary, part-time lecturers). The Department also employs about 35 teaching assistants.
- 4.5 staff. Department Administrator III (Deborah Moore); Program Specialist (Ana Parra Lombard), Senior Fiscal Services Tech. (Crystal Davis), Building Manager (Robert Ortiz, 0.5 FTE), Coordinator of Education Support (Srini Vasan, PhD).
- 23 graduate students in pure mathematics, 27 in applied mathematics, and 32 in statistics. 114 undergraduate majors in mathematics and 27 undergraduate majors in statistics. About 8,500 students take departmental courses per Fall semester; the number is smaller in Spring and Summer. The Department supports about 45,000 student credit hours per year.

Teaching.

- The Department educates two groups of students. Lecturers, contingent faculty and TAs support our service courses (100-200 level), interacting with thousands of students each semester. Tenure-stream faculty chiefly support our upper undergraduate and graduate courses (300-600 level). Moreover, they mentor students in the Undergraduate Honors Program and graduate students pursuing MS and PhD degrees. They also advise all majors.

  Over 80 percent of our credit hours stem from 100-200 level courses (pre-calculus and calculus); our temporary faculty perform an heroic role. Since only 6% of freshman arrive calculus-ready, ensuring that students fulfill their General Education Core requirements (and beyond) presents a marked challenge, one pitting ideal standards against acceptable passing rates. To partially address this challenge, the Department now supports the MaLL. See Criterion 2 and Criterion 4.

  Few tenure-stream faculty teach pre-calculus and calculus classes, mainly since we do not have enough to cover our 300-600 level courses. Some tenure-stream faculty would like to play a role in lower-level course instruction and design. For calculus, Professor Monika Nitsche oversees our program, preparing materials for about 1,900 students per year.

  Tenure-stream faculty teach our 300-400 level undergraduate and 500-600 level graduate courses, together about 18 percent of departmental credit hours. The research and teaching missions of our tenure-stream faculty cannot be separated. While self-evident from the standpoint of graduate training, this statement also pertains to the teaching of courses at all levels. Beyond their ability to teach more advanced courses, tenure-stream faculty are also positioned to assess the need for and implications of curriculum changes. The students who pass through our undergraduate and graduate programs move on to STEM-related careers. Therefore, beyond the impact that mathematical and statistical research itself has on society at large, teaching engagement in such research has a multiplying effect.

Research and grants.

- Applied mathematics research in numerical methods, scientific computing, partial differential equations, nonlinear waves, fluid dynamics, mathematical physics, and mathematical biology.
- Pure mathematics research in algebra, differential and algebraic geometry, number theory, and operator theory and harmonic/Fourier analysis.
- Statistics research in Bayesian methods with applications to biology and other fields, including strong collaborations with the Mind Institute and the UNM Hospitals.
- Currently, faculty are supported by 20 grants: 10 NSF (included a CAREER grant), 6 Simons Foundation, 1 Sandia National Laboratories, 1 Los Alamos National Laboratory, 1 National Oceanic and Atmospheric Administration and 1 through the University of Alaska. The total support from these grants amounts to $3,391,081, the bulk ($1,198,603) stemming from *Mentoring Through Critical Transition Points* (MCTP), an NSF education grant which ends in 2017.

  In this last 10 year period, the department has benefited from two NSF MCTP grants totaling about 2 million dollars. The impact was felt throughout our programs. The latest grant supported 7 month-long intensive summer math camps in which students from throughout the Southwest took 4 week-long mini-courses in various subjects and were supported with a stipend, travel, housing, and a per diem. The grant also supported undergraduate research projects. During this period, our Department had 30 plus students who worked on research projects, wrote theses, and graduated with honors. In terms of graduate and postgraduate professionals, the grant supported two postdoctoral fellows mentored by our faculty, as well as development of a teacher training class and a qualifying exam preparation seminar (both for graduate students). Finally, the grants supported an outreach program, whereby undergraduates visited local middle and high schools to deliver grade-appropriate presentations and talk to younger students.

0.B. **Brief history of each program.** *A brief description of the history of each program within the unit.*

The Department of Mathematics was founded in 1898 with two faculty members, Edwin Childs and Josephine Parsons. The Department had grown to five faculty members by 1944. In the meantime, Lincoln LaPaz came to UNM, establishing the Meteoritics Institute within the department. The Institute brought fame to UNM, and still does. LaPaz became Chair of what was known for some years as the Department of Mathematics and Astronomy.

In the post World War II era, the Department grew rapidly, with student hours taught growing by 57 percent over 1951–1954 while staff increased by 22 percent over the same period. In 1956 the Department, with 9 faculty members, started a PhD program. At that point the Department began to focus more on research and to secure external funding from the NSF. By 1959 there were 76 graduate students, and the first PhD was granted in 1962.

During 1959-1960 two statisticians/probabilists were hired which helped form a basis for a statistics program within the Department. The number of statisticians in the Department continued to expand. While Julius Blum, a statistician/probabilist from Sandia National Labs, was the Chair in 1963-1964, the Department changed from the Department of Mathematics and Astronomy to the Department of Mathematics and Statistics. Astronomy courses moved to the Physics Department. In 1964 teaching loads were reduced from four courses per semester to two courses per semester (still the current standard), in order to support faculty research. Reduced teaching loads were in part achieved by having large lectures with graduate students running quiz sections.

In the 1970's, a nucleus of computer scientists joined the Department, among them was Cleve Moler, who developed what became the widely used program, Matlab. Ultimately, the computer scientists split off to establish the Computer Science Department in the School of Engineering. In 1976-77 the Department supported 34,174 student credit hours, with part-time instructors increasingly teaching lower-level courses. In 1977 the current structure of having 3 programs: pure math, applied math, and statistics was adopted. By 1980-81 student hours had increased by almost 40 percent to 47,557. In 1985 a number of faculty left the Department due to low salaries and a low number of teaching assistants.

In the 2000's, external funding increased with several million dollars in external grants. Prerequisites were enforced for lower-level courses with the goal of increased passing rates and retention, and the Algebra, Calculus, and Introductory Statistics tables at Dane Smith Hall were established.

In late 2010, the Department moved from the Humanities Building into the newly constructed Science and Mathematics Learning Center (SMLC). The SMLC was extended in 2015, and now serves the department well.

0.C. **Organizational structure and governance.** *A brief description of the organizational structure and governance of the unit, including a diagram of the organizational structure.*

The Department of Mathematics and Statistics has a democratic style of governance that attempts to involve all faculty in key decisions. When the department's chair position is vacated, all full–time faculty recommend by majority vote a new Chair to the Dean of the College of Arts and Sciences. The vote results are sent to the Dean in two reports, one representing tenure–stream faculty and the other representing lecturers. Appointment of a new Chair by the Dean requires approval by the Provost.

The Department has an Executive Committee consisting of the Chair and four or five elected faculty members representing areas of interest in the department. Formation of the Executive Committee starts with a slate of eight nominees made by the full–time faculty. An election of four committee members is then conducted before the end of the Spring semester of each year. The four committee members represent Applied Mathematics, Pure Mathematics, Statistics, and Lecturers. Departmental policies also state that if none of the four elected committee members is from one of the traditional under–represented groups, then a second election will be conducted to determine a fifth committee member.

The Chair appoints the Associate Chair and various committees. Besides the Executive Committee, the most important committees are the Graduate and the Undergraduate Committees.

0.D. **External program accreditations.** *Information regarding specialized/external program accreditations associated with the unit including a summary of findings from the last review, if applicable. If not applicable, indicate that the unit does not have any specialized/external program accreditations.*

There is no accrediting body for the Department of Mathematics and Statistics. The Department undergoes review as part of the general UNM Academic Program Review process.

0.E. **Previous Academic Program Review.** *A brief description of the previous Academic Program Review for the unit. The description should note when the last review was conducted. The description should also provide a summary of the findings from the review team's final report, the resulting action plan to address the recommendations, and a summary of actions taken as a result of the previous academic program review.*

The last APR of the Department of Mathematics and Statistics was carried out during the period April 21–23, 2008. The review committee consisted of Sastry Pantula (Statistics) from North Carolina State University, Irene M. Gamba (Applied Mathematics) from the University of Texas–Austin, and V.M. Kenkre from UNM. Another member of the original review team was N. Ercolani (Pure Mathematics) of the University of Arizona, but for medical reasons he was not able to participate in the review. The Reviewer's Report[1], the Unit's Response Report[2] and the Initial Action Plan[3] are posted at `http://apr.unm.edu/apr-unit-records/art-and-sciences/index.html`.

0.E.1. *Review findings.* The Reviewer's Report from the 2008 APR noted that the research in the department was strong, with interdisciplinary components and successful in attracting external funding and in making connections to other strong departments on at UNM. The Report's main finding was that faculty numbers were alarmingly low. At that time, the number of tenure-stream faculty in the Department were 10 in Pure Mathematics, 9.5 in Applied Mathematics, 5.3 in Statistics, and 1.5 in Math Education; 26.3 FTE in total. It was pointed out that the low faculty numbers along with the heavy reliance on part-time instructors for covering the lower-level courses could have a negative impact on the teaching mission at all levels of the curriculum.

In summary, the specific recommendations of the review team were:

(1) *Create some visiting professor lines, and bring some senior visitors immediately to help with teaching and research during the academic year 08-09.*
(2) *Repair the dangerous situation with faculty losses in Applied Mathematics and Statistics by hiring 2 senior and 3 junior faculty members in statistics over the next 3 years and at the same level in Applied Mathematics.*

[1] `http://bit.ly/2kT43g5`
[2] `http://bit.ly/2mgzamV`
[3] `http://bit.ly/2mgx6LA`

(3) *Encourage joint appointments to foster multidisciplinary research.*
(4) *Encourage Math Education initiatives in Department.*
(5) *Postpone discussion of separating Mathematics and Statistics.*
(6) *Faculty with active research grants must be given a reduced (2+1) course load in order for them to continue to be successful in their research and grant funding.*
(7) *Apply for NSF funding to upgrade outdated and inadequate computing facilities for students.*
(8) *Set up a common departmental tutorial room for the TAs to meet their students.*
(9) *Allocate permanent budget lines to the department to manage the PTI hiring and to efficiently manage the budget.*
(10) *Give the Department possibility to use lapsed outlays to bring visitors to cover the upper level courses.*

0.E.2. *Action plan and actions taken.* The Initial Action Plan was adopted in April 2012 and, at that time, the recommendation items (7) and (8) had been largely resolved by the move to the SMLC. Furthermore, recommendation (5) was followed, but recommendations (9) was not. The following remarks pertain to the remaining recommendations.

Regarding recommendations (1,10), the Dean supported the use of a vacated lecturer line to hire a postdoctoral scholar with a light teaching load over 2013-2015. Using funds from the MCTP grant and the Efroymoson foundation, the Department has been able to appoint post-docs. However, the MCTP grant ends in 2017. The Department lacks funds to bring in senior visitors on a regular basis.

Regarding recommendation (2), the Dean of A&S was supportive of increasing the number of tenure-stream faculty in the Applied Mathematics, Pure Mathematics, and Statistics groups to 12 faculty each, aiming for mid-career or senior hires in Statistics. During the 2008 to 2016 period, with the Dean's support, the recommended growth for the Applied Mathematics Group was nearly achieved. The Applied Mathematics group has grown from 9.5 to 11.5 FTE, just 0.5 short of the recommended 12. The recommended 12 faculty in Pure Mathematics and Statistics has not been achieved. The Pure Mathematics group has decreased from 10 to 9. In Statistics there were no hires at either the Associate Professor or Professor rank. The Statistics group has only grown by 1 member; it is now at 7.

Regarding recommendation (3), impediments to joint appointments exist, such as ambiguity in tenure standards, the dearth of candidates with expertise in two fields, and fund-division issues. While we are working with the College to overcome these, as yet this recommendation has not been followed. The Dean's office has offered to facilitate relevant discussions with other entities on Campus.

Regarding recommendation (4), we have lost 1.5 faculty who worked in mathematics education. The Dean, in a Fall-2016 letter to the Provost, stated that, given the current low number of faculty in Pure Mathematics, he did not support a replacement hire for mathematics education in the Department.

Regarding recommendation (6), The Dean did not support the strong recommendation of the Review Team to reduce the teaching load to (2-1) for faculty with active research grants. Resources were committed to hire a postdoctoral fellow for two years to help with the instruction of 300+ courses.

Criterion 1: Program Goals

The unit should have stated learning goals for each program and demonstrate how the goals align with the vision and mission of the unit and of the university. (Differentiate by program where appropriate.)

As mentioned in the introduction, our Department performs multiple roles. First, we are a service department, maintaining gateway courses taken yearly by thousands of undergraduates and providing the mathematical-reasoning component of the required UNM Core. Second, each of our primary groups (applied mathematics, pure mathematics, and statistics) functions as other non-service departments, training undergraduate majors and graduate students, engaging in fundamental research, and supporting the University and beyond through service. Therefore, our Department might be broken down into "programs" along either the service/academic discipline line or our three primary disciplines (four, including mathematics education). Furthermore, our undergraduate-major and graduate courses also serve the needs of other department's students. These observations suggest various ways to define our "programs". Throughout the following summaries and descriptions, we aim to keep the "program" context clear. Criteria 1.A to 1.F provide brief responses, sometimes pointing elsewhere in the document for elaboration. However, Criterion 1.G lists departmental outreach and activity in detail.

1.A. **Vision and mission.** *Provide a brief overview of the vision and mission of the unit and how each program fits into the vision and mission of the unit.*

Department mission statement.

The UNM Mathematics and Statistics Department is committed to preparing our students for a variety of careers in industry, government and the teaching professions; and to advance fundamental knowledge in the areas of Pure Mathematics, Applied Mathematics and Statistics through world-class research.
Key components include:

- *A comprehensive curriculum ranging from introductory, core and service courses to upper-division and graduate courses to prepare future mathematicians, statisticians, scientists, engineers and teaching professionals.*
- *A vibrant research agenda in mathematics and statistics advancing the fundamental knowledge in the mathematical and related sciences through professionally recognized scholarship.*
- *A commitment to professional and community service through participation in national and international societies, New Mexico institutions and organizations, and through sustained support of colleagues throughout the University.*

The Department mission statement was recently revised and approved by faculty vote on December 21, 2016. At present, we do not have a vision statement. The Department's elementary service courses plainly support our mission statement, in particular its first bullet. These service courses are integral to the University. The same statement holds for our core (undergraduate and graduate) courses. The statement's second bullet refers to the research efforts of our tenure-stream faculty and their graduate students, as described more fully in Criterion 5. Our faculty also support the third bullet. For example, they voluntarily serve as referees for articles submitted to academic journals and as panelists for grant-proposal review. Our faculty have also forged connections with other NM institutions; see Criterion 1.G below.

1.B. **Vision and mission of the Department in relation to UNM's vision and mission.** *Describe the relationship of the unit's vision and mission to UNM's vision and mission.*

The Department's aims align with those expressed in the University's vision and mission statements which appear below. Examples of this alignment include the following.

- Education of students who are prepared for fields which support both the state and national economies and impact national security.
- Discovery of knowledge with impact within and beyond the disciplines of applied mathematics, pure mathematics, and statistics.
- Ties with the community of scientists and engineers at both Los Alamos and Sandia National Labs.
- Interaction with the community of state and regional teachers, both in K-12 and post-secondary education.
- Sponsorship of events such as the *UNM-PNM Statewide Mathematics Contest*, *Albuquerque Math Teachers' Circle*, and the *Southwestern Undergraduate Mathematics Research Conference* (see below).
- Actualization (and celebration) of an environment built on diversity and integrity.

In summary, the Department wholeheartedly shares the goals of the University and its vision.

University vision statement.

UNM will build on its strategic resources:

- *to offer New Mexicans access to a comprehensive array of high quality educational, research, and service programs,*
- *to serve as a significant knowledge resource for New Mexico, the nation, and the world; and*
- *to foster programs of international prominence that will place UNM among America's most distinguished public research universities.*

University mission statement.

The University will engage students, faculty, and staff in its comprehensive educational, research, and service programs. UNM will provide students the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, to contribute to the state and national economies, and to lead satisfying lives. Faculty, staff, and students create, apply, and disseminate new knowledge and creative works; they provide services that enhance New Mexicans' quality of life and promote economic development; and they advance our understanding of the world, its peoples, and cultures. Building on its educational, research, and creative resources, the University provides services directly to the City and State, including health care, social services, policy studies, commercialization of inventions, and cultural events.

1.C. **Overall learning goals for undergraduate and graduate programs.** *List the overall learning goals for each undergraduate and/or graduate program within the unit. In accordance with the Higher Learning Commission's Criteria for Accreditation, student learning goals and outcomes should be articulated and differentiated for each undergraduate and graduate degree/certificate program.*

During the 2015-2016 academic year, the department's Undergraduate Committee crafted broad program goals and student learning outcomes (SLOs) for all our undergraduate majors. Appendix E describes these SLOs in detail.

Broadly, the goals for *mathematics* majors are the following.

- **Mathematical knowledge.** Students should demonstrate an understanding of the foundations of calculus and linear algebra as well as the ability to think logically and critically.
- **Problem solving skills.** Students should formulate, analyze, and solve problems through analytical and computational techniques and apply them to other disciplines when appropriate.
- **Employment skills.** Students should attain the needed written and oral communication skills to translate their degree into a viable career path.

The goals for the mathematics MS degree are that students demonstrate the same knowledge and skills at a deeper level, as evidenced by a written thesis with an oral defense or the successful completion of 3 qualifying examinations. The PhD degree additionally requires students to complete the 3 qualifying examinations with higher scores, pass a comprehensive exam on their chosen research subject, and write a dissertation extendable to an independent research program after graduation.

Broadly, the goals for *statistics* majors are the following.

- **Statistical knowledge.** Students should demonstrate proficiency in probability and statistical theory and methods.
- **Presentation and interpretation of data.** Students should demonstrate the ability to manipulate and visualize data and to compute standard statistical summaries.
- **Mathematical knowledge.** Students should demonstrate skill in applying fundamental mathematical techniques.
- **Employment skills.** Students should attain the needed written and oral communication skills to translate their degree into a viable career path.

The goals for the MS degree in statistics are that students demonstrate the same knowledge and skills at a deeper level, as evidenced by a written thesis with an oral defense or the successful completion of a two-part qualifying examination. The PhD degree additionally requires students to pass a comprehensive exam on their research subject and write a dissertation extendable to an independent research program after graduation.

1.D. **Communicating learning goals to students.** *Explain the manner in which learning goals are communicated to students and provide specific examples.*

Whether at the undergraduate or graduate level, learning goals for individual courses are communicated via the traditional avenues: announced expectations for exams, homework, and projects; graded coursework, and advisement. In addition, the Department website, `http://www.math.unm.edu`, also collects pertinent information. For example, the undergraduate tab on our homepage prominently displays the link to the learning goals and outcomes for the undergraduate program. Other pages on the site provide information on advisement, placement and sequencing, and the undergraduate Honors Program. From the website, prospective and current graduate students can download the most recent versions of the *Graduate Handbook for Mathematics* and the *Graduate Handbook for Statistics*. These documents communicate relevant learning goals and expectations for the graduate program. Also available for download are prior examples of the MS/PhD qualifying examinations in all subjects. These examples set a standard for the mastery of core subjects.

UNM's Office of Assessment is dedicated to institutional effectiveness. From the office's website, `http://assessment.unm.edu`, one may find further information related to the communication of learning goals.

1.E. **Primary constituents and stakeholders.** *Describe the unit's primary constituents and stakeholders.*

Our primary constituents are the students of the University of New Mexico. In all, the Department offers approximately 45,000 student credit hours per year. Through the MaLL (described further in Criteria 2, 6, and 7), the Department provides services for about 3,500 students per year. The purview of the MaLL is remedial instruction in MATH 101, 102, 103, and limited sections of MATH 121. The UNM Core Curriculum requires a mathematical reasoning component which is satisfied by MATH 121, 129, 150, 162, 163, 180, 181, 215; STAT 145 or University Honors 201. Appendix A lists descriptions for all numbered courses in mathematics and statistics.

Courses offered by the Department serve many other campus departments and programs such as BA/MD, computer science, engineering, and physics. Mathematics and statistics courses required by these departments form an integral part of the undergraduate degree for these majors. Moreover, graduate students from engineering and science departments often enroll in our graduate courses. Within our department, our primary constituents are our undergraduate majors and graduate students. Currently, the Department has one-hundred and forty (140) undergraduate majors and a total of eighty-two (82) graduate students.

Our primary stakeholders are the College of Arts and Sciences, and the State of New Mexico. Responsibility to these stakeholders is governed by the Department through the Department Chair and faculty under the direction of the Dean of the College of Arts and Sciences, as well as the Provost and President. Our varied teaching and service roles, makes other colleges and schools at UNM secondary stakeholders.

1.F. **How satisfaction of program goals serves constituents.** *Provide examples of how satisfaction of the program goals serves constituents.*

Our goal of providing a comprehensive curriculum ranging from introductory, core, and service courses to upper-division and graduate courses serves students (our constituents) in a variety of ways. First, it prepares students to be enlightened and productive citizens. Higher level courses prepare future mathematicians, statisticians, scientists, engineers and teaching professionals for careers in their chosen field. Graduates from our MS and PhD programs are successfully employed in positions utilizing their skills. Appendix B provides employment data for 2006-2016 alumni.

Information in Criterion 2 provides details about our curriculum. Specifically, Criterion 2.B discusses the Department's contributions to general education and to other UNM units. We refer to Criterion 2.C for a discussion of modes of delivery and 2.D for measures of student success. Further, discussion of assessment is found in Criterion 3. Finally, Criterion 4 describes our efforts to recruit and retain students. Together, these Criteria provide a comprehensive review of all aspects of our service to the students at UNM.

Finally, we note that as a unit within the State's flagship university, our research mission provides students with unique opportunities for interaction with research active faculty and participation in research projects through our Undergraduate Honors Program, REU's, and graduate study.

1.G. **Examples of outreach or community activities.** *Provide examples of outreach or community activities (local, regional, national, and/or international) offered by the unit. These could include activities such as colloquia, conferences, speaker series, performances, community service projects, etc. Provide an assessment of these activities in relation to the unit's educational objectives.*

1.G.1. *K-12 outreach.*

UNM-PNM Statewide Mathematics Contest. The New Mexico Mathematics Contest was born the year before the first Super Bowl in 1966. It has gone through three name changes during the course of its history and is currently known as the UNM-PNM Statewide Mathematics Contest.

The goal of the UNM-PNM contest is to promote mathematics education in New Mexico by rewarding students, teachers, and their schools for mathematics excellence. Between 700 to 1200 New Mexico students benefit from this program annually. The contest is aimed at all students in grades 7 through 12, but is open to interested students in lower grades. The contest has two rounds of exams designed to test mathematical potential and ingenuity as well as formal knowledge. Round I is administered at the student's home school. Students from non-registered schools can take the Round I exam at the UNM campus. The top finalists are invited to the UNM Campus in early February to compete in Round II. The contest also awards the schools with the highest participation in the First Round. Awards are presented to the winners in a banquet hosted by the Department at UNM in April. A public lecture presented by a nationally renowned mathematician is given in conjunction with the second round of the competition. See the following website: `http://mathcontest.unm.edu/`

Albuquerque Math Teachers' Circle. The Circle supports local teachers who desire exploring mathematical ideas in a fun, encouraging environment. The meetings provide an opportunity for participants to work on interesting problems, developing their mathematical knowledge, skills, and intuition, with the support of leading mathematicians and scientists from the local community. For more information see `http://www.unm.edu/~mathtc/overview.pdf` and the following website: `http://www.unm.edu/~mathtc/index.php`

1.G.2. *Undergraduate outreach.*

Putnam Mathematical Competition. The Putnam Mathematical Competition is an annual contest for US and Canadian college students. More than 4000 students from over 500 colleges and universities take part in this most prestigious mathematics competition in America. The Department of Mathematics and Statistics at UNM has been supporting the competition by providing local guidance and proctoring for UNM contestants. The competition stimulates the development of cross subject problem solving skills and allows UNM students to assess their mathematical skills on the national level. Last year 4 UNM students took part in Putnam Mathematical Competition. They were among 4275 contestants from 554 institutions. One of our students made the Putnam top 500 list. He ranked 273.5 which is in the top 7 percent. See the Putnam tab at the following website: `http://www.math.unm.edu/~maxim/`

Southwestern Undergraduate Mathematics Research Conference (SUnMaRC). Every spring semester, a group of universities and community colleges in the Southwest holds the Southwest Undergraduates Mathematics Research Conference (SUnMaRC). This conference provides students an opportunity to see math research, to meet other students throughout the Southwest with similar interests, to explore possibilities for graduate studies, and, for those who already have been working on a research project, to present their work. UNM has participated in SUnMaRC since 2007. The participating institutions are Arizona State University, Mesa Community College, New Mexico State University, Northern Arizona University, Pima Community College, University of Arizona, University of New Mexico, University of Texas El Paso, United Stated Air Force Academy, and Western New Mexico University. The yearly host rotates among these institutions. In 2009 and 2013 UNM hosted the conference, with approximately 100 students and faculty from all over the state participating each time (organizer M. Nitsche). In 2015, UNM's group of 8 students won the Math Contest Trophy. See the following web site: `http://www.math.unm.edu/mctp/sunmarc`

1.G.3. *Community outreach.* The Statistics Consulting Clinic (SCC) is an internal statistical consulting service of The University of New Mexico. Staffed by statistics faculty and advanced statistics graduate students from the Department of Mathematics and Statistics, the service is offered without charge to faculty, staff, and student clients at UNM in support of their academic research and other statistical needs. The goals of the SCC are to promote scientific collaboration between disciplines, enhance the quality of research at UNM, and improve the education of UNM students. This service is funded by the College of Arts and Sciences and the Department of Mathematics and Statistics. See the following website: `http://www.stat.unm.edu/~clinic`

1.G.4. *Local conferences.*

AMS conferences. The Department has hosted Sectional Meetings of the American Mathematical Society (AMS) five times in the last 13 years (in 2004, 2007, 2010, and 2014).

- April 4-6, 2014, University of New Mexico, Albuquerque, NM (Western Spring Sectional Meeting). Meeting #1099, Notices Program Issue: April 2014, Abstract Issue: 35/2. There were 23 Special Sessions, 10 sessions organized by 15 UNM Math Faculty.
  Website: `http://www.ams.org/meetings/sectional/2215_program.html`
- April 17-18, 2010, University of New Mexico, Albuquerque, NM (Spring Western Sectional Meeting). Meeting #1059, Notices Program Issue: April 2010, Abstract Issue: 31/3. There were 15 Special Sessions, 7 sessions organized by 10 UNM Math Faculty.
  Website: `http://www.ams.org/meetings/sectional/2169_program.html`
- October 13-14, 2007, University of New Mexico, Albuquerque, NM (Fall Western Sectional Meeting. Meeting #1032, Notices Program Issue: October 2007, Abstract Issue: 28/4. There were 14 Special Sessions, 5 sessions organized by 10 UNM Math Faculty.
  Website: `http://www.ams.org/meetings/sectional/2143_program.html`
- October 16-17, 2004, University of New Mexico, Albuquerque, NM (Fall Western Sectional Meeting). Meeting #1000, Notices Program Issue: October 2004, Abstract Issue: 25/4. There were 14 Special Sessions, 5 sessions organized by 10 UNM Math Faculty.
  Website: `http://www.ams.org/meetings/sectional/2112_program.html`

The AMS holds eight sectional meetings annually. Generally, there is one meeting in the spring and one in the fall in each of four section of the US (Western, Central, Eastern, and Southeastern). The meetings rotate among the states that belong to each section. The Western Section is comprised of those states west of Nebraska (and those provinces of Canada north of that portion of the US). It is an honor to have UNM chosen as host about every 4 years. These meetings have each attracted between 250 and 400+ participants to Albuquerque.

Southwest Local Algebra Meeting. To be held on March 4-5, 2017, Albuquerque, NM. Funded by NSF (15K PI: J. Vassilev). This conference is in its eighth year, and has been held previously in Las Cruces, Texas, Arizona, Oklahoma, and next year it will be in Arkansas. This is a conference that usually gathers about 60 to a 100 participants, geared to graduate students.

Witt Rings in Arithmetic, Geometry, and Topology. Held on May 14-18, 2012, Albuquerque, NM. Speakers came from the US, France, Australia, and Denmark, funded by a Defense Advanced Research Projects Agency (DARPA) grant. This was the third in a series of conferences organized around the theme of absolute geometry. The first 2 conferences were in Leiden, Netherlands (2009) and Nagoya, Japan (2010).

West Coast Operator Algebra Seminar (WCOAS). Held on October 1-2, 2011, Albuquerque, NM. Funded by NSF (25.5K PI: Loring). WCOAS has been an annual tradition for 18 years. It is intended to reinforce ties among the operator algebraists in Western universities. This conference gathered 42 participants from US and Canada. The talks covered C^*-algebras and von Neumann algebras, related areas in ring theory and functional analysis, and in mathematical physics.

Although participants at the conference from the University of New Mexico did not receive funding from this grant (per policy), an important outcome of the event was to bring eight physics graduate students in contact with a group of operator algebraists and expose them to a variety of talks. Likewise, the talk by physicist Alexi Kitaev was a rare chance for operator algebraist to hear of his discovery of an association between K-homology and finite lattice models of free fermions.

The 6th Material-Point Method (MPM) Workshop. Held on August 9-10, 2010, Albuquerque, NM. The meeting featured 17 presentations over 1 1/2 days and had 37 participants. MPM is a numerical method (developed at UNM) for solving problems in continuum mechanics and has been applied to solve problems that involve features such as composites, fracture, fluid-structure interaction, contact, impact, foams, multiphase flows and porous media. The speakers came from industry, national laboratories, and academia; and included participants from Australia, The Netherlands, the UK, as well as the US. Funding was provided by the Department of Energy (DOE), Advanced Science and Computing (ASC), Center for the Prediction and Reliability, Integrity and Survivability of Microsystems. For more information see conference website: `http://www.math.unm.edu/~sulsky/MPMWorkshop/Home.html`

LAAZ ASUNM Daze 2008. Held on February 29-March 01, 2008, Albuquerque, NM. Funded by the LANL Institute for Advanced Study. This conference is held every year in order to maintain regular contact between the Applied Mathematics Program and the Mathematics Department at the University of Arizona, the Mathematics Department at Arizona State University, the Mathematics Department at the University of New Mexico and the Center for Nonlinear Studies at Los Alamos National Laboratory. This meeting provides an opportunity to exchange ideas, present new findings, and meet new people (postdocs, professors, and graduate students). For more information, please see the following website: `http://math.unm.edu/~plushnik/LAAZ_ASUNM_Daze_2008`

New Mexico Analysis Seminar (NMAS). NMAS, an annual conference alternating between UNM and NMSU, ran uninterruptedly from 1998-2009, and from 2014-present. It had NSF support for the last 12 editions (4 separate grants for a total of $ 117,000, PI: Pereyra). In 2005 the NMAS ran in Las Cruces in an abbreviated form and in conjunction with a CBMS-NSF Lecture Series where the main lecturer was Terence Tao (who subsequently got the 2006 Fields Medal), in 2017 the NMAS will run in a similar fashion in conjunction with another CBMS-NSF Lecture Series featuring Anna Gilbert in Las Cruces. In 2004, 2007 and 2014 the NMAS was run as a two day event prior to an AMS meeting held here in Albuquerque; it consisted mostly of mini courses and invited lectures, while the short talks where given as invited talks in Special Sessions in the AMS meeting. The 2007 and 2014 events also included An Afternoon in Honor to Mischa Cotlar (in 2007) and An Afternoon in Honor to Cora Sadosky (in 2014), two world renowned mathematicians. These were large events with participants from several continents, and from all over the US. The Albuquerque meetings have had between 60-100 participants, many of them graduate students and junior participants. The NMAS has historically been a forum for junior participants, with world experts delivering excellent lecture series, a few invited lectures, and a number of contributed talks. We have a very good record in terms of diverse speakers and participants. See the website for the 15th NMAS in 2016: `http://www.math.unm.edu/conferences/15thAnalysis/`

New Mexico American Statistics Association (ASA) conference. In April of each year, we have a New Mexico ASA conference, either in Albuquerque or Santa Fe, for all statisticians from the state. Researchers are mostly from Los Alamos National Lab, Sandia National Labs, New Mexico State University, our own statistics group, and UNM's Comprehensive Cancer Center.

1.G.5. *Departmental seminars and colloquia.*

Applied Mathematics Seminar. The applied mathematics seminar meets weekly. It is a forum for students, faculty and visitors to present research. The seminar gives students an opportunity to speak publicly about their research. The seminar also exposes students to a broad range of research topics as presented by faculty and outside visitors. Speakers include visitors from other universities, visitors from national labs and faculty from other departments at UNM. The last three semesters we have also hosted a seminar series *Computational Mathematics at Sandia National Laboratories* in which Sandia staff members discuss their research and projects. Some of these presentations have also provided information about summer programs, internships and employment opportunities at Sandia. The seminars are broadly advertised and attended by students and faculty from other departments.

Geometry Seminar and Analysis Seminar. The Geometry Seminar has met every semester for more than 20 years. It features our own faculty, graduate students, and visiting mathematicians. The topics range from geometry, algebra, number theory, algebraic topology, and more. The Analysis seminar has met most semesters for the last 20 years. It features our own faculty, graduate students, and visiting mathematicians. The topics range from harmonic analysis, differential equations, C*-algebras, global analysis, operator theory, functional analysis.

QuantBrains UNM/MRN Research Seminar Series. The Department of Mathematics and Statistics hosts a series of lectures on applying mathematics and statistics (including machine learning) to brain imaging data, in collaboration with The Mind Research Network (MRN). Multidisciplinary ideas and methods relevant to Computer Science, Physics, Engineering, and Psychology are discussed. The seminar series focuses on methods and models for analyzing brain imaging data including signal and image processing, statistical inference and testing, graph theory, machine learning, and dimension reduction. Additional topics include brain image data modalities (MRI and EEG), clinical research questions, brain physiology and magnetic resonance physics, as well as discussions of future research directions (dissertation and thesis areas). Website: `http://tinyurl.com/QuantBrains16`

Colloquium. We have Mathematics Colloquia and Statistics Colloquia once or twice a month on average. The speakers are visitors from nearby laboratories, from other universities in the US, or from abroad. These lectures are expected to be less specialized than a seminar and for a broader mathematically literate audience; in particular, it is an excellent occasion for faculty, graduate students, and even some advanced undergraduate students, to be exposed to a diverse array of research topics in mathematics and statistics.

Colloquia, seminars, and local conferences are great opportunities for both researchers and students to learn about their fields and form collaborations. For example, the recent visit of Dr. Lauren Hund from Sandia National Laboratories resulted in one of our students obtaining a research internship at Sandia.

Reflective question.

Extension of 1B. In order for the university to better showcase your unit, please explain the importance of its contribution to the wellbeing of the university including the impact of the unit's degree/certificate programs on relevant disciplines/fields, locally, regionally, nationally, and/or internationally?

Mathematics and statistics play a central role in science and engineering; they are also fundamental branches of knowledge in their own right. The Department plays an indispensable role educating students at UNM. Each year, we are responsible for thousands of students graduating with vital problem-solving and mathematical-reasoning skills. These core skills are broadly applicable across myriad career paths.

Calculus is the gateway to engineering, physics, biology, and other disciplines, and the knowledge students gain in our calculus sequences enables their success. In upper-division and graduate courses we prepare future mathematicians, statisticians, scientists, engineers, and teaching professionals for a variety of careers. We educate students from the state, nation, and world at large. Many of our students become teachers; a number at CNM, UNM-West, and elsewhere throughout New Mexico. *The students we train today will train a subsequent generation's post-secondary students tomorrow.* Many move on to graduate programs across the USA.

Appendix B showcases the successful paths of our graduates. They move on to successful scientific careers across the globe, and are contributing to scientific knowledge. Like other research departments of mathematics and/or statistics, the role we play is crucial for national security and important for society here and abroad.

Criterion 2: Teaching and Learning: Curriculum

The unit should demonstrate the relevance and impact of the curriculum associated with each program. (Differentiate for each undergraduate and graduate degree/certificate program concentration by the unit.)

This Criterion has three parts. Criterion 2.A presents the undergraduate program for our majors and minors, and the MS and PhD program for our graduate students. For each, it describes the degrees and the corresponding requirements. The next two parts summarize the wide spectrum of our teaching contributions. These contributions, itemized in Criterion 2.B, contribute to the University on many levels, as reflected by our central role in general education and the core requirements in other programs. Criterion 2.C describes the variety of innovative modes used to deliver course content, including self-paced courses, traditional lecture style courses, coordinated courses, courses with Peer Learning Facilitators (PLFs), flipped courses, and ITV courses. Note that initiatives to attract, retain, and support our undergraduate majors and graduate students are addressed later in Criteria 4.A, 4.D, and 4.E. Staffing and resources are discussed in Criterion 6.

2.A. **Detailed description of curricula for each program.** *Provide a detailed description of curricula for each program within the unit. Include a description of the general education component, required and program-specific components for both the undergraduate and graduate programs. Provide a brief justification for any bachelors degree programs within the unit that require over 120 credit hours for completion.*

As described in the University Catalog, as part of their baccalaureate program all students must complete the Core Curriculum, which includes one course chosen from MATH 121, 129, 150, 153, 162, 163, 180, 181, 215; STAT 145; University Honors 202. This criterion describes the required program specific components. Further details are also found in the University Catalog.

2.A.1. *Undergraduate program.* The undergraduate curriculum consists of a major or minor in either mathematics or statistics. Majors in mathematics or statistics earn a BS degree. Within mathematics, the student chooses one from the following concentrations: Pure Mathematics, Applied Mathematics, Mathematics of Computation, or Mathematics Education. We support an Honors Program for qualified students.

The following are the specific program requirements for the major and minor in mathematics (including individual concentrations), the major and minor in statistics, and the Honors Program. Both majors leading to the BS degree are structured for completion within 120 credit hours.

- **Mathematics BS.** All mathematics students take common courses in calculus, linear algebra, complex variables, advanced calculus, in addition to electives and courses specific to their concentration. All are also required to have knowledge of a computing language such as MATLAB. All applied mathematics students are required to have a minor, preferably in an applied science. Only the computation concentration requires a specific minor in computer science. Of the mathematics and statistics courses taken, at least 27 credit hours must be numbered 300 or above.
- **Statistics BS.** All statistics students are required to have knowledge of a computing language such as MATLAB. A strong mathematical background is attained through course requirements in calculus and linear algebra. In addition, as enrichment courses the program includes at least 6 additional credit hours of 300+ level courses approved by the student's undergraduate advisor. These can be taken in an appropriate discipline of the student's choosing; for example, anthropology, biology, business, chemistry, computer science, economics, engineering, mathematics, or psychology.

- **Mathematics and Statistics Minors.** The Minor in Mathematics requires 3 semesters of calculus and 12 credit hours in mathematics and statistics courses numbered above 300, at least 6 of which must be in mathematics. Statistics majors can minor in mathematics but all 12 credit hours must be in mathematics. The Minor in Statistics requires one year of calculus, 12 credit hours in statistics, and an additional 3 credit hours in mathematics or statistics.
- **Honors Program.** Requirements for departmental honors in mathematics or statistics are: (1) a 3.5 GPA in mathematics and statistics courses and a 3.2 overall GPA; (2) application to the department program no later than two full semesters prior to graduation; (3) completion of a project based on 6 credit hours of independent study; and (4,5) a written thesis and oral thesis defense, both presented to the Honors Committee for approval. These requirements are in addition to the major requirements.

2.A.2. *Graduate program.* The graduate curriculum leads to a Graduate Minor in Statistics, or an MS or PhD degree in either mathematics or statistics. Within mathematics, the student chooses one of two concentrations: Pure or Applied. MS students choose either Plan I (26 credit hours and 6 credit hours thesis) or Plan II (32 credit hours and a passing grade on three Qualifying Exams at the MS level or higher).

The following are the program requirements for an MS degree and graduate minor (for more information see the *Graduate Handbook for Mathematics* and the *Graduate Handbook for Statistics* available from the Department's website)

- **Mathematics MS.** The 26-32 credit hours required for an MS in Applied Mathematics are in the areas of linear algebra, numerical linear algebra, ordinary and partial differential equations, and complex variables, in addition to electives listed in the Catalog. In Pure Mathematics, the required courses are in the areas of real and complex analysis, abstract algebra, and topology and geometry, in addition to electives listed in the Catalog.
- **Statistics MS.** A Statistics MS requires a minimum of 26 hours of course work at the 400 or 500 level in statistics and related fields. At least 18 of these hours must be within the Department, and of these at least 12 hours must be at the 500 level. Required courses are in Regression Analysis, ANOVA and Experimental Design, Probability and its Applications, and Statistical Inference. Students must take 14 elective credit hours for Plan I and 20 elective credit hours for Plan II.
- **Statistics Graduate Minor.** We also offer this minor for MS students in other departments; it requires at least 9 credit hours in statistics approved by both the student's home department and the statistics faculty.

Qualifying Examinations are given twice per year. In mathematics, Qualifying Exams are given in each of the following areas: real analysis, complex analysis, abstract algebra, topology and geometry, differential equations, and numerical analysis. Each consists of a 3-hour in-class exam and is based on a sequence of two graduate courses. The Qualifying Exam in statistics consists of one 3-hour in-class exam on probability and statistical inference, and a take-home exam that typically requires, but is not limited to, the analysis of one or more data sets. In mathematics, students can take each of their chosen three exams one at a time. In statistics, students must, on their first try, take the in-class and take-home at the same time. Students entering our program with a Bachelor's degree are expected to take the required courses in their first year of study and take the Qualifying Exams at the end of that year. Students are allowed two attempts to pass their exams.

A Qualifying Exam can be passed at two levels. The MS level counts towards the MS requirements in Plan II. Students need to pass three exams at the PhD level to advance in the PhD program. In addition to passing the Qualifying Exams, the following are the program requirements for the PhD degrees in mathematics or statistics.

- **Mathematics PhD (Pure and Applied).** The PhD in pure or applied mathematics requires a minimum of 18 credit hours beyond the MS degree, taken at UNM. No more than 6 of these may be in a reading or special topics course. In addition, 18 credit hours of dissertation are required, as well as knowledge of one foreign language chosen from French, German, or Russian, and credit for attendance in department seminars or colloquia.
- **Statistics PhD.** General requirements for the PhD in statistics include 18 credit hours of course work above the MS level, no more than 6 of which may be taken in reading or a special topics course. In addition, 18 credit hours of dissertation are required, as well as knowledge of a computer language. Knowledge of a foreign language is not required.
- **Graduate minors.** A PhD student can also obtain a graduate minor in a field different from her/his major area of study, in pure or applied mathematics, or statistics, by taking at least 9 credit hours in that area. Some of these 9 credit hours are electives, others are required, depending on the minor area.

In mathematics, students apply for candidacy in the doctoral program after completing 18-21 credit hours of doctoral coursework and passing all their Qualifying Exams at the PhD level. At that point, the student chooses a Committee on Studies consisting of 3 tenure-stream faculty members, plans projected coursework, and schedules a Comprehensive Exam conducted by the Committee on Studies. The purpose of the Comprehensive Exam is to test the student's foundation in the area in which dissertation work is to be undertaken. Students are expected to pass their Comprehensive Examination within 3 to 4 semesters after passing the Qualifying Exams. In mathematics, the Comprehensive Exam is oral.

In statistics, the Comprehensive Exam consists of a written exam covering core material in Advanced Inference I and II, Linear Model Theory, and Multivariate Analysis and Advanced Linear Modeling. After passing the Comprehensive Exam, the statistics student formally declares a Committee on Studies.

Doctoral students constitute a Dissertation Committee after passing the Comprehensive Exam. This committee is typically, but not necessarily, the same as the Committee on Studies. The Chair of the Dissertation Committee, together with other members, is responsible for directing and advising the dissertation research; overseeing the writing, evaluating, and approving of the completed dissertation; and presiding over the defense. The PhD candidate defends his or her dissertation in an oral presentation to a Defense Committee of 4 members (usually the same as the Dissertation Committee). The final defense is public and open to all who wish to attend.

2.B. **Department teaching contribution.** *Describe the contributions of the unit to other internal units within UNM, such as offering general education core courses for undergraduate students, common courses for selected graduate programs, courses that fulfill pre-requisites of other programs, cross-listed courses.*

This section includes a description of the department's contribution to UNM's general education courses and to other UNM units, as well as cross-listed courses.

2.B.1. *Department's service component.* Over the last 10 years, the Department has taught on average about 46,000 credit hours per year, with a peak of 49,000 credit hours in 2012. This number of credit hours is more than any other *college* on campus, except for Arts & Sciences, of which we are part. As will be shown in Criterion 4.A, over this period the Department had on average about 160 undergraduate majors and 80 graduate students. They can be expected to take, on average, 3-4 courses per year for undergraduates and 5 courses per year for graduates, which amounts to a total of about 3500 credit hours. Hence, most of the 46,000 credit hours are service to students in other Departments. Students in other majors take our 100-200 level courses to satisfy UNM's General Education Core mathematical-reasoning component (10 of our courses can be used to fulfill this requirement) or to fulfill requirements for their majors or minors. Many of our 300-400 level courses are also required by other majors. Finally, we also have students from other disciplines taking our 500-600 level courses.

The enormous demand for and enrollment in service courses necessitates offering multiple sections of these courses. The general education courses include multiple sections of the following.

- **Intermediate Algebra.** MATH 101-102-103, formerly MATH 120. These courses cover remedial K-12 mathematics and are a prerequisite for all other mathematics classes. These courses do not count toward the General Education Core requirement. The material in these courses used to be taught as one 3-credit hour course, MATH 120, in small groups in the classroom. Since 2012 it is taught in the Mathematics Learning Lab (MaLL) as a sequence of three 1-credit hour modules, which have been renamed MATH 101-102-103. A goal of this reorganization was to increase success rates in the course, thereby advancing students through the curriculum more efficiently. Since the change in 2012, the number of credit hours attributed to students taking this course has dropped from 6000-8000 down to its current level of about 4000.
- **College Algebra.** MATH 121. The total number of credit hours in MATH 121 also dropped significantly after 2013, from a high of 7500 to now about 5000 per year. Most likely, fewer students take 121 (with a prereq of 101-102-103) and instead pursue STAT 145 and MATH 129 (with a prereq of only 101-102) to satisfy the General Education Core requirement. This is consistent with the strong rise in credit hours in STAT 145. It has also been a goal of our advisement to direct students who are not on a calculus track into the more appropriate STAT 145 or MATH 129 courses.
- **Trigonometry and Precalculus.** Comprises MATH 123, 150, 153. Enrollment in this group of courses has been fairly steady at about 5000 credit hours per year. These courses are preparatory for calculus.
- **Survey of Mathematics.** Comprises MATH 129. This course is taken by students who most likely will not take another mathematics class, and it satisfies the UNM General Education Core requirement. Since about 2012, enrollments in this class have dropped by about 40%. The data indicate that recently students are choosing STAT 145 over MATH 129. We are moving toward better coordination of MATH 129 sections. Since 2012, we have assigned a course coordinator. The coordinator prescribes part of the final exam, while individual instructors contribute other material reflecting their section's emphases.
- **Introduction to Statistics.** Comprises STAT 145. Enrollments in STAT 145 have increased by about 20% over the last 10 years. The overall increase is by about 1000 credit hours, which is also the overall drop in MATH 129.
- **Calculus I, II and III.** Comprises MATH 162-163-264. Enrollment in this sequence has increased by more than 70% over the last 10-years, from about 4500 to 7800 credit hours per year. This course is the gateway calculus course for engineers and most science majors.
- **Elements of Calculus I, II.** Comprises MATH 180-181. Elements of Calculus is directed toward business and biology majors. Enrollment in this sequence has increased by about 10% over the last 10 years, from about 5200 to 5800 credit hours per year. Note that enrollment in this sequence used to be larger than in the 162 sequence, which is no longer the case.
- **Mathematics Education.** Comprises MATH 111-112-215. These are our 3 Mathematics Education courses until recently required for education majors. (After recent changes in the College of Education, MATH 112 is no longer required for most aspiring elementary school

teachers.) The enrollments have been decreasing since about 2013. This may be attributed in part to loss of faculty in Mathematics Education, from 2.5 to 0.5 FTE.

Upper division mathematics and statistics courses serve a dual purpose as courses for our majors and courses that form essential components of curricula in other disciplines. The 300-level courses that fall in this category are:

- **Ordinary Differential Equations.** Comprises MATH 316. Enrollments in this class have increased by over 30% over the last 10 years, with only moderate dips during times of decreasing University enrollment. Most students in this class are engineering or science majors. The fact that enrollment is large in spite of the fact that the School of Engineering accepts a 200-level course from CNM in its place, speaks to the fact that we are teaching a worthwhile course.
- **Statistics and Probability.** Comprises STAT 345. Enrollments are increasing and have more than doubled over the last 10 years. STAT 345 also has a heavy engineering enrollment. Statistics in now required by ABET and this course provides that component of the engineering accreditation.
- **Linear Algebra.** Comprises MATH 314. This is another service course with a large contingent of engineering students. Enrollments have increased moderately, even though most engineering departments have dropped the linear algebra requirement for their students.
- **Vector Analysis, PDEs, Numerical Methods.** Comprises MATH 311, 312, 375. These applied courses all have strong enrollments, with a slight increase noticeable in MATH 375 (Numerical Methods).

Several of our graduate courses often have a substantial engineering enrollment. Among them are linear algebra, numerical analysis and differential equations courses. We formally cross-list the following courses with the Computer Science Department.

- Introduction to numerical computing, MATH 375/CS375.
- Introduction to parallel computing, MATH 471/CS471.
- Introduction to numerical linear algebra, MATH 504/CS575.
- Introduction to numerical analysis, approximation and differential equations, MATH 505/CS576.

At present, the Philosophy Department teaches two courses that are cross-listed

- Symbolic logic, MATH 356/PHIL356.
- History and philosophy of mathematics, MATH415/PHIL415.

2.B.2. *Service courses offered in collaboration.* The Department also collaborates with multiple programs and units to offer specialized sections for specific populations. These sections run regardless of enrollment numbers. At UNM West we collaborate to offer MATH 101, 102, 103, MATH 121, MATH 129, MATH 162, and STAT 145, by contributing Human Resource (HR) services and main campus instructors. Courses at UNM West rarely meet minimum enrollment. Moreover, since these courses can put instructors over their FTE maximum, they can impact the number of sections and courses we can offer on main campus. Also, the College pays for these courses.

The Department also collaborates with two programs from North Campus: BA/MD and the HSC Office of Diversity to offer special sections. For BA/MD, MATH 121, MATH 180, and MATH 181 sections are designated for their specific population. These courses traditionally meet enrollment minimums or the program opens the section to the general population. BA/MD provides 50% of the instructor and teaching assistant's salaries. The Department provides the other half. HSC Office of Diversity offers a Summer program housed in our MaLL offering courses in MATH 101, MATH 102, MATH 103, and MATH 121. HSC pays 100% of a main campus mathematics or statistics instructor's salary. They are solely responsible for recruitment, cost of software, and registration.

The department offers support in scheduling, HR processes for the instructor, and use of all MaLL resources.

African American Student Services and American Indian Student Services also offer summer bridge programs to help student populations get a head start in mathematics the summer before they start at UNM. They offer MATH 101, 102, 103, 106/107, and MATH 121. In efforts to offer a similar head-start opportunity for the general population, the Department offers, to eligible students, an 8-week section of MATH 101 that runs in the second half of the semester. The College of Arts & Sciences pays the salary of this mathematics/statistics main campus instructor.

More recently (Fall 2016 and Spring 2017), we are offering a number of seats in a section of MATH 153, MATH 162, and MATH 163 for students in the Navy ROTC program. The instructor and TA are paid for by the Department.

The Department also participates in the interdisciplinary Nanoscience and Microsystems Engineering Program and the Computational Science and Engineering Certificate Program for graduate students. Respectively, see the following.
`http://nsme.unm.edu/about/index.html`
`http://www.carc.unm.edu/education-outreach/cse-certificate-program/index.html`

2.C. **Modes of delivery used for teaching courses.** *Describe the modes of delivery used for teaching courses.*

2.C.1. *Class size and staffing.*

- 100-200 level mathematics courses have on average 40-55 students per class. 300-400 courses have on average 25-45 students. 500-600 courses have on average 12 students; with some courses having as many as 30.
- Class sizes in statistics are generally larger than in mathematics.
- Class sizes in the MATH 162-163-264 calculus sections are the highest of all, with STAT 145 a close second.

Here we comment on the faculty distribution in our classes

(1) In mathematics 90% or more of the 500 level courses are taught by research faculty. We have had numerical analysis, MATH 505, taught by a SNL researcher or a retired SNL researcher.
(2) In mathematics only 70-80% of the 300-400 level courses are taught by research faculty. Research faculty include all tenure-stream faculty, as well as research visiting professors, and research postdocs, including the MCTP postdocs at 4 courses/year for 2013-2014, and 2 courses/year for 2012, 2015. It does not include lecturers, contingent faculty, and graduate students. Overall, in mathematics there are 10-18 sections of 300-400 level courses that are not taught by research faculty. We view this as unacceptably high.
(3) The percentage of research faculty teaching calculus is unacceptably low. The coverage includes the calculus coordinator and the faculty member in the BA/MD course, for a total of 2-3 sections per year. We should have at least 2-3 faculty teaching the 180 and 162 sequence each semester, that is, 4-6 faculty per year. Furthermore, junior faculty should be teaching these courses, in order to better understand our student's backgrounds.
(4) In statistics the percentage of 300+ courses not taught by faculty was very high around 2008-2009. With increased hires in statistics, the situation has improved. More recently, there are about 4 statistics courses not taught by research faculty. With a successful upcoming hire, this situation will improve.

Summary. Our non-research faculty and many graduate students do an excellent teaching job, including in several 300-level courses, and graduate students benefit significantly from this experience as well. However, we need to find the right balance. Currently, we are unable to adequately teach and lead the content of our courses to help prepare our students at all levels, which leads to uneven quality of our offerings to our students.

It is important that research faculty teach students at all levels. It is also important for research faculty to get to know the students at 100-200 levels so they better understand the students' background and needs in the 300+ level courses. Involvement of research faculty in our preparatory courses can help guide the content of these courses and enable them to mesh better with upper division offerings. Research can help place material in context of upper level courses and its uses and extensions in research, which can serve as a stimulant and motivator for students.

2.C.2. *Methods and delivery modes.* A variety of teaching methods and delivery modes are used throughout our courses.

- **Self-paced, computer-aided.** MATH 101-102-103. As mentioned, Intermediate Algebra is a self-paced sequence of 3 1-credit hour courses held in the MaLL. This sequence replaced the 3 hour traditional classroom-style MATH 120 course in 2012. The MaLL courses use the ALEKS online system to guide students through mathematics topics. Topics must be mastered before a student can move on to the next course. Once all topics are complete, students take an exam to determine their grade. The MaLL is open six days a week; students can complete all topics in less than a semester. For students who finish this sequence mid-semester, two sections of MATH 121 are also offered as a self-paced course using ALEKS in the MaLL. Students in the MaLL are not expected to learn the material on their own. They are offered multiple resources. Every section is assigned an instructor who coordinates the administrative processes in ALEKS, and who is available for questions. In addition to instructors, the MaLL employs peer mentors/tutors who are available to answer questions at any time the MaLL is open. Intermediate Algebra has seen a significant increase in pass rates since the MaLL was introduced. The Office of the Provost has analyzed data which suggests that students in MATH 121 have done better since the changes were instituted in the preceding course.
- **Coordinated courses.** All of our 100-200 service courses are coordinated. All sections share a common syllabus and a list of homework problems. Homework is not generally collected (except in the 4-credit hour courses) due to lack of personnel. Most courses share a common final exam. These classes are coordinated by the Department's lecturers (except for 162-163-264) and mostly taught by contingent faculty.
- **Courses with recitation section(s).** These courses are 4-credit hour courses, with 3 hours/week in lecture with a faculty instructor and 1 hour/week in a recitation led by a graduate student. The MATH 162-163-264 calculus sequence and MATH 401, the advanced calculus course for our majors, are examples of this delivery mode. In the calculus sequence the class sizes are large (50-60 students on average, and the recitations are half that size. Homework and syllabi are common to all sections.
- **Courses with PLFs.** Several sections of MATH 121, MATH 150, MATH 153, MATH 162 use Peer Learning Facilitators (PLFs) supported by UNM's Title V project. These more advanced undergraduate students are in the classroom to interact with the students, to explain the material, and to help with problem solving.
- **Traditional lecture style courses.** Many such courses, however, incorporate elements of group work, flipped classrooms, technology, web-enhancement, and other innovations within the traditional setting.

- **Flipped Courses.** The department is continuously piloting new innovative modes of delivery. In STAT 145, Professor Erik Erhardt is piloting a flipped classroom pedagogical strategy.
- **Courses with large active learning component** Both STAT 427 taught by Professor Erhardt and the MATH 180-181 special sections for biologists taught by Helen Wearing have incorporated a large component of collaborative learning, including the use of in-class group assignments. In 2016-17, Professor Wearing's sequence is being taught in one of UNM's learning studio classrooms.
- **ITV.** The department also offers courses online and through ITV. MATH 101, 102, 103, MATH 121 (2 sections) are offered online using the ALEKS system. STAT 145 is offered online using the UNM Learn system. In addition to online, ITV sections offer courses (M327, M579/S579, and M316) to students at sites such as UNM Los Alamos and Sandia Laboratories.

Reflective questions.

Extension of 2.A. There appear to be very few tenure-track faculty teaching lower division courses. Would students in lower-division courses benefit from occasionally learning from tenure-track faculty in these courses? Are there particular discipline-specific impediments to this possibility?

The sole impediment is lack of sufficient numbers of faculty to staff these courses. It is important that research faculty occasionally teach students at all levels. It is also important for research faculty to know the students at 100-200 levels, in order to better understand their students' background and needs in the 300+ level courses. Involvement of research faculty in our preparatory courses can help guide the content of these courses and enable them to mesh better with upper-division offerings. Research faculty have the mathematical depth to place even lower-level material into broader context. These contributions are often small insights in the larger scheme of the course curriculum, but they can stimulate and motivate students.

Extension of 2.A. Which skills that are outlined in the new NM HED Core structure would the unit's undergraduate curriculum align with and target? Explain what innovative practices could be implemented to ensure students are able to better achieve these skills?

The critical skills outlined in the HED Core structure are: communication, quantitative reasoning, critical thinking, information literacy, and personal & social responsibility. Although it is planned for mathematics to address quantitative reasoning and critical thinking, all of these skills are aligned with and are targeted by our undergraduate curriculum. Criterion 1 articulates our goals, and Criterion 3 discusses the student learning outcomes for our courses. These goals and outcomes clearly align with and promote the targeted skills. Earlier in this section, we detailed the various innovative modes of course delivery currently in use. Criterion 4 addresses course and program assessment and our efforts to continuously evaluate and refine our practices.

Extension of 2.B. Regarding Math 153, would it be possible to create a "parachute" plan for students passing either the Math 123 or Math 150 portion?

We have not as yet determined a "parachute", *per se*. Currently, there are essentially two tracks. The two-semester sequence, MATH 123 – MATH 150, serves students who need a more deliberate pace. While MATH 153 is a relatively new course that allows students to take a single 5 credit, 1 semester course covering the same material.

We may be able to organize MATH 153 in order to distinguish which portion needs to be repeated should a student not succeed at the faster pace. Then, the student could potentially take only one of MATH 123 or MATH 150 to complete the requirements.

Extension of 2.B. Math courses generally serve as the most important "gateway" courses to all STEM disciplines. What can be done to improve the Math success rates (i.e., passing grades and improved learning outcomes) of students in other STEM majors? In your view, are the mechanisms sufficient for collaborating with other departments regarding the math needs of their students? What could be done to improve these collaborations? What plan do you have in place to ensure that the instructional staffing is adequate to deliver sufficient number of sections needed to meet the requirements of GenEd and the major?

The Department strives to meet with client departments to discuss their needs. For example, our regular meetings with the Physics & Astronomy Department resulted in better coordination of our courses with their curriculum through adjustment of the MATH 162-264 calculus syllabi to better mesh with PHYS 161 which students often take concurrently with MATH 162. We have met with engineering faculty and the Associate Dean in the past regarding curricular needs. These meetings could certainly be more frequent. Recent meetings with the Associate Provost have led to scoping a combined MATH 153/ENG 120 course.

There is no particular mechanism in place for collaborating with other departments, other than the good will of the faculty. This works well for more routine adjustments to the curriculum. However, since there are many pressing demands on our time, it is not often easy to carve out sufficient time for meetings. Thus major initiatives need to be supported institutionally. Release time for faculty to research issues and formulate solutions is essential in this case.

Staffing levels are entirely beyond our control. As we have documented in this study, we do not feel that current staffing is adequate. Allocation of new tenure-stream and lecturer hires is not in the Department's purview. Regarding contingent faculty, each semester we work with the Dean's Office to determine the budget for temporary, part-time hires. It is our understanding that there is no budget line that covers these hires, and funds must be carved out of the College budget each semester. It is these discussions that determines the number of sections that can be offered.

Extension of 2.C. The Department of Mathematics and Statistics offers very few online Algebra courses. Thus, many of our students have started to take the online math classes offered at the UNM branch campuses. Does the department have plans to create additional online sections to meet students' demand?

- *If so, what are the timelines for implementation of the plans?*
- *If not, provide an explanation as to why.*

This has not been on the front burner. If student demand is being met by the branch campuses, it may not be necessary to duplicate efforts. Nevertheless, we are open to considering this option, but would like to examine data regarding the effectiveness of the approach and the resources required.

Criterion 3: Teaching and Learning: Continuous Improvement

The unit should demonstrate that it assesses student learning and uses assessment to make program improvements. In this section, the unit should reference and provide evidence of the program's assessment plan(s) and annual program assessment records/reports. (Differentiate for each undergraduate and graduate degree/certificate program and concentration offered by the unit.)

This criterion describes assessment of our student's learning and the program improvements made in response. Our teaching program has three primary components: our service courses, undergraduate courses for majors, and graduate courses. The largest component is that of service courses at the 100-200 level, with about 40,000 credit hours per year, as opposed to about 7,000 at the 300+ level. Most of our assessment has focused on these early preparatory courses, as described in Criterion 3.A. Criterion 3.B synthesizes the impact of the program's assessment activities. Criteria 3.C and 3.D are auxiliary sections not mandated by the APR Manual. Respectively, they discuss assessment of our undergraduate program for majors and our graduate program.

3.A. **Assessment and evaluation of learning outcomes – preparatory MATH and STAT 100- and 200-level courses.** *Describe the assessment process and evaluation of student learning outcomes for each program by addressing the questions below.*

- *What skills, knowledge, and values are expected of all students at the completion of the program (refer to learning goals outlined in Criterion1)?*
- *What are the student learning outcomes for the program?*
- *How have the student learning outcomes been changed or improved?*
- *How are the student learning outcomes clearly defined and measurable?*
- *How are the student learning outcomes communicated to faculty and students?*
- *What current direct and indirect assessment methods are used to evaluate the extent to which students are meeting the student learning outcomes?*
- *How have the programs assessment methods been changed or improved?*

The Department has designed the courses in the core sequence (MATH 121-264, and STAT 145) to provide coherent and effective instruction for students in a variety of majors and programs. We expect our students to effectively use quantitative and symbolic reasoning and analysis. Our goal is to prepare them to succeed in their future studies and to incorporate analytic reasoning in their everyday decisions; see the broad program goals for both mathematics and statistics itemized in Criterion 1.C. The Student Learning Outcomes (SLOs) describing what a student should be able to do at the end of each mathematics course are posted online (see `http://math.unm.edu/courses/materials`), as well as on each course's main website. They provide a focus and a standard for the classroom, both for the instructor and the student. The extent to which we achieve the goals stated in the SLOs is assessed as described herein.

All courses at this preparatory 100-200 level, except as noted, have the following in common: they are coordinated by a faculty member, and they have a common final exam which is graded uniformly, with exception of MATH 123, 111, 112, 215 (all of which have no common final), and MATH 129 (part of the final is common). In addition, all mid-semester exams in STAT 145 are common as well. Student learning is assessed in terms of performance on the common exam. Details of the assessment in individual courses in this preparatory level are described next. An annual report of these results is provided by each coordinator to the University's Assessment Office.

3.A.1. *MATH 111-112-215.* All instructors who actively teach one of these Math Education courses meet approximately every month during the Fall and Spring Semesters. One purpose of these meetings is to discuss assessment of SLOs. The instructors agree on one common question per exam and establish a common grading rubric. After each exam, they discuss the student results and brainstorm about how one might improve student success. Some ways the courses have been altered include: changing the syllabus to allow for more time on difficult topics, sharing teaching strategies that proved successful for one instructor, and adjusting the homework.

3.A.2. *MATH 121.* We have been assessing with two questions on the common core exam. To meet the SLOs students had to demonstrate: 1. That they could accurately compute the inverse of a function using algebraic techniques and 2. that they could accurately graph a rational function and specifically label the intercepts and asymptotes of the graph.

3.A.3. *MATH 123.* MATH 123 does not satisfy UNM's General Education Core requirements, and we do not do assessments for this class. Mainly for historical reasons, this course has no common final exam. It used to be a 2-credit hour course when a common final was difficult to implement in practice. These particular aspects of this class should be revisited.

3.A.4. *MATH 129.* Assessment data is collected from a core portion of the final exam. Each section's final exam contains 25% written by the 129 coordinator that addresses core SLOs. The coordinator provides a grading rubric for these problems, which equally weigh accuracy in the problem solving process and communication of mathematical information in an organized, clear manner with appropriate notation. The data is examined across all sections, and strengths and weaknesses in student learning are determined. These are addressed in the plan for the next academic year. The academic plan during the school year is managed by quarterly meetings each semester among all 129 instructors, where updates on successes, difficulties, new processes, and new techniques are shared.

3.A.5. *MATH 150.* Assessment is performed by selecting a problem on the final exam that can be directly linked to one of the SLOs for MATH 150. The coordinator for MATH 150 grades that problem. After the finals are graded, the total score for the final and the corresponding score for the SLO are recorded. The scores for the final and the SLO problem are broken into 3 categories: Good, Fair, Poor. A 3×3 matrix is created which records the number of students falling into the resulting 9 categories. This data is also useful in assessing the SLO problem relative to the overall exam.

3.A.6. *MATH 153.* We have been assessing one question on the common core exam. To meet the SLOs students had to demonstrate that they could accurately compute the inverse of a function using algebraic techniques.

3.A.7. *STAT 145.* The STAT 145 instructors meet as a group six times each term. At the fifth meeting the group reviews the draft of the upcoming final exam, and the coordinator presents results from the previous term's assessment. After a discussion, the group selects a subset of the student learning outcomes to be assessed, and recommends possible curricular changes to be implemented in subsequent terms, and possible changes to the assessment process itself. The selected SLOs are representative of course core competencies and essential skills that students should be able to perform after taking STAT 145. Since Fall 2013, three essential questions on Test of Significance, Confidence Interval, and Parameter/Statistic Definition have been selected to be measured every term. At least one other question was recently added for assessment each term. The sixth group meeting each term is the final exam grading session. Here, the SLOs are assessed by choosing one page on the exam and recording the grades for a randomly chosen subset of final exams (seven exams per STAT 145 section). The resulting data is analyzed using histograms, and pass rates for the selected questions are compared to pass rates from similar questions from previous terms. Pass rates for the final exam score (not the course pass rate) generally lie within 70-80%.

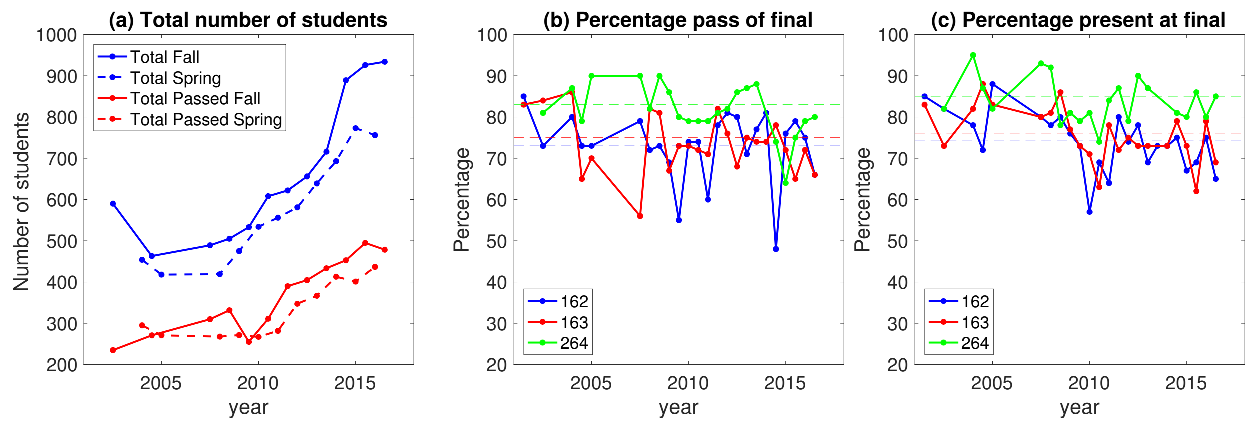

FIGURE 1. (a) Number of students in Fall/Spring Semesters in all of 162-163-264, and number of students that passed with a C or better. (b) Percentage of students passing the course out of those students that took the final exam. (c) Percentage of students present at the final exam out of those students present in week 3.

3.A.8. *MATH 180-181.* Assessment data for both courses is obtained by selecting a set of problems on the common core final exam reflecting a specific SLO. Different SLOs are selected each academic year. Each student's performance on the selected problems is given an SLO score, graded either 1 or 0, according to whether they received 70% on the problems or not. The final exam score is then paired with the SLO score to produce a 2×2 matrix of pass/fail SLO versus pass/fail final exam. In meetings during the in-service week at the beginning of each semester, the results are shared with all instructors to enhance the attention paid to the addressed topics.

3.A.9. *MATH 162-163-264.* Our sequence of Calculus for Engineers serves about 2000 students a year (8000 credit hours) and forms an important gateway for students majoring in engineering, physics, chemistry, biochemistry, earth and planetary sciences, as well as mathematics. Our goal is to prepare students so that they understand and can apply basic concepts to problems arising in applications, even if the problem is stated in a form unlike a standard textbook question, or contains redundant information, or is stated out of context of the current section covered in class. In addition, we aim to improve the student's basic algebra, graphing and mathematical writing skills as they progress through our sequence. We continuously assess our success in accomplishing our goals and make improvements in response, as follows:

(1) *Evaluation of skills based on individual and common final exam results.* The group of instructors meets repeatedly during the semester and during the final exam grading. They discuss weaknesses observed in their classes. In response, the group makes curricular changes, if necessary, by redistributing the time alloted to various topics in the syllabus, and by revising the homework problems. Recently, we have also added mixed-review problems to the daily homework problems that reinforce areas of weaknesses, out of context of current material. Weekly quizzes are more closely geared to reinforcing the homework problems.
(2) *Similar expectations across sections.* All sections use the same syllabus and homework set, the same policy for quizzes, homework collection, grading scheme, and common final exam. All instructors place their mid-semester exams in a Dropbox to be viewed by all others, which helps adjust the level of the exams to a common median. The final exam sets a common curve for all sections.
(3) *Passing rates.* We have been tracking total student numbers in this calculus sequence and student passing rates for over 15 years. **Figure 1**(a) plots the total number of students in

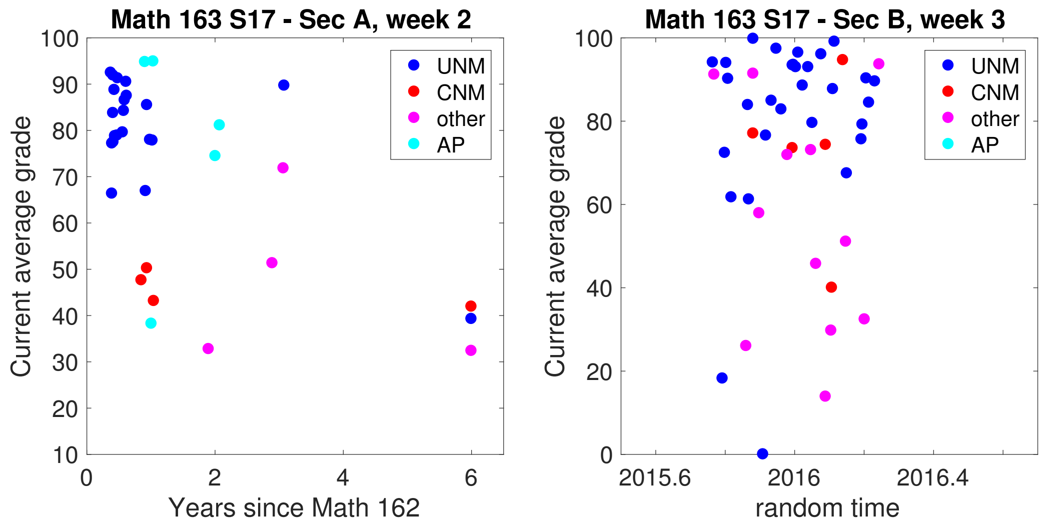

FIGURE 2. (a) Current grade in week 2 in one section of MATH 163 vs the number of years since the student took the MATH 162 prereq, separated by where the prereq was taken. (b) Same information at week 3 for another section. However, information on the number of years was not available.

the Spring and Fall Semesters, as well as the number of students that have passed with a C or better. It shows that enrollment in this sequence has increased significantly since 2010, even in recent times when university enrollments have been decreasing. The number of students passing with a C or better has increased in rough proportion. **Figure 1**(b) shows that out of the students that finish a course and take the final exam, about 70-85% pass, on average, with increasing rates for higher level courses in the sequence. We do however lose a number of students who, due to lack of preparation, drop the class before the final exam. **Figure 1**(c) plots the percentage of students present by the end of week 3 (after which they have to pay for the course) that take the final exam. This percentage rate has decreased during the recent years of increased enrollment for this sequence, indicating that as the enrollment increases, students are overall less prepared. This fact may be coupled to the placement policies of the University, to which we are, however, not privy.

(4) *Success in the follow-up course.* We have recently begun to statistically track success of our students in follow-up courses. **Figure 2** plots the current grade of students in two sections of MATH 163 and distinguishes the institutions where the student took the MATH 162 prereq, as well as when it was taken (in the case of **Figure** 2(a)). The grade this early in the semester, based on quizzes and homework, is a good indicator of the students chance of success. The data indicates that students that have taken 162 recently at UNM are doing well, with current grades over 60%, while students that have taken it elsewhere have to overcome some deficiencies. We will continue to collect this data throughout the semester. The Office of the Provost (by personal communication of Associate Provost Heileman) also has data indicating that students coming from our classes perform better than those coming from elsewhere, but again, we are not privy to this information. We do, however, view the plots given here as an indication of success of our efforts.

(5) *Continuous feedback and communication between instructors.* All faculty teaching the calculus sequence meet and interact on a regular basis, sharing feedback on problematic issues, or anything they view can be improved.

(6) *Interdisciplinary meetings with faculty in UNM's Department of Physics and Astronomy.* We have met with physics faculty to raise awareness on both sides of the material we each cover. As a result of these meetings, we have changed our syllabus to cover differentiation earlier so students in PHYS 160 are better prepared when they need this material. Moreover, we are introducing the harmonic oscillator as part of the section on differential equations, which will help physics, engineering, and mathematics students. We hope to have similar productive meetings with faculty in engineering, biology, and business.

3.B. **Synthesis of the impact of the program's assessment activities.** *Synthesize the impact of the program's annual assessment activities by addressing the questions below.*

- *How have the results of the program's assessment activities been used to support quality teaching and learning?*
- *How have the results of the program's assessment activities been used for program improvement?*
- *Overall, how is the program engaged in a coherent process of continuous curricular and program improvement?*
- *How does the program monitor the effects of changes?*

Assessment of our preparatory 100- and 200-level service courses is extensive, and we have learned much about our students. Assessment results have led to improved course content, syllabi, and assigned problems to better serve out students. In all, these constitute program improvement. However, the current course sequences have been in place for over 30 years. Our student's preparation and needs, as well as the realities of the work environment we are preparing them for, have since changed. Faculty familiar with these courses are interested in critically re-evaluating and re-designing these sequences from scratch; we are discussing a plan to this end.

Assessment procedures for our undergraduate majors and our graduate program are in their early stages (descriptions are given in the next two subsections); as yet, they have not spurred significant changes in our program. However, the dialogue surrounding these procedures and student learning outcomes has yielded better understanding among the faculty of expectations for student performance. We expect that our developing assessment plan will prove integral for continuous improvement of our programs.

3.C. **Assessment of the undergraduate program.** Formal processes for program-level assessment are still in their infancy within the Department. In the academic year 2015-16 the Undergraduate Committee crafted broad program goals and measurable student learning outcomes (SLOs) for all undergraduate majors within the Department. This was complemented by an assessment plan which evaluates student performance in achieving these outcomes. The SLOs emphasize knowledge, problem solving, communication, and skills for employment or graduate school. The plan was formulated in close consultation with both the Department's faculty and the Assessment Committee within the College. It was approved by faculty vote in May 2016. The Undergraduate Committee is carrying out the assessment measures this 2016-2017 academic year. Appendix E is a copy of the assessment plan with the SLOs.

Direct measures of assessment within the assessment plan involve data collection in a selection of courses where student achievement on program-level SLOs can be meaningfully measured. Each semester, a different slate of courses will be chosen so that all SLOs are covered in a 3 year window. Instructors of these courses are expected to aggregate data from graded work throughout the semester, in order to report on the number and percentage of students performing at an "excellent", "very good", "satisfactory", "questionable", or "unacceptable" level, as it pertains to each SLO relevant to the course. In order to foster uniformity of the process, rubrics are given to the instructors so that there is a clear indication of what constitutes a given performance tier, see Appendix

F for examples. These measures are complemented by an indirect method of assessment, whereby students respond to a survey which asks them to self-assess their achievement on these SLOs.

In addition to the direct measures outlined above, exit surveys are given to the graduating students. These ask students to self-assess their achievement on these SLOs after program completion, and they poll students regarding their future plans.

The results from data collection and surveys will be compiled by the Undergraduate Committee and synthesized into a yearly report to be submitted to the Office of Assessment. The report will also be circulated to the faculty, and its content will be presented and discussed at a faculty meeting. This will give an opportunity for faculty to understand expectations for the program and, as a byproduct, the courses within. It also will lead to avenues for improvement in the curriculum design, assessment mechanisms, and pedagogy.

SLOs are communicated to students and faculty through course syllabi, announcing expectations for homework and exams, graded coursework, and advising. The Department has posted its assessment plan, which includes all SLOs on its website and also the College's assessment website. The self-assessment component of the above procedures also provide a means of communicating SLOs to students.

3.D. **Assessment of the graduate program.** Program assessment at the graduate level is still under development, with SLOs and formal assessment measures being discussed within the Graduate Committee this academic year. The SLOs at the graduate level are expected to have much in common with those at the undergraduate level, emphasizing knowledge, problem solving, communication, and preparation for employment in industry or academia. However, in addition the graduate-level SLOs are expected to address proficiency in independent research for thesis-based master's degrees and doctoral degrees.

We expect plans for assessment of our graduate programs to formalize and expand upon in-place procedures, described shortly. Further assessment will hopefully focus and enhance the dialogue which already occurs concerning the achievement of our graduate students. As with assessment at the undergraduate level, it is anticipated that yearly faculty meetings will provide an opportunity to consider avenues for improvement within the program.

3.D.1. *Current assessment practices.* Our Department already has infrastructure in place for assessment of graduate degrees. First, student learning is assessed in graduate classes through challenging homework assignments, exams, and possibly end-of-term projects. Second, for each of our groups (Applied Mathematics, Pure Mathematics, and Statistics) an established and well-tended system of qualifying exams is in place. Third, PhD students must pass a comprehensive exam.

The subject matter and expectations for the qualifying exams varies over the three groups, but precise details may be found in the *Graduate Handbook for Mathematics* and the *Graduate Handbook for Statistics*, each downloadable from the Department's website. Qualifying exams apply to both the MS and PhD degrees, but we also support a thesis-option MS. The faculty meets every semester to discuss the results of the qualifying exams at both MS and PhD levels. This already creates a dialogue concerning the achievement of our students towards learning outcomes that are commonly recognized by the faculty as being important. The nature of our PhD comprehensive exam differs between mathematics and statistics; again, precise details are found in the handbooks. Nonetheless, through these exams faculty assess whether students have sufficiently mastered the recondite background material necessary to attack their proposed research problem. At this level, a faculty advisor and committee members assembled for the exam may learn as much as a PhD candidate, especially if the proposed research arises from an emerging field.

Dissertation defenses (and thesis defenses for thesis-option MS students) provide a further means of assessing student achievement, although formalization of set outcomes would seem elusive (candidates discover new knowledge). Finally, the Graduate Committee regularly tracks the career paths of graduate students; see Appendix B for a list of recent graduates and their current positions. The ultimate assessment of a PhD dissertation is whether the research yields peer-reviewed publications; see Appendix B which shows that our students are successful by this measure.

3.D.2. *Ten-year window on our graduate program.* To assess the success of the graduate programs thus far, we have asked the following questions.

- Are our MS and PhD graduates by and large employed in jobs directly related to their obtained degree?
- Are our MS and PhD graduates contributing to society with the skills acquired in our program?

To answer these questions in a quantitative and qualitative way, we collected information regarding our MS and PhD alumni in a 10 year window (Fall 2006-Summer 2016); see Appendix B. Among the 156 students who received their MS in Mathematics (88) or Statistics (68) in that window, more than 75% are working in areas related to their expertise, whether doing research; teaching; working in industry, financial, or government institutions; and/or pursuing PhDs in related fields. The remainder are students that we could not track down, except for 3 who are not working in mathematics/statistics related areas (see Sections 1.2 and 2 in Appendix B). Among the 66 students who received their PhD in Mathematics (44) or Statistics (22), 94% are working in areas related to their expertise, whether doing research; teaching; or working in industry, financial, or government institutions (see Sections 1.3 and 3 in Appendix B). Many of our PhD alumni (80%) have contributed to the body of mathematical and statistical knowledge, as measured by published papers resulting from their graduate research while at UNM. We have on record about 100 publications in peer-reviewed journals (see Sections 1.4 and 4 in Appendix B).

By and large, our graduates are working in jobs related to their degrees; many are contributing to society by educating younger generations in STEM areas, and by producing valuable scholarly work. Furthermore, when this data is coupled with the comparison to our peer institutions (see section 8.A.5 on PhD production), using data normalized by the number of faculty (ours is one of the smaller departments) and taking into consideration our teaching load (see `http://www.ams.org/profession/leaders/culture/CultureStatement11.pdf`), we are working miracles (see `http://www.ams.org/meetings/CultureStatement12.pdf`) in maintaining a competitive graduate program.

3.D.3. *Assessment of TAs.* Through their assigned duties, graduate student TAs learn skills of vital importance for their future careers. We assess and support our TAs as follows.

- New Teaching Assistants also meet with their class coordinators during in-service week. In this meetings an initial assessment is made in terms of the student's ability to teach, and if necessary they are switched to grading. Coordinators and/or instructors (when TAs are teaching a calculus recitation session) will closely watch the new TAs.
- For the last 9 years we have offered an in-house Teaching Seminar every fall, as a support network for our new TAs. Over the last 5 years this has been supported by an NSF-MCTP grant. Information regarding this seminar is available at `http://www.math.unm.edu/mctp/gstts/2014/`
- New TAs have to make 5 class visits of peers and exemplary instructors. Their classes will also be visited and feedback provided.
- Recitation session instructors, and instructors for 3-4 credit hour classes receive student evaluations like every other instructor. They may distribute different surveys/evaluations during the semester.

- The best TAs who are also excelling academically are nominated every year for university-wide teaching awards, and a Department TA usually receives one of them each year. Between 4-5 TAs are selected by the Graduate Committee and nominated by the Department Chair, based on excellence in teaching and in academic performance.

Criterion 4: Students (Undergraduate and Graduate)

The unit should have appropriate structures in place to recruit, retain, and graduate students. (Differentiate by program where appropriate.)

This Criterion describes our undergraduate and graduate admission and recruitment processes (including transfer articulation), student populations, advisement, support services provided by our Department, and initiatives taken by our Department to support our students and help them succeed (retainment). Admissions, recruitment and transfer articulation are adressed in 4.A. Our undergraduate majors and graduate student populations are described in 4.B. Criterion 4.C describes advisement. Criteria 4.D and 4.E describes services and initiatives taken by the Department to support our students, at all levels. Since there is no clear distinction between these two, we list them combined in one section, Criterion 4.E. Criterion 4.F documents the success of our graduate students.

4.A. **Student recruitment, admissions, and transfer articulation.** *Provide information regarding student recruitment and admissions (including transfer articulation).*

4.A.1. *Admissions.* Requirements for undergraduate admission are determined by the College of Arts and Sciences and the Department of Mathematics and Statistics: a minimum of 26 credit hours and a cumulative grade point average of at least 2.00 on all work, completion of the University Writing and Speaking Core, the University Mathematics Core, the University Foreign Language Core, and the Department of Mathematics and Statistics admission course work, completion of MATH 163 with a grade of "C" or better.

Graduate admissions are determined by the Graduate Committee, who review the following credentials: three letters of recommendation, the student's letter of intent, and the student's history and GPA in mathematics and statistics courses. The Department offers graduate support in the form of Teaching Assistantships (TA), with funding for the for the top candidates. Teaching Assistantships are distributed as evenly possible between the concentrations (Pure, Applied, and Statistics). Admitted students can also be offered Research Assistantships (RA) sponsored by faculty.

4.A.2. *Recruitment.* Efforts to recruit undergraduate majors include: (1) Advisors from Arts & Sciences and from the Department staff tables at student recruitment events. (2) High school students are invited each year to participate in the UNM-PNM contest, raising awareness of our program. (3) Each year the Department supports the attendance of many students in the yearly Southwestern Undergraduate Mathematics Research Conference (SUnMaRC). (4) Supported by two NSF-MCTP grants, the Department has offered a month-long summer math camp during seven years between 2008 and 2016. After participation in these camps several non-majors have decided to pursue a career in mathematics or statistics. (5) The NSF-MCTP grants also supported an outreach program in which our undergraduates visit high schools and middle schools in the Albuquerque area.

Graduate student recruitment has been supported by two Graduate Studies Recruitment grants ($1500 in 2013, $1000 in 2015) enabling visits of potential graduate students. Our Applied Mathematics group has also produced a flier summarizing the groups expertise and has emailed it to mathematics departments across the country.

4.A.3. *Transfer articulation.* This Department has been one of the most proactive at UNM when it comes to transfer articulation. On our website, we have an online form for students to submit transfer equivalence requests. The course is reviewed by the Department, and any equivalences are immediately logged with the main transfer database in the Registrar's Office. We have also opened up our system to be used by other disciplines. Students can submit requests for equivalence

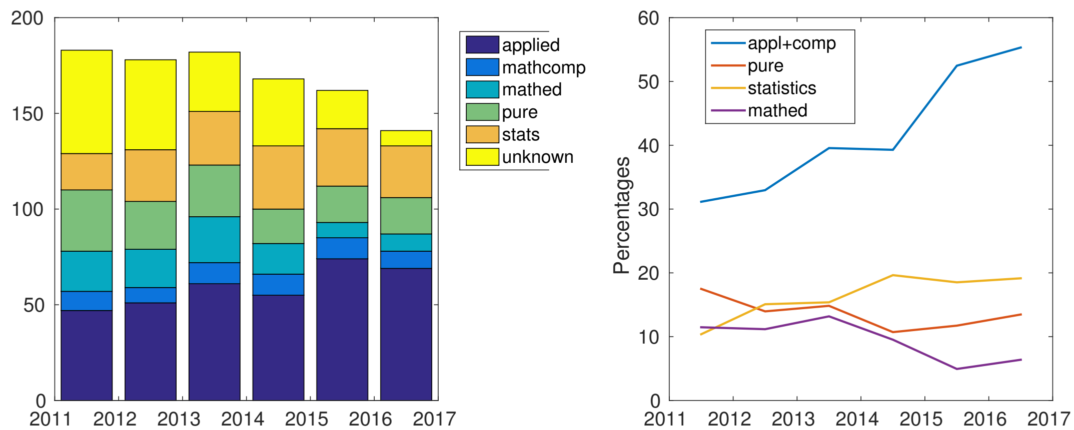

FIGURE 3. (a) Total number of undergraduate students in program, separated by major. (b) Percentage of undergraduate students in our different concentrations. Data obtained from UNM for 2007-2011 was faulty and could not be included.

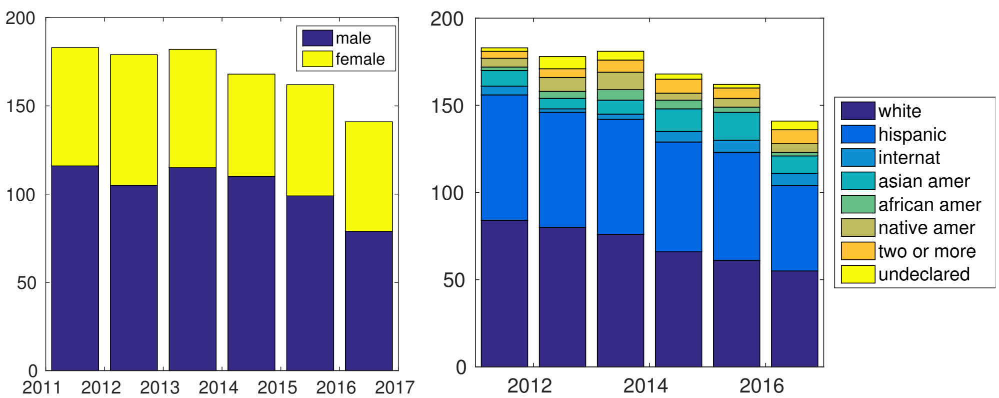

FIGURE 4. Composition of undergrad student body. (a) Number of female students. (b) Declared minorities.

review and also main database archival of any course at UNM. Since Math and English courses are the most transferred core courses to UNM, it was imperative for our Department to populate the Transfer Evaluation System (DARS) as quickly and accurately as possible. Courses were reviewed by both the Department advisor and the undergraduate committee Chair. Our faculty has taken an active role in creating efficient transfer articulation processes for Math and Stat courses. Karen Champine, Lecturer, has been working with the NM HED to ensure common Student Learning Outcomes for mathematics and statistics courses across NM institutions.

4.B. **An analysis of enrollment trends, persistence, and graduation trends.** *Provide an analysis of enrollment trends, persistence, and graduation trends.*

4.B.1. *Undergraduate Students.* This section describes the size and composition of our undergraduate student body. **Figure 3**(a) shows the total number of undergraduate students in our program for 2011-2016, as well as the number in each concentration. We note that data for 2007-2011 was faulty and was therefore excluded. The figure shows that on average the undergraduate program has had about 160 majors.

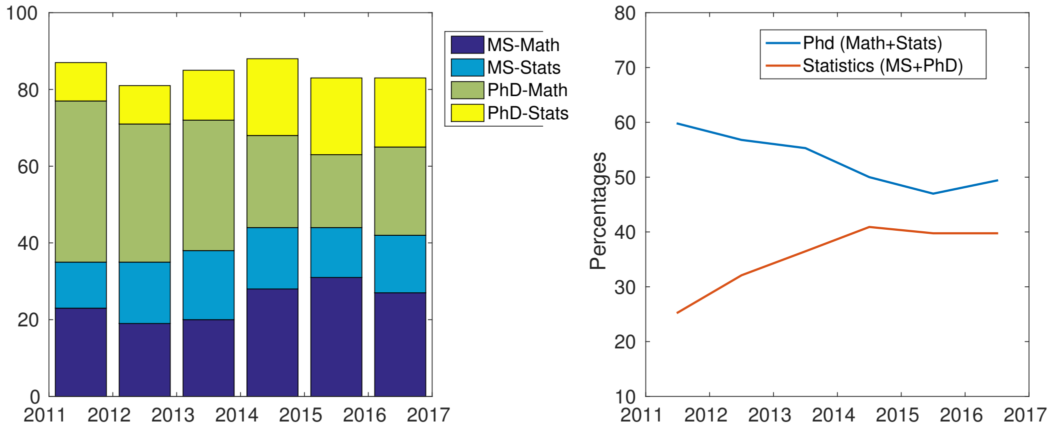

FIGURE 5. Number of students in MS/PhD program, separated by MATH/STAT.

Figure 3(b) more clearly shows the distribution of our students across different concentrations. The percentage of students in applied mathematics and mathematics of computation is largest, having risen from 30% to about 55% in the given time-interval. The percentage of students in statistics has grown from 10% to 20%, while those in pure mathematics have decreased slightly from 18% to about 13%. The group that has decreased the most is that in math education, which is not surprising since we have lost most of our faculty in the area (we are down from two and a half faculty lines to one half).

Figure 4 shows the gender, ethnic, and academic age composition of our undergraduates. **Figure 4**(a) shows the number of males vs females, we have about 35-45% female, which is rather high for a STEM field. **Figure 4**(b) shows the ethnic composition of the student body. In particular, the Hispanic component is about as big as those that declare themselves to be “white”. **Figure 4**(d) shows that currently around 60% of our students consider themselves some type of ethnic minority. Another statistic worth mentioning is that over 50% of our majors are seniors, illustrating that these students choose their major rather late in their studies.

4.B.2. *Graduate students.* **Figure 5**(a) shows the total number of graduate students in our program for 2011-2016, as well as the number in the MS or PhD program in Mathematic or Statistics. We have a total of about 85 students, without much change over the years. Figure (b) shows that the majority of them has typically been in the PhD program. Currently, the percentage in the PhD program is down to about 50%. **Figure 5**(b) also shows the percentage of graduate students in statistics. Although only 20% of our undergraduates are in statistics, currently about 43% of the graduates are in statistics. In fact, statistics offers relatively few courses at the 300-level or below, and all 400+ level courses are cross-listed with 500-level courses. This figure shows that similarly, their graduate program is large relative to their undergraduate program.

Figure 6 shows the gender, ethnic and resident composition of our graduate student body. **Figure 6**(d) shows that 30–40% of our graduate students are female. Again, this is a rather large percentage for a STEM area. About 36% of them are minorities, with the largest minority group being Hispanics, followed by Asians. About 50–60% of them are non-residents, either from other states of the U.S. or international.

4.C. **A description of program advisement for students.** *Provide a description of program advisement for students.*

Our undergraduates receive academic and administrative advisement from faculty advisors and professional staff from the Department and Arts & Sciences. The advisement ranges from correct

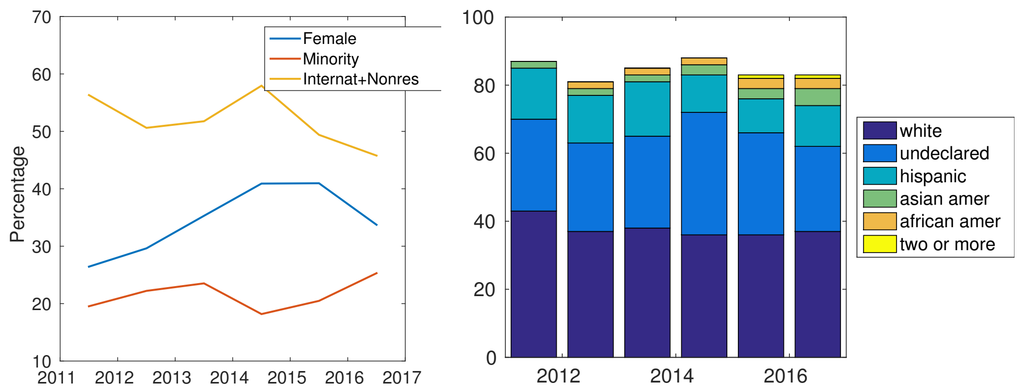

FIGURE 6. Composition of grad student body. (a) Percentages of female, minority, and non-NM students. (b) Declared minorities.

placement in major courses, to mentoring of research opportunities, to honors course-work, to writing letters of recommendation. In the past students were mandated to meet with their faculty advisors before registering for courses but this hold has been removed with the effect that some students may no longer use the opportunity to meet with their advisor.

The Department offers our Graduate students multiple forms of advisement throughout their program. The Department Advisor assists graduate with administrative procedures and serves as the initial point of contact for incoming graduate students. Once admitted, the graduate students meet with a member of the graduate committee from their respective area for initial advising. They are then assigned a faculty advisor in their concentration for academic advising. Students who decide they are interested in writing a Master's thesis and those who are ready to begin their PhD research find a professor in their research field to work with. That professor is also their Committee Chair.

4.D. **Student support services.** *Describe any student support services that are provided by the unit.* The Department offers many resources to undergraduate and graduate students in addition to the traditional resources (office hours, etc.). All of these are really initiatives taken by our Department to help our students succeed, so we choose to list all together below in Criterion 4.E.

4.E. **Student success and retention initiatives taken by the Department.** *Describe any student success and retention initiatives in which the unit participates.*

The department has made large efforts to motivate, attract, and help our students succeed, at all levels. This section describes our initiatives to support our students at 4 different levels: students in our 100-200 level preparatory service courses, our undergraduate majors as well as interested non-majors, our graduate students, students in the broader community.

Many of these activities have been supported or made possible with two NSF-MCTP grants totalling $2 million, awarded to the Department during the years 2008-2016. The grants have had 1 faculty PI and 4 Co-PIs, yet many more faculty have been involved, and about *350 students* have directly benefited from it. The Department has also benefited from 2 MCTP postdocs fully supported by the grant and revenue in form of IDC from the grant, which was graciously donated to the Department by the Office of the Vice President for Research, the College of Arts & Sciences, and the College of Engineering. These postdocs participated in activities for the graduate students, and taught an average of 3 courses per year for 4 years. The MCTP supported initiatives are marked below. For a detailed description of the MCTP program see `www.math.unm.edu/mctp`.

4.E.1. *Success and retention initiatives for students in our 100-200 level preparatory service courses.*

- **Algebra and Calculus Tables.** The Department has created a free tutoring system for all UNM students. Department instructors of courses at the 100-200-level in mathematics and statistics are available in Dane Smith Hall (DSH) during business hours five days a week. The location of the Algebra and Calculus Tables was chosen to be near to where students spend much of their time. The main goal is to provide help to students by instructors teaching the courses and thus are immersed in the material.
- **MaLL, Intermediate Algebra.** Former MATH 120, now MATH 101-102-103, is a gateway set of courses for new freshmen. Those students who are not successful in this course in their first semester, are more likely to leave UNM than those who placed higher in mathematics. The MaLL was created with the goal to improve these students' opportunity for success.
- **Precalculus and Trigonometry.** MATH 153 is a 5-credit hour course that covers precalculus and trigonometry, the two pre-requisites to enter the MATH 162-264 calculus sequence. It was created to reduce the time students need to pass calculus, itself a prerequisite for many courses in engineering, physics, and mathematics. The MATH 153 course was piloted as one section in Fall 2012; we now offer 4-6 sections per semester with enrollment capped at 35 students per section.
- **Calculus for students in engineering and the physical sciences.** The co-ordination of our calculus sequence 162-163-264 has refocused the emphasis of these classes away from memorization and towards challenging the student with an adequate amount of problems at several levels of difficulty, many of them in context of applications. Simultaneously the student is asked to review previous material out of context of current lectures in mixed review problems. The course content and the problems are continuously evaluated and modified. Since the changes in emphasis of this course were made, the passing rates have increased from about 40% to an average of about 55%. Data indicates that students that have taken our MATH 162 course do relatively well in the followup course, MATH 163.
- **Calculus for Biologists – BA/MD Program.** MATH 180/181, Elements of Calculus I and II, is required for students in the business school and in biology. There are many sections taught every semester, coordinated by Term Instructor Kevin Burns. Since Fall 2007, the Department has offered a special section of MATH 180 each Fall semester often followed by a special section of MATH 181 in the Spring, designed specially for students from the life sciences. This sequence places an emphasis on modeling biological systems, interpreting models, problem solving and reasoning skills. This section of MATH 180 is co-sponsored by the BA/MD program which provides support for a 0.5 Teaching Assistant and an undergraduate Supplemental Instruction Leader. Approximately 20 of the 50 seats in the class are reserved for BA/MD freshmen. For the past 6 years, the section of MATH 180 has principally been taught by Prof. Helen Wearing who has transformed the format of the class to increase active learning, including the use of in-class group assignments. In 2016-17 the entire sequence is taught in one of UNM's learning studio classrooms.

4.E.2. *Success and retention initiatives for our undergraduate majors and interested non-majors.* Several programs are geared towards engaging students in mathematics and undergraduate research, and support each other. For example, students attending the undergraduate research conference SUnMaRC often start an undergraduate research project themselves, which in many cases is done in the Honors Program, leading to a thesis and graduation with honors.

- **SUnMaRC-Southwest Undergraduate Mathematics Research Conference (MCTP supported)**. SUnMaRC is an annual regional mathematics conference for undergraduates held in the Southwest, at various institutions on a rotating basis. The University of New

Mexico participates yearly and has hosted the conference twice, in 2009 and 2013. About 100-140 students and 10 supporting faculty members from throughout the US Southwest participate each year. All students from UNM with interest in mathematics at the level of precalculus of above are invited. Our Department provides full support, including travel, lodging and meals, for all participants. Those students involved in undergraduate research projects give presentations on their work, and all participants benefit from meeting like-minded students in the SW, visiting other universities and their faculty, learning from other students talks and from invited talks on special topics and on professional opportunities. About 5-25 students from UNM participate each year, and about 2-6 give research presentations. Several students reported increased awareness and interest in mathematics after attending the conference, and switched major to mathematics. In addition, the SUnMaRC conference serves as support to the undergraduate majors, and provides a venue to present for those in the Honors program. This conference has been supported by the Office of Student Affairs, the College of Arts & Sciences as well as many departments within the College, including ours. In the last 4 years the conference has been fully supported by the NSF-MCTP grant.

- **Undergraduate Student Research (MCTP supported).** Since 2008, about 38 students have worked on undergraduate research projects listed on the MCTP webpage. Many of them have continued to graduate school in mathematics. The NSF-MCTP grant has supported undergraduate research students with a stipend for $4000 per students.
- **Undergraduate Honors Program.** The Mathematics and Statistics Undergraduate Honors Program is designed to provide intensive and personal instruction for selected students. The students work on a project guided by a faculty member, write and present an honors thesis, and graduate with Departmental Honors, with either cum laude, magna cum laude, or summa cum laude. The purpose of the program is to intensify and deepen the student's knowledge within the fields of Mathematics and Statistics. Participation also reflects well on the students resume and gives them and advantage them when applying for graduate school. Many of our Honor students have continued on to further graduate or professional studies.
- **MCTP Summer Math Camp (fully MCTP supported).** The Department offered a 1 month long summer math camp in each 2008, 2009, 2010,2012, 2013, 2014, 2015. Each camp consists of 4 week-long mini-courses taught by a total of 12 research faculty in various topics, such as algebraic structures, matrix analysis, Fourier analysis and wavelets, modeling infectious diseases, statistical approaches applied to genetics and evolution, numerical analysis, fluid dynamics, and topics in mathematics education. The camp also includes visits to Santa Fe Institute and Los Alamos National Laboratory. Each summer about 22 students from across the US Southwest were supported supported with a stipend, housing and transportation, and a per diem. During some years the camp also included a week about teaching mathematics, which was attended by about 15 K-12 teachers from the Albuquerque area.
- **Putnam Preparation Seminar.** Last year 4 UNM students took part in Putnam Mathematical Competition. They were among 4275 contestants from 554 institutions. One of our undergraduate students, who is now in our graduate program, made the Putnam top 500 list. He is ranked 273.5 which is in the top 7%. Faculty have supported this activity by running Putnam preparation seminars.

4.E.3. *Success and retention initiatives for our graduate students.*

- **Graduate Student Teacher Training Seminar (MCTP supported).** The Department has offered a teacher training seminar for new graduate students which discusses issues that arise in teaching, including different teaching styles, tools to motivate students, writing and grading homework, quizzes and exams, active learning techniques, use of technology, midterm evaluations, and more. The seminar is also a forum for our graduate students to raise any concerns that they have, and contributes to build a sense of community and belonging. This seminar was offered around 2005 three times, run by tenure-steam faculty and lecturers who volunteered for this activity, Since 2012, the seminar has been offered by the MCTP postdocs and MCTP supported graduate students, with full support by the grant. A course pack for the seminar is being written with the goal of running it on a regular basis in the future.

- **Qualifying Exam Preparation Program (MCTP supported).** As a part of the MCTP program a tenure-stream faculty member has led a summer seminar aimed at preparing our graduate students for their Qualifying exams.
- **MCTP Postdoctoral Program (MCTP Supported).** The grant supported two postdoctoral fellows, each for 3 years, that had a low teaching load (1-1). The postdocs interacted with the graduate students in various activities and also provided informal mentoring.
- **Local conferences.** These conferences (see section 1.G.4) foster a sense of belonging to a larger community and provide a forum for our graduate students to present their work to the larger mathematical/statistical world. It gives them visibility and an opportunity to network which may yield later job offers.

4.E.4. *Initiatives to support students in our broader community.*

- **UNM-PNM Statewide Mathematics Contest.** The yearly Contest is organized by faculty in the Department of Mathematics and Statistics, with major financial support from PNM. The goal is to promote mathematics education in New Mexico by rewarding students, teachers, and their schools for mathematics excellence. Between 700 to 1200 New Mexico students participate in this program annually. The contest is open to all students in grades 7 - 12 as well as interested students in lower grade levels. The contest has two rounds of exams designed to test mathematical potential and ingenuity as well as formal knowledge. Round I is administered at the students' home school. The top finalists are invited to the UNM Campus in early February to compete in Round II. The contest concludes with a dinner and award ceremony to which all finalists, parents and teachers are invited. The contest raises awareness of and interest in mathematics, and introduces many students to the UNM campus.
- **Statistics Clinic.** The Statistics Clinic is a service the Department offers to UNM and Albuquerque communities. Graduate students across disciplines have utilized this service to aid in the interpretation and organization of their research data. Members of the community have also utilized this service to aid them in analyzing data for their professional and personal endeavors.
- **MCTP High School Outreach Program (MCTP Supported).** Mathematics and Statistics undergraduate students visited Albuquerque schools in pairs and gave presentations to middle and high school students.
- **Initiatives to support K-12 Teachers in Mathematics.** These initiatives are both outreach to the community and a useful resource for our undergraduate and graduate students interested in teaching.
  - *International outreach.* Two three week trips to Nigeria (2009 and 1010), supported by the NSF and the International Mathematical Union. The first time Professor Michael Nakamaye went alone, the second time with a doctoral student. In both instances, Professor Nakamaye developed materials for three weeks of instruction of multiple classes.

- *Albuquerque Math Teachers' Circle.* Michael Nakamaye organized a team to go to a training program in Washington D.C. and started regular meetings with Albuquerque K-12 teachers in 2011. They have monthly meetings during the school year and have had three extended summer meetings, two in Taos and one in Albuquerque.
- *Illustrative Mathematics* Michael Nakamaye has written hundreds of tasks illustrating the Common Core State Standards for Mathematics, with a goal of helping teachers to develop materials to support the new standards. He worked with the Khan Academy to help them develop materials that support the new standards. He worked with teachers around the country to write a module for Smarter Balanced Assessment Consortium (SBAC) supporting understanding of ratios and proportions. He helped SBAC write hundreds of new sample items and developed new task models. For the past year, he has helped to write a complete curriculum for grades 6 through 8.
- *Curtis Center (UCLA)* Michael Nakamaye has developed materials for week long summer institutes designed for teachers. They have institutes for elementary, middle, and high school teachers and he has developed materials for all three.

4.F. **A summary of the success of graduates of the program.** *Provide a summary of the success of graduates of the program by addressing the following questions:*

- *Where graduates are typically placed in the workforce?*
- *Are placements consistent with the program's learning goals?*
- *What methods are used to measure the success of graduates?*
- *What are the results of these measures?*

This section presents some snapshots from the data we have collected for 156 MS and 66 PhD alumni in Mathematics and Statistics for the 10 year window from 2006 to 2016. The raw data can be found in Appendix B.

By and large our MS and PhD graduates are working in jobs related to their degrees. Some highlights that supports this assertion are:

- Of the 156 MS alumni 122 students (78%), are working in areas related to their expertise whether doing research, teaching, working in industry, financial or government institutions, or went on to pursue PhDs or other degrees in related areas. Out of the remaining we were not able to find information for 31 students and only three students moved on to do things unrelated to their field of study.
- Of the 66 PhD alumni in record all but three, i.e. 63 students (96%) are working in areas related to their expertise in mathematics or statistics whether doing research, teaching, working in industry or financial institutions. out of the remaining ones, one is no longer working in mathematics and we have no information on two.
- Many of our PhD alumni (80%) have contributed to the body of mathematical and statistical knowledge as can be measured by the papers published as a result of their research while graduate students at UNM, we have in record about 100 publications in peer reviewed journals.

The fact that our graduates for the most part are working in jobs related to their degrees, for example as researchers at the nationals laboratories, in industry or in government, and as educators in STEM at various levels of the educational system, is testament to the success of our graduate program. Implicitly this is evidence that the broad goals of our programs are met.

A significant challenge for mathematics and statistics is to the increase the diversity and proportion of US citizens in the STEM workforce. We feel that our MS and PhD programs are successful in meting these challenges. Around a third of the students in our MS program are minorities and females and over one half are US students. For the PhD program the statistics are even better, over half of our PhD's are awarded to minorities, about one third of our PhD's are awarded to women and about one third of our PhD's are awarded to US students.

Reflective questions.

Extension of 4.B. Are the enrollments (as a percentage of the total student population) similar to our peer institutions? Given that we are located in a region where math degrees are highly valued by employers, what are realistic targets for increasing the number of majors? Are there more possibilities for growth and enrollment as the undergraduate and/or graduate levels?

Comparing to New Mexico State University, which in 2016 had 21 tenured/tenure-track faculty, 43 undergraduate majors and 37 graduate students, our Department has higher enrollment per faculty. The corresponding numbers for our Department are 29 tenured/tenure-track faculty, and on average 160 undergraduate majors and 85 graduate students.

Not only are we located in a region where the employers are eager to hire graduates that have mastery of mathematics and statistics, but we also predict that with the upcoming waves of retirements at the national laboratories this demand will grow. Given this demand and with appropriate increase in resources, we believe the Department would be able and willing to grow both the undergraduate and the graduate programs.

Extension of 4.B. Data indicates there is low enrollment of female students in your majors. What can be done to address the low representation of these students.

As we mention in Criterion 5.A and sections 4.B.1 and 4.B.2, the percentages of female faculty and female undergraduate and graduate students are higher than the typical statistics as reported by the AMS. This is encouraging, as it is important to attract more female students with positive role models.

Some of our faculty and graduate students are involved with the Association for Women in Mathematics (AWM), an organization that promotes a welcoming and inclusive environment in general, but also offers targeted programs for women graduate students and recent PhDs that our graduate students attend.

Unlike most engineering disciplines, applied mathematics and statistics are not tied to a specific class of problems but can be applied more broadly. It should therefore be possible to target the recruitment to further reduce the gender gap in STEM.

Extension of 4.F. What career initiatives do you have in place to connect your graduates/majors with potential employers in the workforce?

Almost all of the faculty in the Department have connections with other researchers at the national laboratories and various other potential employers. The faculty advisement of our majors therefore plays an important role in identifying potential career paths for our graduates and majors. For example, one of the main recruitment tools for Los Alamos and Sandia are their summer schools/summer internship programs, and we have had a good success rate in helping our students with applying for these programs. Additionally, we have been in discussions with staff from Los Alamos on partnering with them to host some components of their summer schools on campus in Albuquerque.

We also note that the Department sponsors a Society for Industrial and Applied Mathematics (SIAM) Student Chapter (`http://siam.unm.edu`) which schedules seminars and panels with representatives from industry.

Furthermore, we encourage, and when possible support, graduate students to attend national meetings, for example, the Joint Mathematics Meetings and Joint Statistics Meeting. These meetings offer employment services.

Criterion 5: Faculty

The faculty associated with the unit's programs should have appropriate qualifications and credentials. They should be of sufficient number to cover the curricular areas of each program and other research and service activities. (Differentiate by program where appropriate.)

The Mathematics and Statistics faculty is dedicated to offering New Mexicans access to high quality educational, research, and service programs. The faculty is a significant knowledge resource for New Mexico, the nation, and the world, and they foster scholarly programs of international prominence.

This criterion describes the composition, credentials and qualifications of the faculty of the Department of Mathematics and Statistics with respect to curricula, research and service. The faculty collective credentials and contributions to each of these components are discussed in detail in sections 5.A.1 and 5.A.2. In particular, these sections provide examples of how the qualifications of the faculty are being recognized, for example through invitations to conferences, external funding, and teaching awards. Criterion 5.B discusses the opportunities for professional development of the faculty and Criterion 5.C summarizes and gives selected examples of faculty research. **Table 1** lists faculty names, ranks, degree/institution, and research area when applicable. Finally, a comprehensive listing of the faculty vitae can be found in Appendices C and D.

Note that this criterion does not include a description of the large contingent faculty that is relied on to teach many of the lower level courses. This practice, along with the insufficient numbers of tenure-stream faculty to cover the upper level curriculum, leads us to describe the current human resources of the Department as *minimally adequate to inadequate*, see further Criterion 6: Resources and Planning.

5.A. **Composition of faculty and their credentials.** *Describe the composition of the faculty and their credentials. Provide an overall summary of the percent of time devoted to the program for each faculty member and roles and responsibilities within each program.*

The Department of Mathematics and Statistics is currently (Spring 2017) composed of 27, nine-month, full-time, tenure-stream faculty members, and two (2) half-time members (28 FTE). One of these half-time faculty members has a joint appointment with the Department of Biology, and one full-time member is on leave. In addition, the department has 6 lecturers who are non-tenured faculty.

The Department of Mathematics and Statistics consists of four main components:

(i) The pre-calculus service in mathematics and statistics and lower division mathematics education programs, cared for by our six (6) lecturers.
(ii) The applied mathematics program including teaching, research, and service components cared for by our eleven and a half (11.5) applied mathematics tenure-stream faculty members.
(iii) The pure mathematics program including teaching, research, and service components cared for by our nine and a half (9.5) pure mathematics tenure-stream faculty members.
(iv) The statistics program including teaching, research and service components cared for by our seven (7) statistics tenure-stream faculty members.

Table 2 lists the lecturers and the tenure-stream faculty members in each group.

The current breakdown by gender and ethnicity of the 35 faculty members are: Male: 24 (69 percent); Female: 11 (31 percent); Non-hispanic White: 26 (74 percent); Hispanic: 5 (14 percent); Asian: 4 (12 percent).

We note that, similar to the State of New Mexico and UNM, the composition of the faculty is ethnically diverse.

Faculty	Rank	Degree and Institution	Research Areas
Appelö, Daniel	Associate Professor	PhD Royal Institute of Technology (Sweden)	Partial Differential Equations, Scientific Computing
Berkopec, Timothy	Lecturer II	MS University of Illinois (Urbana-Champaign)	
Blair, Matthew	Associate Professor	PhD University of Washington (Seattle)	Analysis, Partial Differential Equations
Bolli, Jurg	Principal Lecturer	MS University of Zurich (Switzerland)	
Buium, Alexandru	Professor	PhD University of Bucharest (Romania)	Algebraic Number Theory, Geometry
Champine, Karen	Senior Lecturer	MA University of New Mexico	
Chaudhry, Jehanzeb	Assistant Professor	PhD University of Illinous (Urbana-Champaign)	Partial Differential Equations, Scientific Computing
Christensen, Ronald	Professor	PhD University of Minnesota (Minneapolis)	Statistics, Biostatistics
Degnan, James	Assistant Professor	PhD University of New Mexico (Albuquerque)	Statistics
Embid, Pedro	Professor	PhD Unversity of California (Berkeley)	Partial Differential Equations
Erhardt, Erik	Associate Professor	PhD University of New Mexico (Albuquerque)	Statistics
Greenberg, Nina	Senior Lecturer	MS University of New Mexico (Albuquerque)	
Huang, Hongnian	Assistant Professor	PhD University of Wisconsin (Madison)	Analysis, Geometry, Partial Differential Equations
Huerta, Gabriel	Professor	PhD Duke University	Statistics, Scientific Computing
Korotkevich, Alexander	Associate Professor	PhD L.D. Landau Institute for Theoretical Physics of the Russian Academy of Sciences	Mathematical Physics, Scientific Computing
Lau, Stephen	Associate Professor	PhD University of North Carolina (Chapel Hill)	Mathematical Physics, Scientific Computing
Li, Li	Assistant Professor	PhD University of South Carolina (Columbia)	Statistics
Lorenz, Jens	Professor	PhD University of Munster (Germany)	Partial Differential Equations
Loring, Terry	Professor	PhD University of California (Berkeley)	Analysis, Mathematical Physics
Lu, Yan	Associate Professor	PhD Arizona State University (Tempe)	Statistics
Lushnikov, Pavel	Professor	PhD L.D. Landau Institute for Theoretical Physics of the Russian Academy of Sciences	Dynamical Systems, Mathematical Biology, Mathematical Physics, Partial Differential Equations, Scientific Computing
Martinez, Derek	Senior Lecturer	PhD University of New Mexico (Albuquerque)	
Motamed, Mohammad	Assistant Professor	PhD Royal Institute of Technology (Sweden)	Partial Differential Equations, Scientific Computing
Nakamaye, Michael	Professor	PhD Yale University	Math Education
Nitsche, Monika	Professor	PhD University of Michigan (Ann Arbor)	Scientific Computing
Pennybacker, Matthew	Assistant Professor	PhD University of Arizona (Tucson)	Dynamical Systems, Partial Differential Equations, Scientific Computing
Pereyra, M. Cristina	Professor	PhD Yale University	Harmonic Analysis
Skripka, Anna	Associate Professor	PhD University of Missouri (Columbia)	Analysis, Operator Theory
Sorensen-Unruh, Karen	Lecturer II	MS University of New Mexico (Albuquerque)	
Sulsky, Deborah	Professor	PhD New York University	Mathematical Biology, Scientific Computing
Vassilev, Dimiter	Associate Professor	PhD Purdue University	Analysis, Geometry, Partial Differential Equations
Vassilev, Janet	Associate Professor	PhD University of California (Los Angeles)	Algebra
Wearing, Helen	Associate Professor	PhD Heriot-Watt University (Scotland)	Mathematical Biology
Zhang, Guoyi	Associate Professor	PhD Arizona State University (Tempe)	Statistics
Zinchenko, Maxim	Associate Professor	PhD University of Missouri (Columbia)	Analysis, Mathematical Physics

TABLE 1. Faculty credentials.

Moreover, our tenure-stream faculty is 31% female, whereas posted AMS data[4] shows that the 40 departments classified as Medium Size Public[5] have 1289 male and 249 female full-time faculty, i.e. 16% female. We excel by this measure of diversity.

5.A.1. *Non-tenured faculty.* The 6 non-tenured faculty (Lecturers) carry out the duties of coordinating, teaching and assessing the pre-calculus courses MATH 121, MATH 123, MATH 129, STAT 145, MATH 150, MATH 153, and the Math Education courses MATH 111, MATH 112, and

[4]See the AMS faculty demographics page `http://ams.org/profession/data/annual-survey/demographics` and `prefix/www.ams.org/profession/data/annual-survey/2015Faculty_Gender_Detail.xlsx` where `prefix` is the string `http://ams.org/profession/data/annual-survey`

[5]See `http://ams.org/profession/data/annual-survey/groupings`

Lecturers	T. Berkopec, J. Bolli, K. Champine, N. Greenberg, D. Martinez, K. Sorensen-Unruh
Applied Math	D. Appelö, J. Chaudry, P. Embid, A. Korotkevitch, S. Lau, J. Lorenz, P. Lushnikov M. Motamed, M. Nitsche, M. Pennybacker, D. Sulsky, H. Wearing (0.5 FTE)
Pure Math	M. Blair, A. Buium, H. Huang, T. Loring, M. Nakamaye (0.5 FTE Math Ed), C. Pereyra, A. Skripka, D. Vassilev, J. Vassilev, M. Zinchenko
Statistics	R. Christensen, J. Degnan, E. Erhardt, G. Huerta, L. Li, Y. Lu, G. Zhang

TABLE 2. Group members

MATH 215. These courses have been thoroughly reviewed in Criterion 2.B (Department Teaching Contribution).

Non-tenured faculty have an enormous responsibility in maintaining and teaching most of the Core Courses[6]. They coordinate and oversee the teaching of multiple sections of these classes taught by Part-Time, Temporary Instructors and Term Instructors.

Lecturers design student learning outcomes for the pre-calculus courses, they oversee their assessment and implement changes when needed (see section 3.A.1). These courses have common syllabi, common homework, common finals (except MATH 123 and 129 that have a partial common final), STAT 145 has in addition common midterms.

The department non-tenured faculty are some of our most experienced and well qualified teachers, many with a prior history as Part Time Instructors at UNM. Most of them have been nominated to Lecturer of the Year or Part-Time Instructor of the Year, and several have won departmental or university-wide teaching awards. For example, Derek Martinez won an Arts and Science Weber Teaching Award in 2014 and was selected to be a UNM Teaching Fellow for the academic year 2015-2016. The non-tenured faculty are involved in creative new teaching experiments, for example MATH 153 and STAT 145 (with involvement from Associate Professor Erik Erkhardt).

Additionally, some of the non-tenured faculty members have research experience having worked in the past as data analysts, chemists, or engineers. One of the lecturers holds a patent, another performs statistical analysis for Project Echo on UNM's Medical School, a third was a High School teacher. All of the non-tenured faculty have MS degrees in Applied Mathematics, Pure Mathematics, or Statistics. One lecturer has a PhD in Mathematics, and two others have an additional MS, one in Theoretical and Applied Mechanics and one in Marine Science.

Lecturers have been involved in university-wide and state-wide initiatives such as: the Partnership for Assessment of Readiness for College and Careers (PARCC) Assessment, the New Mexico Higher Education Department Common Course Numbering Committee, the Arts and Science College Assessment Review Committee, and the UNM Assessment Connections Retreat.

The Lecturers' Curriculum Vitae can be found in Appendix C.

5.A.2. *Tenure-stream faculty.* The Mathematics and Statistics tenure-stream faculty are dedicated to offer New Mexicans access to high quality educational and research programs. They are a significant knowledge resource for New Mexico, the nation, and the world, and they foster programs of international prominence.

The 29 tenure-stream faculty (two of them half-time employed) in the Department of Mathematics and Statistics are separated into three major groups: Applied Mathematics, Pure Mathematics and Statistics. Each group oversees the undergraduate, graduate, research and service programs in their area.

[6]The calculus sequence MATH 162-163-264 has been tightly coordinated by Professor Monika Nitsche for many years and most or our lecturers contribute to this sequence as trusted instructors; the business calculus sequence MATH 180-181 is coordinated by Term Instructor Kevin Burns; the calculus for the BA/MD program is coordinated by Associate Professor Helen Wearing.

Scholarly output and visibility. The applied group has strong researchers in numerical analysis, scientific computing, partial differential equations, mathematical physics, and mathematical biology. They often collaborate with scientists from Sandia and Los Alamos National Laboratories, creating research and job opportunities for their students. The pure group has strength in geometry (differential, arithmetic, and algebraic) and in analysis, running weekly seminars in both areas. The statistic group has strong researchers in Bayesian methods with applications to biology and other fields. They collaborate with the Mind Institute and the UNM Hospitals. They run UNM's Statistics Consulting Clinic.

The Department has one Fellow of the Institute of Mathematical Statistics (IMS), one Fellow of the American Statistical Association (ASA), two (one emeritus) Fellows of the American Mathematical Society (AMS), six Simons Collaboration grants, one National Science Foundation (NSF) Career Grant, nine additional NSF Research Grants and three other grants supported by the National Oceanic and Atmospheric Administration (NOAA), Sandia National Laboratory and Los Alamos National Laboratories.

Before describing in more detail the credentials and scholarly contributions of our tenure-stream faculty, we want to quote a statement from the American Mathematical Society (AMS) on 'The Culture of Research and Scholarship in the Mathematical Sciences':

> *Mathematics is often considered as part of the physical and natural sciences, but its publication practices differ from these other disciplines in several fundamental ways.*
>
> *Mathematicians tend to publish at rates that are modest compared to some other sciences. The majority of mathematical research is published in refereed research journals, rather than conference proceedings or books[7]. Articles typically represent considerable advances on a mathematical question. In addition, since mathematics research is usually not considered time-sensitive, time to publication is typically much longer than in other STEM fields. Even some of the best young mathematicians publish relatively few papers[8]. Even more senior mathematicians have modest publication rates[9].*
>
> *The information above about those who have won prestigious awards strongly supports the view that, when judging the work of mathematicians, the key measure of value for a research program is the quality of publications rather than the rate. While these facts are familiar to mathematicians, they are often unfamiliar to scholars from different professional cultures.*[10]

With this in mind we now record the evidence supporting the statement that the Department of Mathematics and Statistics tenure-stream faculty are a significant knowledge resource for New Mexico, the nation, and the world, and they foster programs of international prominence.

Current tenure-stream faculty members have written numerous technical books (22). Since 2007 current faculty has produced about 475 peer reviewed articles which translates on average 43.2 articles per year. **Figure 7**(a) shows the number of peer-reviewed articles per year per current tenure-stream faculty member in the window 2007-2016. It is worth mentioning, that not all 29 current tenure-stream faculty members have been at UNM all these years. In fact 12 out of the

[7]Of the 274 publications by these Guggenheim Fellows, 75% were in refereed journals. Only three publications were books. In fact, of all items covered by Mathematical Reviews in the years 2001-2005, fully 80% were from refereed journals, according to an Analysis of MathSciNet data by AMS staff, 2014

[8]A study of the 40 mathematicians winning Sloan Fellowships in 2005-2006 shows that 70% published an average of two or fewer articles per year in the five years preceding their award, according to an Analysis by AMS Committee on the Profession, 2014

[9]Of the 22 mathematicians receiving Guggenheim Fellowships from 2002-2006, half published an average of two or fewer articles per year in the five years preceding their award.

[10]AMS statement on 'Rates of Publication' at `http://www.ams.org/profession/leaders/culture`

29 current tenure-track faculty were hired in 2009 or later, this means that on average we are aggregating data for 23.7 faculty per year, giving an average of 2 articles per year per faculty member.

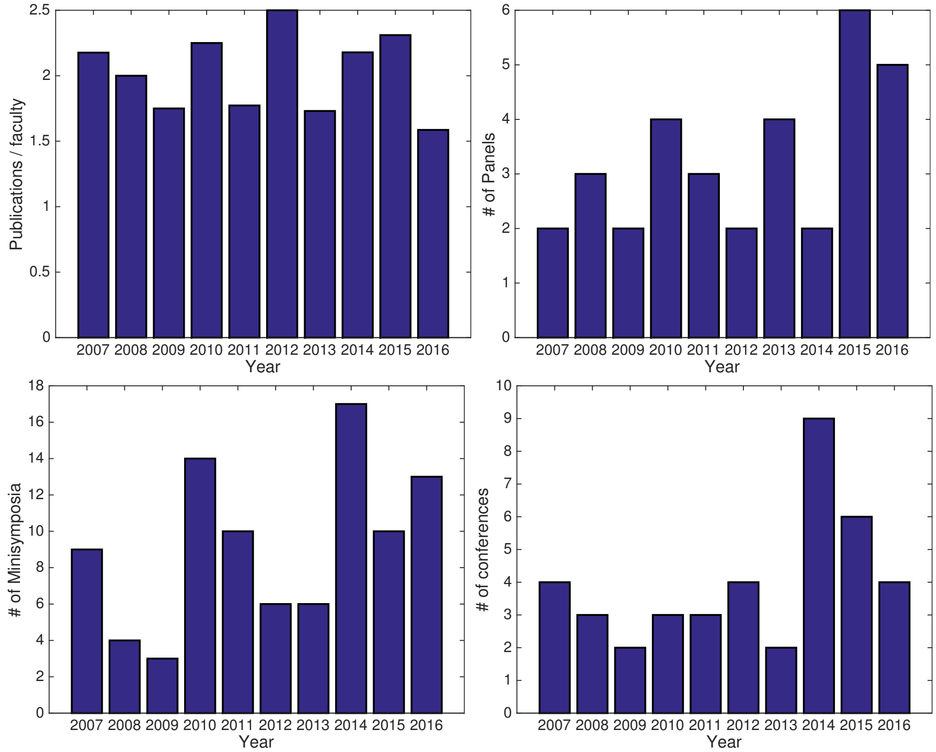

FIGURE 7. Current tenure-stream faculty contributions per year 2007-2016. Top left (a) Number of articles per year per faculty. Top right (b) Number of panels per year. Bottom left (c) Number of faculty co-organizing special sessions/mini-symposia per year. Bottom right (d) Number of conferences organized per year.

About half of these articles are published in interdisciplinary or other disciplines' journals, in disciplines as diverse as Physics, Engineering, Computational Chemistry, Computational Biology, Bioinformatics, Biology, Signal Processing, Material Sciences, Oncology, Atmospheric Sciences, Ecology, Medicine, Neuroscience and Quantum Information.

Quality of the publications is a better indicator than quantity. Our faculty are publishing in premium outlets from absolute top journals in science, in mathematics, in applied mathematics, in physics, in biology, and in statistics, to top ranked specialized journals within these disciplines and more. These journals include Proceedings of the National Academy of Sciences, journals from the national societies of several disciplines, journals from prestigious university presses, and even the oldest mathematical journal still in existence, Crelle's Journal, founded in 1826 (Euler and Gauss published in this journal) .

Current tenure-stream faculty have been members of world renown institutes in the US, Canada, France, Germany, Rumania, Russia, and Spain. Among them, the Institute for Advanced Study (IAS) at Princeton, best known as the academic home of Albert Einstein. Faculty members are regularly invited to lecture in conferences/workshops/special sessions/symposia/colloquia/seminars world-wide, and to deliver graduate/post-graduate research level series of lectures, often structured as mini-courses in the US (e.g. Cornell University, IAS) and abroad (e.g. Argentina, Mexico, Spain, Nigeria, Venezuela).

Tenure-stream faculty members serve in national (NSF, DOE) and/or international (NSERC Canada, ANR France, DFG Germany, Israeli NSF) panels every year, **Figure 7**(b) shows the number of panels current tenure-stream faculty has served on since 2007. The average is 3.4 panels per year. The faculty's expertise is solicited to review individual proposals from national and international funding agencies. The faculty is heavily engaged in the peer review process: as referees/reviewers for multiple papers per year from top journals in their areas of expertise, as editors (main or associate), and as members of editorial boards for journals in Mathematics, Applied Mathematics, and Statistics. The faculty has edited several volumes of cutting-edge research in their areas of expertise (6). A faculty member is serving a second two-year rotation term as Program Director for NSF in Applied Mathematics. It should be pointed out that papers in mathematics and statistics often are lengthy and thus the refereeing process is correspondingly time consuming.

Faculty members serve in Scientific Committees for national and international events. They organize multiple special sessions/mini-symposia in the mathematics and statistics associations sectional/national meetings (92 since 2007, that gives an average of 9.2 per year). **Figure 7**(c) shows the number of current tenure-stream faculty co-organizing one of these events per year since 2007. Faculty members also organize national and/or international conferences/workshops every year. Several of these events have been in Albuquerque, including four Sectional Meetings of the American Mathematical Society, the annual meetings of the New Mexico American Statistics Association, and two editions of the Southwest Undergraduate Mathematical Research Conference (SunMaRC), with its obvious benefits to the local economy and more importantly to the local academic community (see Criterion 1.G for a list and short description of the local conferences we have hosted since 2007). The international conferences/mini-symposia have been organized in Albuquerque, NM; Las Cruces, NM; Brown University, RI; Canada, Mexico, France, Denmark, Russia, Switzerland, Bulgaria, Greece, China, Germany, Korea. Looking ahead, faculty members are organizing conferences in Albuquerque (March 2017), a workshop in Canada (2017), an international conference in France (Jan 2018), and a satellite conference to the International Congress of Mathematicians (ICM) that meets every four years (Summer 2018, Brazil). **Figure 7**(d) shows the numbers of conferences organized by current tenure-stream faculty per year since 2007 (a total of 40 since 2007, giving an average of 4 conferences organized per year).

The tenure-stream faculty regularly host postdoctoral fellows (on average 5 since 2011, supported mainly by individual grants or the MCTP grant), visiting graduate students for short-time periods (since 2011 from the US: Brown University and Southern Methodist University, from Finland, Germany, Nigeria, Sweden, currently we have one from France), visiting scholars (since 2011 from US, Brazil, Romania).

Currently, the tenure-stream faculty is supported by 20 grants that are housed in our Department, 10 from NSF, 6 from the Simons Foundation, one from Sandia National Laboratories, one from Los Alamos National Laboratories, and one from the National Oceanic and Atmospheric Administration. The total grant support from these 20 grants amounts to \$3,391,081. A major portion of the grant support (in the amount of \$1,198,603) is related to education, an NSF-MCTP grant, Mentoring Through Critical Transition Points. Three faculty are currently supported (as PIs, coPIs, or co-Is) by large National Institutes of Health (NIH) grants housed in the Mind Research Network, UNM North Campus, and in the Biology Department. Since 2007 the current faculty has had grants from NSF, Department of Energy, National Nuclear Security Administration, Defense Advanced Research Projects Agency, Office of Naval Research, NASA, Los Alamos National Laboratory, and Sandia National Laboratories.

Other scholarly contributions by the tenure-stream faculty, perhaps harder to quantify but involving hours of work that benefit larger segments of society, include writing software/code and maintaining the repositories, assisting in epidemiology/neurosciences/health sciences studies.

Teaching, mentoring, and service. The 29 tenure-stream faculty members are responsible for the undergraduate and graduate programs in mathematics and statistics. These programs have been described in detail in Criterion 2.A, whereas Criterion 6.A.3 describes the staffing of 300+ Level courses. Teaching all the 300+ classes needed to maintain these programs has been a challenge due to the small number of faculty. This constant shortage of faculty prevents us from teaching lower division courses on a regular basis and it also limits the possibility to provide special topics courses aimed at keeping the graduate students informed of the current trends in research. Despite the challenges we have been able to keep the programs alive, and one could even argue thriving. However, this is a very fragile state of affairs, the faculty is stretched to its limits. For a quick comparison, our program currently has 141 majors and 82 graduate students, whereas the second largest research university in the state, New Mexico State University with 21 tenure-track faculty, has 43 majors and 37 graduate students.

Tenure-stream faculty members are dedicated mentors to high school, undergraduate, and graduates students, as well as to postdoctoral fellows. They have successfully guided students in the completion of: High School Science Fair Projects that have won State[11] and National[12] awards, Undergraduate Honor's Theses and research for undergraduate projects, MS theses, and PhD dissertations that almost always result in the publication of peer reviewed articles. A summary of the successes of our graduate students has been recorded in Criterion 4.F, for more information see Appendix 2: 2006-2016 MS and PhD graduates in Mathematics and Statistics. A comparison to UNM's 22 official peer institutions regarding PhD production is done in Criterion 8, see the narrative in Criterion 8.D. In a nutshell, when the average number of PhD students per year is normalized by the number of faculty members, UNM ranks third, only outranked by The University of Texas at Austin and University of Iowa.

Current tenure-stream faculty has received university-wide teaching awards: UNM Presidential Teaching Fellow (2006-2008), UNM Teaching Fellow (2016-2017), four UNM Outstanding Teacher of the Year Award (2003-2004, 2007-2008, 2012-2013, 2013-2014), William P. and Heather W. Weber award (2011). Several others have been nominated to these awards, some more than once, but the rules prevent a former awardee from competing in later years in the same category.

Current tenure-stream faculty received two NSF-MCTP grants, totaling about 2 million dollars, that for the nine years 2008-2012 and 2012-2017 have supported a number of activities from K-12 (summer courses for teachers, fun talks brought to Albuquerque middle and high schools by UNM students), undergraduate (month-long summer program, research undergraduate projects, support for the annual Southwest Undergraduate Mathematical Research Conference, twice hosted at UNM), graduate (NSF-MCTP graduate trainee-ships, graduate teaching seminar, qualifying preparation over the summer), to postdoctoral (grant supported postdocs). Faculty has received other grants that have supported outreach efforts for K-12 mathematics teachers in the form of Workshops and Summer Institutes. These and other initiatives spearheaded by the faculty are addressed in section 4.A.2 on Recruitment efforts.

Last but not least, the faculty organizes the annual UNM-PNM Statewide Mathematics Competition with an average of a thousand middle and high school participants from all over New Mexico[13]. Faculty guides and supports undergraduate participants in the nation-wide William Lowell Putnam Mathematical Competition[14]. These have been described in more detail in Criterion 1.G on Examples of Outreach or Community Activities and/or in section 4.A.2 on Recruitment.

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[11] Central NM Regional Science Fair, 3 first and a third placements; NM State Fair: 2 first and 2 second placements.

[12] Intel International Science and Engineering Fair (ISEF) a second and a fourth placements; see
`prefix/education/competitions/international-science-and-engineering-fair.html`
where `prefix` is the string `http://www.intel.com/content/www/us/en`

[13] See the official website for the UNM-PNM Statewide Mathematics Competition `http://mathcontest.unm.edu`

[14] See the official website for the Putnam Mathematical Competition `http://math.scu.edu/putnam/`

Finally, the departmental, college and university service performed by tenure-stream faculty includes joint appointments (e.g. Director of the Biostatistics and Neuro-informatics (BNI), BA/MD program, Director Statistics Consulting Clinic), memberships in departmental[15], college[16], and university[17] committees.

5.B. **Professional development activities of faculty.** *Provide information regarding professional development activities for faculty within the unit.*

The Department has both formal and informal professional development activities. The main formal activity is a mentoring program focused on guiding the junior tenure-stream faculty (at the rank of assistant professor) through the tenure process. The mentor, a tenured faculty member, is assigned by the Chair to the junior faculty after consultation with the involved faculty.

The details of the mentoring process depend on the particular mentor/mentee combination but a typical example of a mentoring activity in the area of teaching is the in-class peer review and feedback that the mentor conducts around once or twice per semester. In the field of research an important function of the mentor is to guide the junior faculty in the search for external research funding, for example by reading and commenting on grant proposals.

Another formal activity, that includes tenure-stream faculty at all ranks, is the UNM mandated annual performance evaluation. The review is conducted by the Executive Committee and is based on a standardized extended resume spanning the last six years. The evaluation consists of a weighted sum (40 percent, 40 percent and 20 percent) of three numerical grades from 1 to 5 in the areas of research, teaching and service. The evaluation is presented in the form of a letter that also communicates the rationale for the scores and also provides feedback and suggestions to improve in the three areas of the evaluation.

In addition, the UNM faculty handbook (§4.3.1(c)) states that one of the elements of the mid-probationary, tenure and promotion review is the following: "The chair shall discuss the review and recommendation with the faculty member." One of the purposes of this discussion is to point out strengths and areas of improvement as the candidate works towards the next level in the promotional system.

Of particular importance to excellence in research is the possibility for our faculty to attend international and national conferences and workshops to keep abreast with the frontiers of our respective areas of research. Within the current operational budget of the Department, there is only room for very limited support of tenure-stream faculty travel. Unfortunately the current support ($500 per year) is so low (and it does not accrue) that unless the individual faculty member has supplemental funds it is not sufficient to cover travel and registration even to national conferences.

There is institutional support for development in the area of teaching at UNM. For example, The Center for Teaching and Learning (CTL)[18], offers both individual and departmental consultations on teaching effectiveness. CTL also offers collaborative peer observations of teaching as well as numerous workshops on diverse aspects of teaching.

5.C. **Summary and examples of research work of faculty members.** *Provide a summary and examples of research/creative work of faculty members within the unit.*

This section will present a summary of the research of the tenure-stream faculty in the Department. It will also highlight some representative examples of research from the Applied Mathematics, Pure Mathematics and Statistics groups. A detailed description of the research expertise for every

[15]for example: Hiring, Graduate and Undergraduate committees

[16]For example: Arts and Sciences Promotion, Tenure and Promotion and Mid-probationary committees

[17]For example: Senate, Provost T&P, Allocations, and Hiring committees

[18]`http://ctl.unm.edu`

tenured/tenure–track faculty can be found in Appendix D. As evidenced by the Curriculum Vitae in the appendix, the expertise in the Department is quite broad.

5.C.1. *Summary of research work of faculty members.* The Applied Mathematics group has considerable expertise in the areas of mathematical modeling, numerical analysis, scientific computing, and analysis of differential equations. A common thread of the research in the applied group is that the problems considered are mainly of the time dependent type (dynamical processes) and that most of the research projects are motivated by applications from engineering and sciences. Although each of the applied faculty has their own unique expertise there are also many commonalities within and across the sub-disciplines, providing avenues for research collaborations. These collaborations often spring out of the co-advisement of students.

The group's impact on both fundamental applied mathematical research and applied interdisciplinary research is evidenced by its many publications in high-quality peer-reviewed journals; see the faculty CVs in Appendix D. Another indication of the broad impact of the applied group is the range of the external research grants (currently four from NSF, one from SNL, one from NOAA, and one from LANL; in addition Professor Wearing is the awardee of an NIH grant which is administrated by the Department of Biology).

The members of the Pure Mathematics group conduct research in a variety of areas of algebra (commutative algebra, number theory), geometry (geometric analysis, Riemannian and Kähler geometry), and analysis (Fourier analysis, non-commutative geometry, partial differential equations, quantum computing). There are numerous interactions between the faculty working in these areas. Seminars are being run on these subjects of research (the Analysis seminar and the Algebra and Geometry seminar) and many discussions and/or collaborations in our department have contributed to a lively research climate.

The groups's impact on fundamental research in pure mathematics is evidenced by its many publications in high-quality peer-reviewed journals; again, see the faculty CVs in Appendix D. Another indication of the broad impact of the pure group is the range of the external research grants (currently five from NSF, one the first NSF-Career grant ever received ever by a department member, and five from the Simons Foundation). In addition this group has produced two Fellows of the American Mathematical Society (one emeritus) out of four in the state (one at NMSU the other at the Santa Fe Institute).

The members of the statistics group perform research on Bayesian methods, linear models, survival analysis, non-parametric methods, survey sampling and inference for phylogenetic trees. The group collaborates intensely with the Mind Research Network, the Biology and Economics Department and the Cancer Research Center at the UNM Medical school. The group organizes the statistics colloquium and the Quant Brains UNM/MRN Seminar Series. The group also runs the Statistics Consulting Clinic which provides support to research activities of UNM faculty and students of other departments.

The group has a strong emphasis on Applied Statistics which can be clearly seen from the many publications in high quality peer reviewed journals reported in the faculty Curriculum Vitae in Appendix D. In addition, one of our Faculty members, Professor James Degnan is the awardee of a NIH Collaborative grant. The group has a Fellow of the American Statistical Association who is also a Fellow of the Institute of Mathematical Statistics (Prof. Christensen). The senior members of the group have been heavily involved in Editorial work of journals such as The American Statistician, Journal of the American Statistical Association, Bayesian Analysis and Environmetrics.

5.C.2. *Examples of research work of faculty members.*

Examples from Applied Mathematics. The Material Point Method[19] MPM was originally developed by Professor Deborah Sulsky (Mathematics and Statistics, UNM), Professor Howard Schreyer (Mechanical Engineering Department, UNM), and Professor Zhen Chen (now in Civil and Environmental Engineering, University of Missouri, then a postdoc at UNM). The method, which has achieved wide recognition in both applied mathematics and engineering, is continuously improved and applied by Professor Sulsky who is regarded as one of the foremost experts on MPM.

MPM is a method for solving problems in continuum mechanics where a fluid or solid body is discretized using a collection of material points that are followed throughout the deformation history. Information from these points is transferred to a background computational grid, where the momentum equation is solved. The grid solution is then used to move the material points and update their properties.

The MPM technique is extremely flexible and MPM has been applied to impact, rebound, and penetration or perforation problems; and to manufacturing problems such as metal rolling, cutting, extrusion, and upsetting. It has also been modified to allow simulations of thin membranes, granular materials, ice, and fracture. A particular strength of MPM is its ability to use any constitutive model, including a model for snow. The short movie *Disney's Practical Guide to Snow Simulation*[20] explains how the Material Point Method was used to create realistic animations of snow for the Disney movie Frozen.

Professor Pavel Lushnikov recently solved a 135-year-old puzzle involving the formation of the limiting Stokes wave from the nonlimiting Stokes wave. Stokes found in 1880 that the oceanic wave of the greatest height (now called the limiting Stokes wave) has a $\frac{2}{3}$-power law singularity with a 120 degree sharp angle on the crest. The nonlimiting Stokes wave has a smaller height with a $\frac{1}{2}$-power law singularity in the complex domain. A study of the approach of non-limiting Stokes wave to limiting Stokes wave describes a mechanism of wavebreaking in the ocean, which is the primary mechanism of exchange of energy between oceans and atmosphere making it crucial for the global climate dynamics. Professor Lushnikov found that the nonlimiting wave has an infinite number of pairs of square-root singularities in an infinite number of Riemann-surface sheets. Increase of the steepness of the nonlimiting Stokes wave means that all these singularities simultaneously merge together forming the $\frac{2}{3}$-power law singularity of the limiting Stokes wave.

With the recent outbreaks of mosquito borne diseases such as Zika and Dengue it has become increasingly clear that there is a growing societal need for mathematical modeling to understand the spread and evolution of infectious diseases. Associate Professor Helen Wearing's research is focused on this topic and her interdisciplinary research group has active collaborations with researchers from fields that span virology to public health.

This particular field of research is growing and developing rapidly and requires expertise in modeling, theoretical analysis as well as incorporation of empirical data, using a combination of analytical, statistical and computational tools. Professor Wearing's research, which draws from classical techniques from the fields of dynamical systems and stochastic processes, has been widely recognized in publications in premiere journals such as Ecology Letters and the Proceedings of the Royal Society B.

An example of applied mathematics research at the intersection of mathematical modeling, numerical analysis and the fundamental understanding of physical processes is Assistant Professor Matthew Pennybacker's research on the development and analysis of models for self-organization in living systems.

A striking example of such self-organization can be found on the head of a sunflower where the seeds form spirals which arrange as Fibonacci patterns. The arrangement of organs (e.g. leaves, bracts, petals, seeds) on the surface of a plant is called phyllotaxis, and has been a target of scientific

[19] `https://en.wikipedia.org/wiki/Material_point_method`

[20] `https://youtu.be/z4e9i0sCX7c`

inquiry for many centuries. Professor Pennybacker's research, the theoretical and computational analysis of equations derived from gradient flows, has led to new developments that improve the understanding of the underlying mechanisms of such processes.

Examples from Pure Mathematics. Three examples of research themes pursued by the Pure Math group are: operator theory, global geometry, and arithmetic geometry.

Operator theory is a vibrant and diverse field of mathematics closely connected with physics and engineering and also applied in other areas of life. For instance, we deal with operators (also known under the name "matrices" in the finite-dimensional case) when we solve systems of linear equations or solve differential equations. Solving such a system involves finding the spectrum of the respective operator. The spectrum of an operator can have an important physical meaning; for example, the spectrum can correspond to frequencies of a vibrating body and we can also observe a rainbow of colors corresponding to different wavelengths/frequences of light. Another example is that observable quantities (like position and momentum of a particle) are described by operators in the mathematical formulation of quantum mechanics. Over the years a number of striking contributions in the area of operator theory were made by Terry Loring, a member of our Pure Mathematics group. As an example, in collaborations with physicists, Terry Loring was recently able to apply the K-theory of C^*-algebras to derive stability results in String theory. K-theory was introduced in the 1950s in the context of algebraic geometry and topology; C^*-algebras were introduced a little earlier in the context of operator theory. The two fields coalesced in the 1970s leading to what is now referred to as non-commutative geometry. These developments found striking applications to particle physics beginning with the 1990s and Terry Loring's work beautifully fits into these developments. Another member of our Pure Mathematics group, Anna Skripka, has recently made a series of spectacular contributions to operator theory and to non-commutative function theory. One of the questions that she has been working on is how perturbation of the parameters of a system affects important physical characteristics of the system. One of the real models behind this mathematical problem is how the free energy (that is, the energy that can be converted to work) of an imperfect crystal can be computed based on our knowledge of the free energy of the perfect crystal and of characteristics of the impurities. The imperfections exist due to vibrations of the crystal lattice sites and due to defects such as missing atoms, "wrong" atoms, etc. that are present in the lab grown crystals. These problems require sophisticated mathematical treatment; the larger the defect, the more delicate the methods that are needed.

Global geometry is also one of the most active fields in Pure Mathematics today. It originates with seminal work of Riemann (mid 1800s), it became the mathematical framework for Einstein's theory of relativity in the early 20th century, and spectacularly entered the picture of particle physics after the 1970s through the realization that physical space-time has extra dimensions modeled on sophisticated shapes described by Kähler geometry (the Calabi-Yau manifolds). The main theorems of the subject required, for their proofs, input from many corners of mathematics, including Riemannian geometry and partial differential equations. A number of people in the Pure Mathematics group are interested in the area of global geometry and have been collaborating on the subject. One of them is Dimiter Vassilev whose research concerns geometric structures, regularity and geometric properties of solutions of partial differential equations, their singularities or order of vanishing. His work has applications in the areas of (conformal) geometry of Riemannian and sub-Riemannian manifolds, analysis, complex analysis and singularity theory, fluid dynamics and physics. A unifying idea of a large portion of his work is the study of symmetric and steady state configurations relevant for geometric structures of physical importance. Another member of our Pure Mathematics group, Hongnian Huang, has obtained beautiful results in global geometry. To mention just one topic of his research, he has made an important advance in the study of the Calabi flow. This work fits into a very active area of research today centered around evolution in time of metrics on manifolds. These evolutions are controlled by sophisticated non-linear partial differential equations whose resolution depends on the understanding of the global geometry of the spaces involved. Ideas like these prove to be immensely powerful; they led in the past to the resolution of famous problems, for instance to the celebrated solution by Yau of the Calabi conjecture on Einstein metrics and to the celebrated solution by Perelman of the Poincaré conjecture about the homotopic characterization of spheres.

Real analysis has its origins in providing rigor to the core theorems of calculus. More generally though, its aim is to provide the groundwork for understanding functions of real variables and the operations on them, such as differentiation, integration, and others. An active field within real analysis is Fourier analysis. This field, which originated in the work of Joseph Fourier on heat transfer, seeks to represent and understand general functions as a sum or integral of trigonometric functions or perhaps other families of functions with a convenient structure. This type of analysis has proven to be effective for studying waves as well. Matt Blair seeks to provide a rigorous mathematical foundation for understanding many of the important equations in physics and engineering. Specifically, studying equations which model sound and light waves. A large portion of his work has focused on understanding how the presence of a hard surface affects the development of these waves, hence providing a link between geometry and the behavior of vibrational modes.

Finally, arithmetic geometry is a generalization of differential geometry to “numbers”. The standard derivative known from calculus, however, is replaced by a p-derivation or Buium derivative δ_p, named after its inventor our very own Professor Alexandru Buium. The p-derivation satisfies a modified product rule:

$$\delta_p(ab) = a^p\delta_p(b) + \delta_p(a)b^p + p\delta_p(a)\delta_p(b)$$

and a modified sum rule

$$\delta_p(a+b) = \delta_p(a) + \delta_p(b) + \frac{a^p + b^p - (a+b)^p}{p}.$$

Using these p-derivations it is possible to find arithmetic analogues of classical differential geometry constructs such as metrics, curvature and connections. Professor Alexandru Buium and his students have made many contributions to this flourishing field.

Examples from Statistcs. Assistant Professor James Degnan’s research has been primarily applying statistical and probabilistic methods to questions in evolutionary biology and genetics. In particular Degnan has worked in human genetics and in applying ideas from population genetics to phylogenetics, the goal of which is to find evolutionary trees (like family trees) that show which species are most closely related. His work has been particularly successful in terms of its impact on other researchers understanding relationships between gene trees and species trees, the design of simulation studies for methods of inferring species trees, and in giving theoretical justification to methods for inferring species trees.

Professor Gabriel Huerta’s applied statistical research has been in collaboration with the Institute of Geophysics of the University of Texas-Austin and addresses uncertainty quantification issues in the context of climate models. This work has been funded by the National Science Foundation and the U.S. Department of Energy. Climate models are typically large-scale computer models that depend on various initial conditions (inputs) and that generate large amounts of data in the form of climate fields such as temperature or precipitation over grid boxes (outputs). One goal has been to develop adequate statistical models that account for spatial and field correlations to enhance model calibrations or tuning of inputs. A subsequent goal has been the study of how model calibration propagates uncertainty into predicting future climate scenarios globally or in particular regions of the Earth.

Associate Professor Erik Erhardt’s applied statistics research has been in the areas of human brain imaging, ecology, biology, and public health. His work developing statistical models for brain imaging data is a continued focus as Co-director of the Biostatistics and NeuroInformatics (BNI) Core for the Center for Biomedical Research Excellence (COBRE) in Brain Function and Mental Illness at the Mind Research Network. In particular, a number of projects focus on dynamic functional connectivity (dFC), models to help understand the spontaneous fluctuations of association between brain regions; his 2013 paper with Elena Allen provided a methodological path for dozens of researchers since. Furthermore, he wrote an invited book chapter to improve visual communication in brain imaging. He also has substantial statistical work in the use of stable isotopes to determine animal diets in ecology. Professor Erhardt is also well connected with many other disciplines, including projects in the areas of photosynthesis and (photo)respiration in plants, case-control studies of childhood Hodgkins lymphoma (CHL) and rhabdomyosarcoma, fish vaccination, field experiments for medicinal herbs, dialectical behavior therapy outcomes, and using packrat middens and ^{14}C-dating to understand how droughts caused a shift from ponderosa to piñon pine trees in the Southwest 5000 years ago.

5.D. **Abbreviated vita or summary of experience for each faculty member.** *Provide an abbreviated vitae (2 pages or less) or summary of experience for each faculty member (if a program has this information posted on-line, then provide links to the information).*

See Appendix C and Appendix D for an abbreviated vitae of each lecturer and tenure-stream faculty, respectively.

Reflective question.

Extension of 5A. Question not included. It is not proper to discuss the performance evaluation of an individual in this (public) document. We always do what is in our power to reward and recognize outstanding contributions.

Criterion 6: Resources and Planning

The unit has sufficient resources and institutional support to carry out its mission and achieve its goals.

The Department's resources fall into human and financial categories. We describe our current number of human and financial resources as *minimally adequate to inadequate.* Our current personnel struggle to achieve the goals of our teaching, research, and service missions. We do not have sufficient resources to adequately cover the demands of our varied curriculum, as evidenced by continued reliance on hiring large numbers of contingent faculty. Moreover, our current funding of staff salaries and staff coverage is inadequate. We delve further into these issues below. Nonetheless, despite ongoing and severe challenges, the Department continues to successfully support both a broad teaching mission and fundamental research in Mathematics and Statistics.

6.A. **Engagement in resource allocation and planning.** *Describe how the unit engages in resource allocation and planning. If the program or unit has an advisory board, describe the membership and charge and how the board's recommendation are incorporated into decision making.*

6.A.1. *Executive summary.* Resource allocation and planning is performed primarily by the Department Chair, staff, and committees on a semester-to-semester basis, with important decisions put to a faculty vote. The Chair consults with an Executive Committee comprised of four faculty drawn from the Department's four groups: Pure Mathematics, Applied Mathematics, Statistics, and Lecturers. See **Table 3** for the Executive Committee members over the 2016-2017 academic year. While the Chair is responsible for the assignment of committees, positions on the Executive Committee are subject to faculty nomination and vote. At a minimum, the Executive Committee performs faculty assessments and advises on both teaching loads and merit-based raises.

Significant allocation and planning duties overseen, but not directly performed, by the Chair are the following.

- Staffing of courses and curriculum planning.
- Assignment of (undergraduate and graduate) student worker duties.
- Committee charges.

6.A.2. *Listing of resources.* Under *human resources* we count the following.

- Administrative staff (4.5).
- Tenure-stream faculty (29), two of which are half-time.
- Lecturers (6).
- Contingent faculty (11 term instructors, 20 temporary lecturers).
- Graduate students (35 teaching and 5 research assistantships).
- Undergraduate student employees (2 office assistants, 3 graders, and 31 MaLL tutors).

We have two main goals in deploying human resources. The first goal is to serve our missions in undergraduate teaching and graduate training, including maintenance of a comprehensive curriculum ranging from basic and service to upper-level undergraduate and graduate courses. Because we not only prepare students for career paths in industry, government, teaching, and academics, but also serve as the gateway to science, technology, and engineering studies, our teaching mission is wide ranging and a marked challenge. The second goal is to advance fundamental knowledge in Pure Mathematics, Applied Mathematics, and Statistics. We stress that these goals are complementary.

Tenure-stream faculty in the Department teach six credit hours per semester, and are therefore expected to maintain a vigorous research program and perform other service roles on behalf of the Department. Again, research activity can not be separated from our teaching mission. Without such activity, our courses at all levels would suffer, and it would not be possible to train graduate students. Therefore, beyond the impact that fundamental research in mathematics and statistics itself has on society at large, engagement in such research has a multiplying effect.

Under *financial resources* we count the following.

- Unrestricted indices stemming from the University, and so ultimately tuition and state revenue. Among these are the department Salary Account ($3,963,514), the department Operating Account ($60,751), MaLL related funds, travel funds, and faculty Startup and Overhead funds.
- Restricted indices stemming from outside grants.

Criterion 6.B below describes the Department's budget in detail; here we only highlight those details pertinent to allocation and planning. Most of the Department's financial resources goes into salaries. Indeed, the operating budget, currently about 1.5 percent of the department Salary Account, has remained flat for nearly 20 years. The MaLL related expenditures are currently about 5 percent of the department Salary Account. Funding has been inadequate in several areas. Staff have not received a raise in three years, a period which has witnessed significant turnover in our main office with a resulting increase in the duties performed by the remaining staff. We are currently only able to fund colloquium and seminar speakers through Faculty research grants, primarily through the Simons Foundation. Finally, while our graduate program has been extraordinarily successful over the past decade, we nevertheless struggle to maintain it with the current number of dedicated assistantship lines.

6.A.3. *Staffing of 300+ level courses.* Staffing of 300+ level courses is the purview of the Scheduling Committee. Each semester a representative from each of the three departmental research groups works on the course assignments within that group. The graduate curriculum is already divided among the three groups, and staffing of these courses is carried out by consensus within each group. The schedule for all 300+ statistics courses is worked out within the Statistics group. Staffing of undergraduate 300-level mathematics courses requires coordination between the Pure and Applied Mathematics groups. While provisional schedules are developed by email and google documents, group meetings attend to outstanding issues.

Given the limits on faculty size, we aim to at least have all 300+ level courses taught by tenure-stream faculty; however, we believe that tenure-stream faculty should certainly have a larger presence in the calculus sequences (MATH 162 – Calculus I, MATH 163 – Calculus II, MATH 264 – Calculus III; MATH 180 – Elements of Calculus I, MATH 181 – Elements of Calculus II) and STAT 145 - Introduction to Statistics. In recent semesters Professor Monika Nitsche, as the Calculus Coordinator, and Professor Erik Erhardt, have taken an active role toward this end. However, we do not have enough tenure-stream faculty to cover all of our 300+ level courses, much less 100-level courses. As a result, we must rely on visiting postdoctoral researchers, scientists from Sandia Labs, and sometimes lecturers to fill out each semester's 300+ level offerings. While these substitutes often can perform on par with our tenure-stream faculty, this practice compromises our undergraduate teaching mission.

Under-enrollment in graduate courses is an ongoing challenge. The core course sequences of our graduate program correspond to PhD/MS written qualifying examinations, which all PhD and exam-option MS students must take. Since the timely progress of our graduate students relies on passing these exams within (typically) a two-year window of entering the program, these core sequences must run every year. If these courses are also to run within the University rules for enrollment (at least 6 students for a graduate course), then we need to admit into our program upwards of 15 or more new graduate students each year (ideally 5 or more in Pure Mathematics, Applied Mathematics, and Statistics). Graduate students earning their degrees through research projects (PhD and thesis-option MS) often rely heavily on their faculty advisors. This places a significant burden on an already stretched faculty. More TA lines, particularly targeted at out-of-state and international students that can be expected to obtain the MS degree through the exam-option, would certainly improve the health of our graduate program. As demonstrated elsewhere in this document (see section 3.D.2 and B) our degree-earning students are finding success in their post-graduate careers.

6.A.4. *Staffing of 100 and 200 level courses.* The following are computer assisted courses held in the MaLL.

- MATH 101 – Intermediate Algebra Part I
- MATH 102 – Intermediate Algebra Part II
- MATH 103 – Intermediate Algebra Part III

Dr. Srini Vasan is in charge of all MaLL operations, and he hires undergraduate tutors to assist. Each section of the course is assigned an instructor. The computer-prompted learning environment changes the nature of interactions with instructors, but instructors remain essential in guiding students, ensuring that they maintain adequate progress, and fielding questions. The remaining lower level courses are

- MATH 111 – Math for Elementary School Teachers I
- MATH 112 – Math for Elementary School Teachers II
- MATH 121 – College Algebra
- MATH 123 – Trigonometry
- MATH 129 – Survey of Math
- MATH 150 – Pre-calculus Math
- MATH 153 – Pre-calculus and Trigonometry
- STAT 145 – Intro to Statistics

as well as the Calculus sequences listed in the last subsection. These service courses support a much larger student body than our 300+ level curriculum, and present different challenges in their staffing. Currently, the scheduling of all lower-level undergraduate courses is initially drafted by the Department Administrator, Deborah Moore, with significant further adjustments by tenure-stream and contingent faculty. Both Senior Lecturer Nina Greenberg and, more recently, Associate Professor Erik Erhardt have assisted with the assignments for STAT 145. Lecturer Tim Berkopec, Principal Lecturer Jürg Bolli, Senior Lecturer Karen Champine, Senior Lecturer Derek Martinez, and Lecturer Karen Sorenson-Unruh assist with the scheduling of lower-level mathematics courses. Professor and Calculus Coordinator Monika Nitsche has taken the lead in assisting with the staffing of Calculus courses. Typically, 100 and 200 level courses are taught by contingent faculty, graduate students and lecturers.

6.A.5. *Assignment of student duties.* Our Department's graduate student TAs serve vital roles in teaching courses, leading recitations, and grading for both upper level undergraduate and graduate courses. Teaching roles are assigned by the Department Administrator as described in the last subsection. Grading assignments are made by the Department Program Specialist, Ana Parra Lombard, in concert with the Graduate Committee. In recent semesters, Professor Cristina Pereyra has worked out the grading duties for graduate students. Guidance from the tenure-stream faculty is crucial here, since assessment of students' background knowledge is necessary before they are assigned to assist with upper level undergraduate courses. Grading of graduate courses falls to our most senior graduate students. Typically, there are too few of these advanced students to cover all possible assignments. Undergraduate graders and office staff assignments are made respectively by the Department Program Specialist and Administrator.

Committee	Fall 2016 & Spring 2017 members (c=chair)
Executive	K. Champine, J. Degnan, S. Lau, J. Vassilev
Undergraduate	M. Blair (c), E. Erhardt, M. Nitsche, J. Vassilev
Graduate	C. Pereyra (c), H. Huang, Y. Lu, M. Motamed, D. Vassilev
Scheduling	A. Buium (c), J. Chaudhry, G. Zhang
Undergraduate Honors	M. Nitsche (c), J. Degnan, H. Wearing, M. Zinchenko,
Computer Use	A. Korotkevich (c), E. Erhardt, M. Pennybacker, D. Sulsky
Website	Y. Lu, M. Motamed, D. Sulsky
Colloquium	A. Skripka (c), S. Lau, L. Li
Promotion & Tenure	R. Christensen (c), D. Vassilev
Library Liaison	D. Vassilev
Putnam Exam	D. Appelö, M. Zinchenko
Stat Clinic	J. Degnan (director)
PNM-UNM Contest	D. Appelö, J. Vassilev
Academic Program Review	D. Appelö, A. Buium, G. Huerta, S. Lau, M. Nitsche, C. Pereyra, D. Sulsky, J. Vassilev
Future of Math Education	M. Nakamaye (c), E. Erhardt, C. Pereyra, D. Sulsky

Table 3. Current committee assignments.

6.A.6. *Committee charges.* Current committee assignments within the Department are listed in **Table 3**. Not all of the committee charges can be construed as resource allocation and planning. Therefore, we only comment on pertinent charges. The charges of the Executive and Scheduling Committees have been described above. The Colloquium Committee has the responsibility of allocating funds to bring in outside speakers. Since there are no such funds provided by the University this academic year, all speakers have been supported through the department's Simons Foundation grants. These grants support research in Pure Mathematics, with some funding explicitly targeted for speakers.

Both the Undergraduate and Graduate Committees are involved with curriculum planning. Issues with our program are first identified by these committees or by other departments. Potential changes to the curriculum are first discussed in faculty meetings and ultimately voted on. The Graduate Committee is also responsible for semester-by-semester review of graduate applications and admissions.

6.B. **General budget.** *Provide information regarding the unit's budget including support received from the institution as well as external funding sources.*

The Department Office is a large academic enterprise which services students taking an average of 20,000 credit hours per semester, as well as the needs of faculty and graduate students. Each year the College provides the Department with an operating budget of approximately $60,000. In addition to the operating budget the Department has forty-six (46) other unrestricted indices which include faculty Start-Ups, faculty Overhead Return, Payroll, Public Service, Extended University, Course Fees, and the department Overhead Return. The Department currently handles seventeen restricted indices with fiscal year budgets totaling $3,391,081 and available balances nearing one million dollars. Additionally, there are eight foundation and endowment indices with corpus funds over one million and spendable funds of nearly $450,000.

The following tables summarize the department accounts. The unrestricted indices are the department and faculty accounts listed in **Table 4.** The restricted indices are faculty grants and endowments, respectively shown in **Tables 5** and **6**.

6.C. **Staff composition.** *Describe the composition of the staff assigned to the unit (including titles and FTE) and their responsibilities.*

The staff composition of the department has changed considerably since the last academic program review; see **Table 7**. At that time, the Department included six (6) full-time and one (1) part-time

Department accounts		
Dept Salary Acct	869041	$3,963,514
Dept F&A	869086	$3,620
Chair's Account	869091	$8,145
Plant Fund	869135	$37,123
Dept Operating Acct	869209	$60,751
Extended University	869360	$14,497
Math Course Fees	869150	$32,838
Stat Clinic	869354	$500
Stat Clinic Consulting	869095	$1,974
NonLinear Student	869089	$1,202
Mu Sigma Rho Honor Soc	869139	$63
Math Learning Lab (MaLL)	869373	$150,655
Precalculus Fund	869094	$2,500
UNM/PNM Program	869093	$53,300
KME Math Honor Society	869087	$1,479
Dean Funded Travel Fund	869394	$13,000

Faculty accounts			
Appelö	869329	Startup	$478
Appelö	869376	IDC	$792
Blair	869172	Startup	$9,763
Blair	869312	IDC	$1,973
Chaudhry	869402	Startup	$13,097
Christensen	869052	IDC	$3,956
Degnan	869383	Startup	$1,922
Erhardt	869317	Startup	$4,998
Erhardt	869377	IDC	$699
Huang	869396	Startup	$2,644
Huerta	869347	IDC	$18,884
Korotkevich	869358	IDC	$81
Lau	869170	Startup	$4,703
Lau	869350	IDC	$846
Li	869395	Startup	$8,810
Loring	869306	IDC	$1,352
Lu	869397	IDC	$183
Lushnikov	869309	IDC	$2,347
Motamed	869384	Startup	$7,534
Nitsche	869315	IDC	$72,814
Pennybacker	869380	Startup	$1,753
Pereyra	869316	IDC	$531
Skripka	869363	Startup	$3,379
Skripka	869375	IDC	$1,341
Sulsky	869307	IDC	$1,924
Vassilev, D.	869355	IDC	$226
Vassilev, J.	869364	Startup	$11,814
Zinchenko	869362	Startup	$629
Zinchenko	869389	IDC	$91

TABLE 4. Indexed accounts.

Agency	Title	PI	Revised budget	End date
National Science Foundation	Hybrid Hermite-Discontinuous ...	Appelö	$258,196	7/31/2017
National Science Foundation	Fourier Analysis on Bounded ...	Blair	$145,000	7/31/2017
National Science Foundation	Dispersion in Fourier ...	Blair	$108,052	8/31/2019
Simons Foundation	Extremal Sasakian Geometry	Boyer	$35,000	8/31/2017
Simons Foundation	Arithmetic Differential Geometry	Buium	$14,000	8/31/2019
Sandia National Laboratories	Adjoint based analysis and ...	Chaudhry	$47,000	9/30/2016
University of Alaska	Mathematical and computational ...	Degnan	$190,732	8/31/2019
Los Alamos Nat. Security, LLC	Simulation Tool for Realistic Gas ...	Korotkevich	$141,800	12/31/2016
National Science Foundation	Sparse Spectral-Tau Methods for ...	Lau	$131,490	8/31/2016
Simons Foundation	Operator Algebras with Applications	Loring	$35,000	8/31/2017
Simons Foundation	Operator Algebras and Topological ...	Loring	$35,000	8/31/2021
National Science Foundation	Spontaneous Formation of Singularity ...	Lushnikov	$240,000	7/31/2017
National Science Foundation	Attracting, Motivating and Preparing ...	Nitsche	$1,198,603	4/30/2017
National Science Foundation	New Mexico Analysis Seminar ...	Pereyra	$49,388	12/31/2016
National Science Foundation	Problems in Operator Theory	Skripka	$99,855	6/30/2018
National Science Foundation	CAREER Anna Skripka	Skripka	$34,657	6/30/2021
Nat. Oceanic & Atmos. Admin.	Sea Ice Mechanics and the ...	Sulsky	$570,178	7/31/2018
Simons Foundation	Geometric Analysis Related ...	D. Vassilev	$21,000	8/31/2018
National Science Foundation	Southwest Local Algebra Meeting	J. Vassilev	$15,130	12/31/2017
Simons Foundation	Spectral Theory for Almost ...	Zinchenko	$21,000	8/31/2018

TABLE 5. Recent and active grants. The total of fourth column is $3,391,081.

staff members. The current staff includes four (4) full-time and (1) part-time staff members. The numerous reclassifications of positions and shuffling of staff has been tumultuous.

Endowment Name	Purpose	UNMF Account	Value 7/1/2015	Earnings (Loss)	Spending Distribution	Value 6/30/2016
Efroymson Colloquium	program	622690	$50,987.43	($1,618.08)	($1,941,69)	$47,427.66
Efroymson Fellowship #1	scholarship	600930	$71,544.28	($2,270.42)	($2,724,53)	$66,549.33
Efroymson Fellowship #1-Match	scholarship	631780	$28,176.42	($894.17)	($1,073,01)	$26,209.24
Efroymson Fellowship #2	scholarship	601280	$44,779.26	($1,421.06)	($1,705,27)	$41,652.93
Efroymson Fellowship #2-Match	scholarship	631790	$29,586.72	($938.93)	($1,126,71)	$27,521.08
Efroymson Lectureship #1	faculty	631600	$106,850.13	($3,390.87)	($4,069,04)	$99,390.22
Efroymson Lectureship #2	faculty	631610	$108,528.55	($3,444.11)	($4,132,96)	$100,951.48
Eleanor Marron and J. Joseph Lopez Memorial Scholarship in Mathematics and Statistics	scholarship	608010	$43,111.67	($1,368.13)	($1,641,77)	$40,101.77
Math and Stats Total			$483,564.46	($15,345.77)	($18,414,98)	$449,803.71

Table 6. Department endowments.

Staff Comparison	
2007-2008 staff	2016-2017 staff
Department Administrator II	Department Administrator III
Administrative Assistant III (Fiscal)	Sr. Fiscal Services Tech
Administrative Assistant III (Programs)	
Coordinator of Program Advisement	Program Specialist
Unit IT Support Manager (0.6FTE)	
Systems Analyst III	
Systems Analyst II	
	Coordinator of Education Support
	Building Manager (0.5FTE)

Table 7. Department staff in 2007 and 2017.

Between 2008 and 2016 the Department Administrator position has been held by three individuals and reclassified by the University from Department Administrator II to Department Administrator III. The Department Administrator (DA) position, currently held by Deborah Moore, manages and organizes the daily functions of this large, key academic department. The DA oversees fiscal and budgetary management, human resource administration (including staff and faculty searches), and facilities and resource management. The DA supervises staff, coordinates research contract and grant efforts, handles scheduling and instructor assignments, manages promotion and tenure files, provides data for workload and annual reports, and oversees the development and implementation of operational procedures and special projects.

The Coordinator of Program Advisement position was responsible for the advisement of undergraduate and graduate students, coordinating graduate recruitment (including the hiring of teaching and research assistants, and graders), overseeing catalog updates and changes, planning convocation, and serving a liaison for the department with other UNM and off-campus constituents. In 2014 the College of Arts and Sciences reorganized the structure of undergraduate advising, and the Department was assigned a part-time undergraduate advisor to work with our students as well as students in other departments. Due to this change the Department sought a reclassification of the Coordinator of Program Advisement position and requested to move Ana Parra Lombard into the position of Program Specialist. In her new role, Ana remains responsible for all administrative aspects of the graduate program, and she has taken on new responsibilities such as assisting with the course scheduling and instructor assignment, developing alumni tracking systems, and maintaining internal manuals, handbooks and policy documents.

In 2012 the Administrative Assistant III (Programs) position was downgraded to a part-time Administrative Assistant II (0.50FTE). In 2013 the Department received permission to change the

Administrative Assistant II position to full-time. The Administrative Assistant II was responsible for overseeing the main office, addressing questions, directing visitors, ordering supplies, answering the telephone, and processing the bi-weekly and monthly time-sheets. This position has since been vacated and eliminated.

The second Administrative Assistant III (Fiscal) position was vacated in 2010, and the Department replaced this position with a Senior Fiscal Services Tech position. The Senior Fiscal Services Tech is responsible for preparing and processing routine financial documents and fund transactions, and reconciling financial records including budgets, grants, contracts, payroll, employment, travel, and purchasing. Two separate staff members either held this position or performed its duties before Crystal Davis was hired as the Senior Fiscal Services Tech in 2016.

The Unit IT Support Manager retired in 2011 and this position was absorbed by the College. The Systems Analyst II was released from his position in 2011 due to University budget cuts. The position was initially retained in the Department but reduced to 0.5FTE. The position was then converted to full-time in 2014 and reclassified as a Senior Application Support Analyst, with the primary responsibility to supervise the System Analyst III position and to oversee and design all operations of the department IT network systems, servers, hardware, and software. In 2016 the University reclassified this position to the title of IT Services Specialist. The person holding this position resigned in 2016 and the College has since provided part-time staffing.

Also in 2016, the System Analyst III position, was reclassified by the University to Systems/Network Analyst III. The person holding this position retired that same year. The College has been providing temporary, part-time staffing for this position as well. This position was responsible for managing all IT network and system services for the department, as well as inventory control.

Upon a directive from President Frank, the Department opened the Math Learning Lab (MaLL) in the summer of 2012. The MaLL provides computerized, individual instruction to students taking our Intermediate Algebra courses. The MaLL was originally supervised by a full-time lecturer who subsequently resigned to move to the University of Illinois, Chicago. Dr. Srini Vasan was hired as the Coordinator of Education Support in 2013, and he supervises all aspects of the MaLL curriculum, computers, scheduling, and supervision of instructors and tutors. At the time of his hire, Dr. Vasan requested a staff position rather than Lecturer.

In 2011 the new Science and Math Learning Center (SMLC) was opened and Robert Ortiz was hired as a temporary Facilities Services Manager. This position was shared (50/50) with the Department of Chemistry and Chemical Biology. In 2012 this position was converted to a permanent position and Robert Ortiz was retained (0.5 FTE Math/Stat and 0.5 FTE Chemistry/Chemical Biology). This position supervises all physical and operational aspects of the SMLC including maintenance requests, safety policies and procedures, access requests, special events planning and scheduling, and classroom logistic support.

The changes in staffing over the years has left a gap at the Administrative Assistant I or II level, *i.e.* someone responsible for addressing questions, directing visitors, ordering supplies, answering the telephone, and processing the bi-weekly and monthly time-sheets. These tasks are currently only partially covered by work-study students who are present for part of the day. Moreover, the recent loss of all IT support within the Department is alarming, and may have a severe impact on computing research, a historic strength of the Department.

6.D. **Library resources.** *Describe the library resources that support the unit's academic and research initiatives.*

Assistant Professor Laura Soito, a librarian at Centennial Library, is designated to work with the Department of Mathematics and Statistics. Laura gives yearly presentations to our graduate students and faculty in regards to the available library resources. She is also readily available to meet with our faculty and corresponds regularly with our Department's library liaison (Dimiter

Vassilev), particularly in terms of receiving and evaluating new and current requests for books and journals.

The library resources are listed in the following subsections.

6.D.1. *Content/reference material in electronic and physical formats.* In addition to a good selection of hard copies of mathematics and statistics-related literature the Science Library has various access to the following databases and collections.

Databases for finding articles.

- MathSciNet. This electronic continuation of Mathematical Reviews, contains searchable reviews, abstracts, and citations from the mathematical literature. It is produced by the American Mathematical Society.
- Web of Science Core Collection. A multidisciplinary index to the journal literature of the sciences, including Science Citation Index Expanded. Allows current subject searching as well as searching by cited authors.

Book Collections and Reference Sources.

- Encyclopedia of Mathematics. Developed as a collaboration between Springer and the European Mathematical Society.
- EBSCO eBook Subscription Academic Collection - North America.
- The Princeton Companion to Mathematics. Introduction to basic mathematical terms and concepts. Includes sections on mathematical history, biography, and connections to other disciplines.
- ProQuest Dissertation and Thesis Global Full Text. Citations and abstracts for dissertations and theses, dating to 1861. It contains a collection of 3.8 million graduate works, with 1.7 million in full text. Designated as an official offsite repository for the U.S. Library of Congress.
- LoboVault. Dissertations, theses, data sets, and other publications from the UNM Journal Collections.
- AMS Journals. Journals from the American Mathematical Society.
- Project Euclid. Electronic platform for mathematics and statistics journals. Many open source.
- SIAM Journals. Journals from the Society for Industrial and Applied Mathematics.
- JSTOR. Access to content for core scholarly journals in a variety of disciplines, including math and science.
- ScienceDirect. Elsevier's journal portal provides full-text access to select scientific, technical, and medical journals.
- Springer eBooks on Mathematics and Statistics. Full-text access to select mathematics and statistics journals published by Springer Verlag. The collection includes their Lecture Notes in Mathematics.

6.D.2. *Research data services.* The UNM Library's Research Data Services Program (RDS) provides a wide variety of services in support of effective research data planning, management, preservation, discovery and use. In addition to consultation and support services, the RDS team also provides support for several key research data infrastructure capabilities that are maintained by the Library for use by UNM's research community.

- Data Management Planning. As data sharing becomes a national priority, the National Science Foundation and many other grant funding agencies require data management plans.

Data librarians can help create data management plans that meet grant application requirements. Operational data management serves for the life of the research project. Data management plans are centrally archived and available for reuse.

- Data Reference. Working in data intensive research areas often requires access to data developed and shared by others. The RDS team helps with research activities by locating data for use in proposals, pilot or research projects and instructional programs. They also evaluate alternative data management tools, technologies and strategies, identifying both on- and off-campus collaborators.
- Data Management. The RDS team supports end-to-end data management and provides recommendations for data management strategies and work-flows; analysis tools and technologies; visualization tools and technologies; and strategies for meeting computational and data intensive research needs.

6.D.3. *Interlibrary Loan and Library Express.*

- Interlibrary Loan. Allows borrowing materials from another library. Books are held at the Zimmerman Service Desk. Articles are posted to ILLiad accounts.
- Library Express (LibXp). A document delivery service that allows requesting materials from the UNM Libraries. Books are held at the service desk of the appropriate branch library. Articles are posted to ILLiad account.

Reflective questions.

Extension of 6.A. Math generates approximately $5M in GenEd courses based on the new tuition-shared model. How is this revenue being utilized to improve resources and the quality of Math GenEd courses? What strategic plan efforts have you discussed with your dean to ensure this revenue is being utilized to improve resources and the quality of the Math GenEd courses?

Over the last decade we have worked with the College to increase the number of Lecturers and Term Faculty so that the reliance on part-time Instructors is somewhat less. Although the number of Lecturers has stayed the same, we have increased Term Instructors and reduced part-time Instructors. Funds have also been invested in the development of the MaLL.

No tuition sharing model has yet been applied across the University, much less in the College, in a way that would actually change allocations. For this fiscal year, a model was applied to colleges, the colleges were then taxed for benefits, resulting in reduced allocations to all colleges. Finally, "compacts" were used to restore the budget of each college to that of the previous fiscal year. Following this, all budgets have been restricted due to changes in the State budget. Thus, the College has less money to work with this year than last year and most of that budget is committed to the salaries of existing employees.

Extension of 6.A. What are the alternative avenues that have been or could be explored within UNM and/or statewide to generate additional revenue in order to maintain the quality of programs and courses offered?

We recently instituted a course fee in the MaLL to fund replacement and maintenance of the MaLL computers and part of the staff line to manage the MaLL. This preserves revenues for other parts of the curriculum. However, since most of the costs of General Education courses are direct instructional costs, they cannot be generated by course fees.

We note that the Department has sought federal funds and obtained two successive MCTP grants from NSF, approximately $2M, to support summer programs and research projects for undergraduates. In addition, the grants supported training and mentorship of graduate students and post docs, who in turn supported undergraduate programs through teaching and mentorship.

Criterion 7: Facilities

The facilities associated with the unit are adequate to support student learning as well as scholarly research activities.

Office space within the Science and Mathematics Learning Center now meets our needs. Classroom space is shared across campus. We have adequate space to hold classes, although classroom design is often suboptimal and classroom technology does not always work well. The space in Centennial Library housing the MaLL meets our needs. We have sufficient computing equipment, although we struggle to fund maintenance and upgrades since this is not explicitly in our budget. Support staff for our computing needs is inadequate.

7.A. **Facilities associated with the unit and associated programs.** *Describe the facilities associated with the unit and associated programs including, but not limited to, classrooms, program space (offices, conference rooms, etc.), laboratories, equipment, access to technology, etc.*

The UNM Science and Mathematics Learning Center (SMLC) was formally opened on March 4, 2011. The 62,000 square foot, three story facility includes a 200-seat auditorium, visualization lab, "smart" classrooms, science labs, department and faculty offices, and study areas. A new addition to the building was opened in 2015 housing two organic chemistry labs and additional office space for the Department.

7.A.1. *Classroom space.* The SMLC has three small classrooms, an auditorium, and two teaching computer labs; see **Table 8**. All are managed by UNM's centralized Scheduling Office. The Department must request use of these rooms; however, as occupants of the building, our requests have priority over others. Due to the lack of classroom space in the SMLC, the majority of our classes are held in University-managed space in buildings such as Dane Smith Hall and Mitchell Hall.

Nowadays, collaborative classrooms are in great demand. The campus has relatively few such classrooms, with a majority housed in the Collaborative Teaching and Learning Building (CTLB) supervised by the College of Education. Faculty must submit proposals for using the new CTLB Learning Studios each semester, with no guarantee of placement in a collaborative classroom.

7.A.2. *Department space.* With the completion of the third-floor office space in 2015, the Department finally had enough space to move part-time instructors into the SMLC. Previously, they had been housed in the Humanities Building, without adequate office support. Eight (8) SMLC offices are currently shared by twenty-six (26) part-time instructors. The Department currently has forty (40) offices for full-time, tenure-track faculty, lecturers, and emeriti. Five (5) offices are reserved for staff, two (2) for post-docs, and sixteen (16) for approximately fifty graduate students. Additionally, the Department has three small conference rooms for meetings and small seminars.

Room	**Capacity**	**Description**
SMLC 102	196	Auditorium seating
SMLC 120	42	Collaborative seating
SMLC 352	24	Seminar seating
SMLC 356	33	Seminar seating
SMLC B59	24	Computer teaching lab (PCs)
SMLC B81	24	Computer teaching lab (PCs)

Table 8. SMLC classrooms. Note that room 120 was designed specifically for Math Education classes.

7.A.3. *MaLL.* During the Fall 2012 semester a pilot program was implemented to convert MATH 120 Intermediate Algebra into three one-credit computer-based learning modules (MATH 101, 102, and 103). The pilot was offered in one of the SMLC computer labs. The concept of the MaLL was based on the Kent-State model implemented at the behest of then President Frank. The current MaLL facility is housed in the basement of Centennial Science and Engineering Library. It has 126 computers in the main room and 15 computers in the testing room. Twelve sections of MATH 101, 102, 103, as well as two sections of MATH 121 College Algebra are offered each fall and spring semester. In summer the MaLL offers regular classes in addition to hosting the Native American Indian Summer Bridge Program, the African American Summer Bridge Program, and the Early Start Program.

7.A.4. *Dedicated research facilities.*

- **Visualization Lab.** The visualization lab (SMLC 118) is a collaborative space providing immersive 3D visualization. Three-dimensional rendered graphics content can be displayed on an active rear projection screen on one wall. In addition, three passive 3D ceiling projectors illuminate marker boards on the other three walls. Unique images can be displayed on each surface, allowing multiple research groups or multiple displays within a group. The room is also equipped with surround sound and high-band-width polycom for live teleconferencing with bi-directional video and audio.
- **Statistics Consulting Clinic (SCC).** The SCC (SMLC 358) is an internal statistical consulting service of the University of New Mexico. Staffed by statistics faculty and advanced statistics graduate students, the service is offered without charge to faculty, staff, and student clients at UNM in support of their academic research and other statistical needs. The SCC's goals are to promote scientific collaboration between disciplines, enhance the quality of research at UNM, and improve the education of UNM students through hands-on involvement with the use of statistics in other fields. This service is funded by the College of Arts and Sciences and the Department.

7.A.5. *Computing equipment/technology.* The department has about 180 computers, of which 46 are servers and the rest are desktop computers. Our computers are on a Virtual Local Area Network (VLAN) branched off the campus network, and behind our own firewall and Network Address Translation (NAT). The NAT shields our VLAN computers from the outside in order to prevent hacking. There are about 220 user accounts on the department network. Accounts are for faculty (tenure-stream, lecturers, and contingent faculty), graduate students (TAs and RAs), a few outside collaborators, and occasional visitors. The desktop computers are mostly surplus Dell computers from the Law School. They have i5 or i7 processors. All have a minimum of 4Gb of RAM, and most have 8Gb. Their operating system is state-of-the-art, production Ubuntu (Linux). The OS is installed with a remote desktop application (RDP) that allows users to connect to a Windows 7 desktop on a server. Each office has at least one desktop, and student offices with more than one occupant have two. A graduate student computing lab in SMLC B71 has 12 computers with i7 processors (10 with 4Gb RAM and 2 with 8Gb RAM). This is a common room with computers available to any user. (Department computers mount home directories automatically, so users have access to their files and personal computing environment on any department computer.) There is a printer in the basement lab and there are also shared printers on the second and third floors. Our two Sharp copiers also act as printers.

The three classrooms in our building (SMLC 120, 352, and 356) have computers on our department VLAN, and are connected to ceiling-mounted projectors. These computers also run Linux and RDP to Windows. Among the servers on our network are two compute servers, Sonrisa and Joyspride. Respectively purchased in 2007 and 2008, these servers are getting on in years. Joyspride has 4 CPUs and 10Gb RAM; Sonrisa has 8 CPUs and 8 Gb of RAM. These servers are on a DMZ (i.e. not behind the NAT), and they provide remote access and platforms for more substantial computing jobs than can be run on a desktop. SMLC 118 contains the 3D visualization lab with a computing cluster (16 cores), 3-wall projectors, and 1 rear-projection wall-sized monitor at the front.

The servers on our VLAN provide Firewall, NAT, VPN, authentication (NIS), Mail, DNS, and ticketing. They also provide file service, Web service (unsecured and secure), database service, SVN (version control) service, list service (department mailing lists), remote monitoring, and maintenance. Another server, running BRU software connected to a tape drive, maintains backups of all user accounts and images storage. Finally, another server hosts the virtual Windows machines. Figure 8 shows a network diagram. Our server room also houses 5 computers purchased with external funds for specific computing projects.

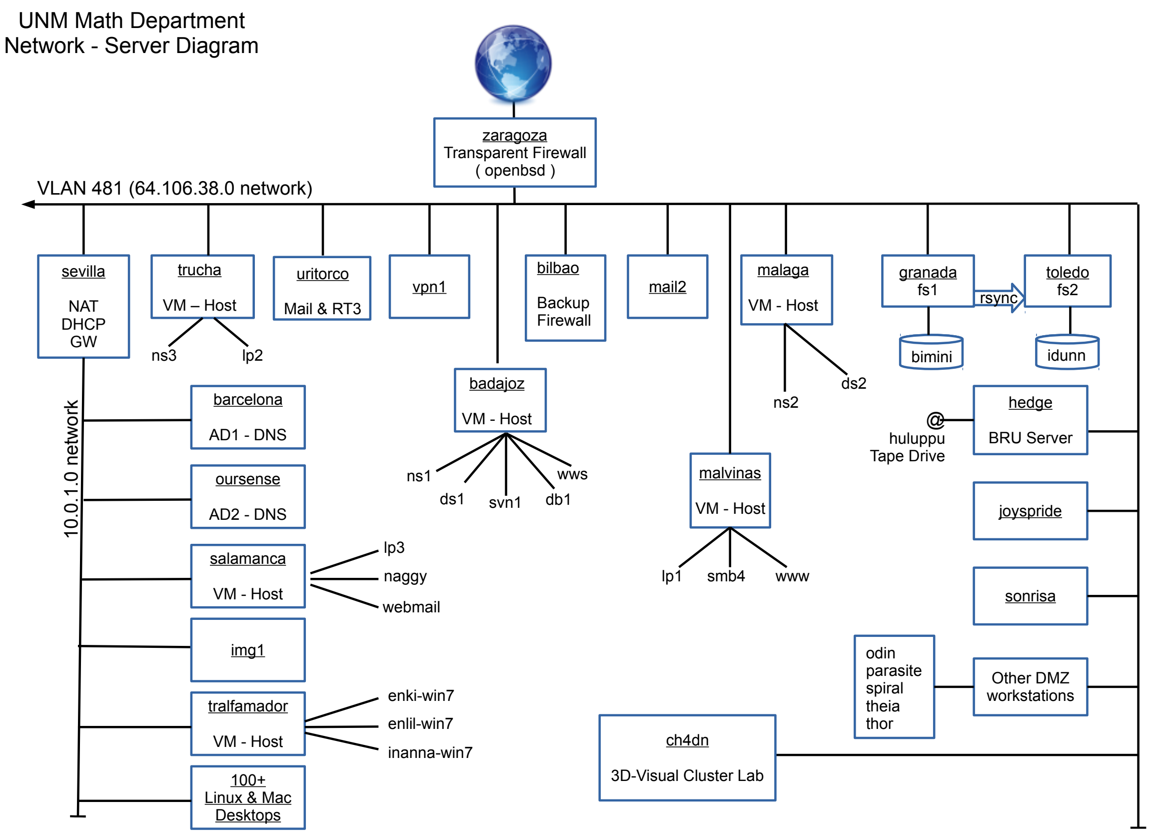

FIGURE 8. Network Diagram.

7.A.6. *Changes since our last APR.* Our servers were upgraded when we moved to the SMLC, and we have been able to secure funds for new purchases as needed. The surplus Law School computers have provided improved equipment for students, contingent faculty, and most tenure-stream faculty. We have discarded old single-core 32-bit computers that students had been using. Rather than one computer in each shared student office, we now have at least two. The use of virtualization for

Windows has notably improved the stability of our computing systems, through elimination of roaming profiles, separate file service for Windows, and dual-boot office machines.

7.B. **Computing facilities maintained by the unit.** *Describe any computing facilities maintained by the unit.*

As of September 9, 2016, no computing equipment is maintained by the Department of Mathematics and Statistics. This function has been taken over by the College. The College has committed at least 0.75 FTE to the Department, and possibly 1.25 FTE if someone new is hired.

7.B.1. *Prior computing support.* For many years we had computer support within the department at 2.6 FTE. This support consisted of a full-time Systems Analyst III, a full-time Systems Analyst II, and a a Unit IT Support Manager (0.6 FTE) providing web and database support. Computer Science (CS), Electrical and Computer Engineering (ECE), and Mathematics and Statistics –departments with a similar research focus on computational science– require in-house systems support. ECE currently employs a Systems/Network Analyst I (grade 12) a Systems/Network Analyst II (grade 13), and additional student employees. CS employs two IT Service Specialists (grade 15) and student employees.

Historically, with 1.0 FTE we are able to maintain the status quo for a year or two, but we are not able to upgrade our systems as better solutions become available. With a second 1.0 FTE, the staff is able to work on projects that enhance provided services.

7.B.2. *Services historically provided by department systems support staff.* Our staff made sure that various servers were up and running, and running current versions of the operating system with current security patches. They were able to monitor all desktops and servers through software accessible via a web browser, and were able to send out configuration changes and fixes from a single location. The staff also maintained and responded to a ticketing system which logs user requests and solutions. The staff was responsible for account creation/deletion, inventory control, and desktop support (installation and maintenance of computer hardware and problem response). In addition, computer (and related) purchase and life-cycle tracking (inventory) were performed by the systems staff. The staff maintained databases (computer, software, knowledge-base) to help perform these tasks efficiently.

The staff was also responsible for designing and recommending upgrades and planning the use of new technology. They were available to configure experimental hardware, install software on new hardware configurations and consult on new hardware procurement for research in computational mathematics.

Our systems support staff were also on call for emergencies.

7.B.3. *Current status of computer support.* When the Unit IT Support Manager (0.6 FTE) retired in 2011, the College absorbed the position with a promise of providing web support. Our web content was moved to a new content management system by College personnel. The College provides bug fixes and upgrades for this system but it is now up to faculty and remaining staff to maintain the content. Moreover, the database that we used to dynamically update certain content was disabled, now requiring manual entry in several locations. Thus, we no longer have a staff person responsible for web content, and the process for updating content has been made more time consuming.

Before retirement and resignation of our systems support, several projects had been planned. The Computer Use Committee is in discussions with the College IT regarding these projects. It is not clear if services will be maintained in the Department or if they will be moved under central UNM/IT control. It is also not clear what impact these changes will have on computing research within the Department. In the past, UNM/IT has not been able to meet our needs, so this is a source of great concern.

The Visualization Lab was built and initially funded when the SMLC was constructed. A year after the lab was operational, a fan failed in the equipment room and the cluster was damaged. We found funds to repair the cluster, but had only one person on the IT staff at the time and we were not able to bring the cluster back on-line. Recently, UNM/IT Classroom Technologies has offered funds to upgrade equipment in the Lab. The College IT has taken over management and is working with UNM/IT to make the lab operational, but the Department has lost say in the equipment to be purchased and control of the lab.

Criterion 8: Program Comparisons

The programs within the unit are of sufficient quality compared to relevant peers. (Differentiate by program where appropriate.)

In detailed comparisons with 8 peers, the Department ranks fourth or fifth based on examination of external rankings or external honors received by professors, and second in PhD production. Among the 22 official peers, we rank third in PhD production per faculty member. In these measures we also rank higher than several peers with a lower teaching load. Given the resources available at UNM for research, the Department is highly competitive in research output.

8.A. **Quality measures and peer comparisons.** *Provide information on the distinguishing characteristics of the programs within the unit (please use the template provided as Appendix G as a guide). Discuss the unit's programs in comparison with other programs such as number of faculty, student characteristics, curricula, and types of programs:*

- *Parallel programs at any of our 22 peer institutions. http://oia.unm.edu/miscellaneous/unm-peer-institutions.html*
- *Parallel programs at other peer institutions identified by the unit.*
- *Regional and national comparisons of academic programs.*

8.A.1. *Executive summary.* The University of New Mexico has 22 official peer institutions. The next subsection compares characteristics of these programs using the required template and additional graphs. With this additional information, we identify 8 realistic peers. The remaining subsections provide a detailed comparison with these peers, including external rankings, external honors, and PhD production. The Mathematics and Statistics Department is highly competitive on these metrics.

8.A.2. *Distinguishing characteristics and realistic peers.* The University of New Mexico has 22 official peer institutions. The required template for providing characteristics of these programs is shown in **Table 10**.

Public data related to performance of the peer institutions in mathematics and statistics are rare and difficult to obtain consistently across all peers. We found two metrics that can be realistically applied to mathematics and statistics programs at UNM and to our 22 official peer institutions. These are the rankings in mathematics by the "U.S. News and World Report" and a custom metric, described in more detail below, based on the number of certain honors per professor for each program.

The data on the various honors accumulated, shown in **Table 11**, immediately indicate that larger departments have more honors, and that most of our peers have larger departments. One of them, Texas A&M, is much larger and has a large number of active grants. With some probing, we find that Texas A&M has the eighth largest endowment in the United States[21], at just under 10 billion dollars. To get a better idea of resources generally available to our peer departments, we examine teaching load as a proxy. Within our official peers, the teaching load in mathematics ranges from 1.5 courses per semester to 2.5 per semester. Assuming that a teaching load of 3 courses per semester reflects roughly zero expectation of research production, this indicates that some departments in this large group have considerable additional resources for research than others. Further evidence for this hypothesis is shown in **Table 12** where our two metrics are plotted against teaching load. There is a clear correlation between either metric of research production and teaching load. Lower teaching loads tend to result in more honors per professor and higher ratings.

[21] `https://www.usnews.com/education/best-colleges/the-short-list-college/articles/2016-10-04/10-universities-with-the-biggest-endowments`

	Total University Enrollment	Unit Undergraduate Degrees/ Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	Status/ Rank/ Comp.	Semester teaching load
University of New Mexico	22,857	**BS**: applied math, math ed, computational, pure math, statistics.	BS: applied(57), math ed(9), computational(9), pure math(17), statistics(15).	**MS**: stats, pure math, applied math; **PhD**: stats, pure math, applied math	**MS**: stats(15), pure(10), applied(17); **PhD**: stats(17), pure(13), applied(10)	**35**: (29 tenure track, 6 lecturers)		2.00
Arizona State University	83,301	**BS**: actuarial science, comp math, math, math ed, stats. **BA**: math. **Cert programs**: actuarial science, cryptology	**BS**: actuarial science (102), comp math (93), math (315), math ed (37), stats (87). **BA**: math (46).	**MS:** stats. **MA:** math. **4 PhD programs**: appl math, theoretical math, stats, math ed.	**MS**: stats (30). **MA**: math (8). **PhD**: appl math (47), theoretical math (24), stats (23), math ed (25).	**103** (52 tenure/tenure track, 51 lecturers).		1.75
Florida International University	54,099	**BA**: math, stats	unavailable	**MS**: math, stats	unavailable	unavailable		2.50
New Mexico State University	18,497	**BS**: math. Supplementary Major in Applied Math **(SMAM)**	**BS:** math (61)	**MS:** math, **PhD:** math.	**MS:** math (19), **PhD:** math (18).	**30** (21 tenure track faculty, 9 college track faculty).		2.00
Oklahoma State University	25,962	**BA:** math, **BS:** math, actuarial science, financial math, secondary teaching, appl math.	**113** math majors	**MS:** pure math, math ed, comp math, appl math. **PhD:** appl math, pure math, math ed.	**41** grad students	**59**		2.00
Texas A&M University	64,376	**BA**: math, stats	unavailable	**MS**: math, applied math, math biology	unavailable	**157** (101 tenure track, 56 instructional professors)		1.50
Texas Tech University	35,893	**BA:** math, **BS** math	**BA:** math (115), **BS:** math (209).	**MA**: math, **MS**: math, stat, **PhD:** math, **Grad Cert:** math.	**MA**: math (17), **MS**: math (15), **MS**: Stat (17), **PhD**: math (84)	**53** (40 faculty, 13 lecturers).		2.00
The University of Tennessee	27,845	**BS**: math, math honors	**BS**: math (167), math honors (25)	**MS:** applied math. **Master of Mathematics** appl math, **PhD**: math ecology.	**MS:** (10), **Master of Mathematics** (13), **PhD** (80).	**61** (29 associate & full faculty, 7 assistant faculty, 25 lecturers).		1.50
The University of Texas at Arlington	37,008	**BA**: applied math, pure math, statistics	unavailable	**MS**: pure math, applied math; PhD: pure math, applied math	unavailable	**34** (23 tenure track, 12 lecturers)		2.00
The University of Texas at Austin	50,950	**BA:** math, math teaching, **BS:** math appl, actuarial, math sci, pure math, math teaching, math honors. **BSA:** math, math honors. **Math Entry-Level**	**BA:** math (15), math teaching (5), **BS:** math appl (39), actuarial (254), math sci (216), pure math (92), math teaching (26), math honors (34), **BSA:** math (139), math honors (17), **Math Entry-Level** (274).	**MA:** actuarial, **PhD:** math.	**MA:** actuarial (3), **PhD:** math (104).	**99** (66 tenure track, 33 lecturer)		1.75
The University of Texas at El Paso	23,003	**BS**: applied math, acuarial, statistics	unavailable	**MS**: pure math, applied math, statistics. **MAT**: math ed	unavailable	**52**: (30 tenure track, 22 lecturer)		2.50
University of Arizona	40,621	**BS/BA**: mathematics, statistics	unavailable	**MS**: pure math, applied math, statistics; **PhD**: pure math, applied math, statistics		**68**: (55 tenure track, 13 lecturer)		1.50

Table 9. Continued on next page, with caption.

There are thus at most ten schools within the official list who are realistic peers, those with a two courses per semester teaching load. Two of these schools do not offer a PhD in statistics, namely University of Colorado at Denver and University of Oklahoma at Norman. We arrive then at the

	Total University Enrollment	Unit Undergraduate Degrees/ Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	Status/ Rank/ Comp.	Semester teaching load
University of California-Riverside	21,539	**BS**: stats, math	unavailable	**MS**: math, applied math, stats; **PhD**: math, applied math, stats		**57** (35 tenure track, 12 lecturer)		1.50
University of Colorado-Boulder	32,201	**BS**: stats, math	unavailable	**MS**: math, applied math, stats; **PhD**: math, applied math, stats		**70** (48 tenure track, 22 lecturer)		1.50
University of Colorado-Denver	18,937	**BS**: math	unavailable	**MS**: stat**; PhD**: applied math		**26** (20 tenure track, 6 lecturer)		2.00
University of Houston	42,704	**BS/BA**: mathematics, math finance, math biology	unavailable	**MS**: math**; PhD**: math		**61** (44 tenure track, 17 lecturer)		1.50
University of Iowa	33,334	**BS**: actuarial science, stats	**BS:** actuarial science (49), stats (154).	**MS:** actuarial science, stats. **PhD:** stats	**MS:** actuarial science (29), stats (26). **PhD:** stats (21).	**21**		2.00
University of Kansas	28,091	**BA** and **BS** offered, each with distinction or dept. honors.	Roughly **100** math majors	**MA** and **PhD** programs	**69** grad students	**53** (40 tenure track, 13 lecturers).		1.50
University of Missouri-Columbia	32,777	**BS**: math	unavailable	**MS**: math, math ed, applied math; **PhD**: math		**49** (46 tenure track, 3 Instructors).		2.00
University of Nebraska-Lincoln	25,260	**BS**: math	unavailable	**MS**: math, math ed, stats; **PhD**: math, stats		**49** (49 tenure track).		2.00
University of Nevada-Las Vegas	28,600	**BA:** Math, **BS:** math, math w/ actuarial science		**Dual degrees**: MA econ w/ MS math science, MS electrical engineering w/ MS math science, MS math science w/ PhD electrical engineering. **PhD**: math science w/ concentrations of applied math, pure math, computational math and stats.	**Masters**: 33, **PhD**: 40.	**36** (34 faculty, 2 lecturers).		2.00
University of Oklahoma-Norman	30,824	**BA:** math, math ed		**MS**: math, math ed; **PhD**: math, math ed		**47** (32 faculty, 15 lecturers).		2.00
University of Utah	33,334	**BA:** math, stats, comp math, math teaching, **HBA:** stats, comp math math teaching. **BS:** math, applied, stats, comp math, math teaching. **HBS:** math, applied, stats, comp math, math teaching.	**BA:** math (6). **BS:** math (98), applied (69), stats (73), comp math (25), math teaching (3). **HBS:** math (10), applied (11), stats (2), math teaching (1).	MA, MS, MST, MS.T, PhD	**MS:** (2), **MST:** (11), **MS.T** (25), **PhD** (106).	**74**		1.50

Table 10. Required peer comparison table, continued from the previous page.

eight schools, within the official list of university peers, that we take to be our departmental peers, listed here alphabetically.

- New Mexico State University
- Oklahoma State University
- Texas Tech University
- The University of Texas at Arlington
- University of Iowa
- University of Missouri-Columbia
- University of Nebraska-Lincoln
- University of Nevada-Las Vegas

	Size of math and stat together	CAREER awards in NSF Division of Mathematical Sciences	AMS fellows	Annual Joint Math meetings speakers	SIAM fellows	SIAM annual meeting, invited speakers	ASA fellows	IMS fellows	Active DMS grants at NSF in Tens	Total, not normalized
UNM main campus	29	1	2	0	0	0	1	1	0.9	5.9
Arizona State University	53	1	1	0	1	0	2	1	1.5	7.5
Florida International University	55	0	0	0	0	0	0	0	0.3	0.3
New Mexico State University	21	0	1	0	0	0	0	0	0.4	1.4
Oklahoma State University	42	0	2	0	0	0	2	0	0.5	4.5
Texas A&M University	101	2	13	0	1	0	11	6	5.2	38.2
Texas Tech University	45	0	0	0	1	0	2	0	0.4	3.4
The University of Tennessee	52	0	4	0	2	2	1	0	1.3	10.3
The University of Texas at Arlington	23	0	0	0	0	0	1	0	0.4	1.4
The University of Texas at Austin	66	7	23	2	8	3	2	1	4.6	50.6
The University of Texas at El Paso	28	0	0	0	0	0	1	0	0.2	1.2
University of Arizona	59	0	6	0	1	0	2	2	2.2	13.2
University of California-Riverside	35	0	5	0	0	0	3	0	0.5	8.5
University of Colorado-Boulder	48	1	4	0	6	0	1	0	1.7	13.7
University of Colorado-Denver	20	0	0	0	0	0	0	0	0.3	0.3
University of Houston	44	2	1	0	2	1	0	0	2.3	8.3
University of Iowa	48	1	2	0	1	0	5	2	1.2	12.2
University of Kansas	43	0	2	0	1	0	0	1	1.5	5.5
University of Missouri-Columbia	46	0	3	0	0	0	5	2	1.6	11.6
University of Nebraska-Lincoln	49	0	7	0	0	0	4	0	1	12
University of Nevada-Las Vegas	29	0	0	0	0	0	0	0	0.2	0.2
University of Oklahoma-Norman	32	0	2	0	0	0	0	0	0.9	2.9
University of Utah	54	2	9	3	4	2	0	1	4	25

Table 11. Raw numbers of certain honors at all UNM peer institutions.

8.A.3. *External ranking.* The National Research Council (NRC) used to rank mathematics and statistics departments. However, the latest NRC ranking is based on data collected in 2006, making it of no use for this report. There are no quality rankings issued by the national societies in mathematics or statistics. This leaves us with the rankings done by U.S. News and World Report (USNWR).

Rankings of mathematics and statistics programs are complicated by the fact that pure math, applied math, and statistics are broken up differently at different institutions. Half of the statistics groups at our peer institutions are within a joint department and half are in a separate department. In statistics, the USNWR only ranked two of our departmental peers, namely the University of Missouri and the University of Iowa. Thus, there is little relevant information in the USNWR statistics ranking.

The mathematics ranking by USNWR seems to be a valid source of information, even if we are not entirely sure of the methodology behind it. It is not clear how this ranking deals with separate departments of applied mathematics, but this is not a significant factor within our departmental peers.

By the USNWR mathematics department ranking, we rank fifth in our group of nine (see **Table 13**). This ranking is "based solely on the results of surveys sent to academics"[22] so one suspects smaller departments to be at a disadvantage. This hunch is validated by **Table 14** which shows

[22]www.usnews.com/education/
best-graduate-schools/articles/science-schools-methodology

Abbr	School	Teaching load per semester	Honors per professor	USNWR points
UU	University of Utah	1.5	46.3	3.6
TAMU	Texas A&M University	1.5	37.8	3.4
UCoB	University of Colorado-Boulder	1.5	28.5	3.3
UCR	University of California-Riverside	1.5	24.3	2.8
UAZ	University of Arizona	1.5	22.4	3.4
UTenn	University of Tennessee	1.5	19.8	2.7
UHo	University of Houston	1.5	18.9	2.6
UK	University of Kansas	1.5	12.8	2.8
UTA	University of Texas at Austin	1.75	76.7	4.2
ASU	Arizona State University	1.75	14.2	3
UI	University of Iowa	2	25.4	3.1
UMC	University of Missouri-Columbia	2	25.2	2.9
UNL	University of Nebraska-Lincoln	2	24.5	2.9
UNM	University of New Mexico	2	20.3	2.5
OSU	Oklahoma State University	2	10.7	2.6
UON	University of Oklahoma-Norman	2	9.1	2.7
TTU	Texas Tech University	2	7.6	2.3
NMSU	New Mexico State University	2	6.7	2.2
UTA	University of Texas at Arlington	2	6.1	2
UCD	University of Colorado-Denver	2	1.5	2
UNLV	University of Nevada-Las Vegas	2	0.7	1.6
UTEP	The University of Texas at El Paso	2.5	4.3	1.6
FIU	Florida International University	2.5	0.5	1.6

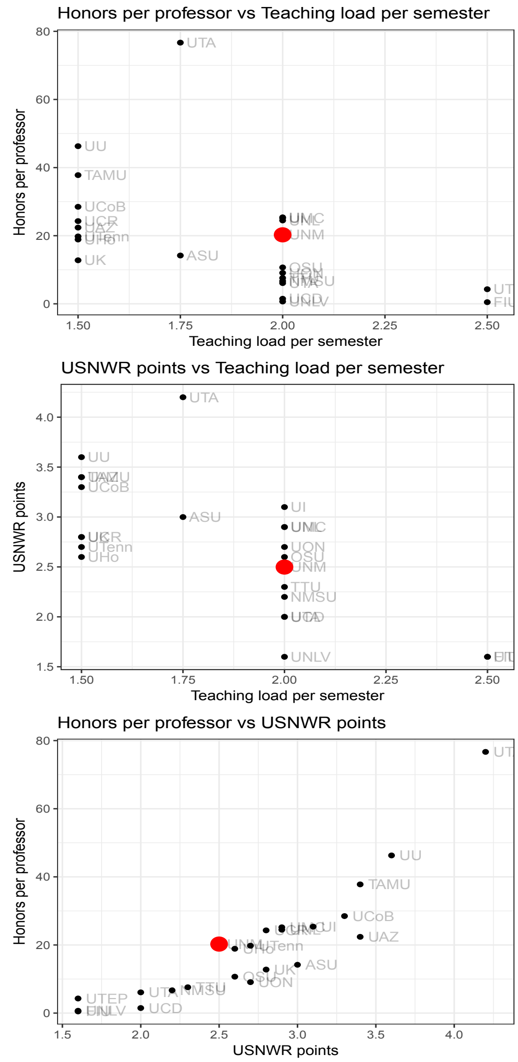

TABLE 12. Normalized metrics vs teaching load.

	Honors per professor	USNWR points
University of Iowa	25.4	3.1
University of Missouri-Columbia	25.2	2.9
University of Nebraska-Lincoln	24.5	2.9
UNM	20.3	2.5
Oklahoma State University	10.7	2.6
Texas Tech University	7.6	2.3
New Mexico State University	6.7	2.2
The University of Texas at Arlington	6.1	2
University of Nevada-Las Vegas	0.7	1.6

	Honors per professor	USNWR points
University of Iowa	25.4	3.1
University of Missouri-Columbia	25.2	2.9
University of Nebraska-Lincoln	24.5	2.9
Oklahoma State University	10.7	2.6
UNM	20.3	2.5
Texas Tech University	7.6	2.3
New Mexico State University	6.7	2.2
The University of Texas at Arlington	6.1	2
University of Nevada-Las Vegas	0.7	1.6

TABLE 13. Two rankings of our departmental peers, with similar results. The left table is sorted by the honors per professor metric. The right table is sorted by the points used in the USNWR ranking.

	Department size	USWNR points
UNM main campus	29	2.5
Arizona State University	53	3
Florida International University	55	1.6
New Mexico State University	21	2.2
Oklahoma State University	42	2.6
Texas A&M University	101	3.4
Texas Tech University	45	2.3
The University of Tennessee	52	2.7
The University of Texas at Arlington	23	2
The University of Texas at Austin	66	4.2
The University of Texas at El Paso	28	1.6
University of Arizona	59	3.4
University of California-Riverside	35	2.8
University of Colorado-Boulder	48	3.3
University of Colorado-Denver	20	2
University of Houston	44	2.6
University of Iowa	48	3.1
University of Kansas	43	2.8
University of Missouri – Columbia	46	2.9
University of Nebraska – Lincoln	49	2.9
University of Nevada – Las Vegas	29	1.6
University of Oklahoma-Norman	32	2.7
University of Utah	54	3.6

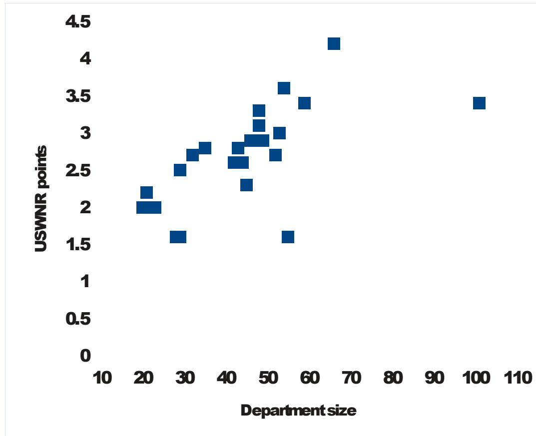

TABLE 14. USNWR ranking vs. number of math and stat professors. A score of 1.6 indicates that department was not in the ranking. The correlation between the points assigned by USNWR and department size is 0.64.

the correlation between department size and ranking. Some correlation makes sense, as most professors in the mathematical sciences would prefer to be in a larger department, assuming other factors being equal.

8.A.4. *External honors.* In this section we describe a custom metric based on external validation for professors. **Table 13** shows the rankings using this metric, and it also shows the ranking to be similar to the USNWR ranking of the departments. Not surprisingly, as with the USNWR ranking, our metric also has a correlation with department size (see **Table 15**).

In the remainder of this subsection, we discuss how this metric is constructed. We select three types of external honors to include which are available across multiple institutions. The first honor is being designated as a fellow in a relevant mathematical or statistical society. The second is delivering a plenary address at the main annual meeting of a relevant mathematical or statistical society. The third is funding within the Division of Mathematical Sciences (DMS) at the NSF. Of course, these all have limitations and bias as metrics.

To count fellows, we looked at data available from the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), the American Statistical Association and the Institute of Mathematical Statistics. Appointing fellows is a relatively new phenomenon at the two mathematical societies, starting within the past ten years. A limitation is that nominations are not restricted to professors in the mathematics or statistics departments. Another limitation is that not all professors wish to support these societies by being members and so cannot be fellows.

We looked online for plenary speakers at annual meetings. For the statistics meetings, gathering the data was unreasonably difficult and we abandoned the idea. The lack of speakers at prestigious statistics meetings in our metric is, one hopes, offset by the inclusion of fellows of the two statistics

	Department size	Honors per professor
UNM main campus	29	48.3
Arizona State University	53	39.6
Florida International University	55	5.5
New Mexico State University	21	23.8
Oklahoma State University	42	21.4
Texas A&M University	101	84.2
Texas Tech University	45	15.6
The University of Tennessee	52	42.3
The University of Texas at Arlington	23	21.7
The University of Texas at Austin	66	139.4
The University of Texas at El Paso	28	10.7
University of Arizona	59	55.9
University of California-Riverside	35	37.1
University of Colorado-Boulder	48	60.4
University of Colorado-Denver	20	15
University of Houston	44	65.9
University of Iowa	48	47.9
University of Kansas	43	44.2
University of Missouri – Columbia	46	56.5
University of Nebraska – Lincoln	49	42.9
University of Nevada – Las Vegas	29	6.9
University of Oklahoma-Norman	32	34.4
University of Utah	54	113

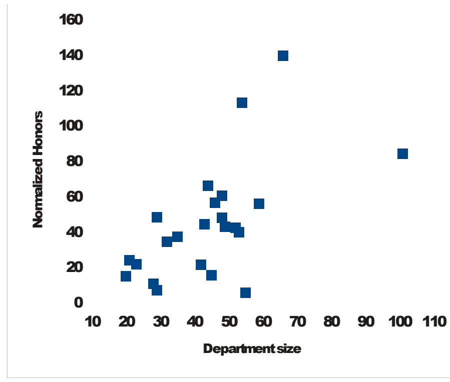

Table 15. Normalized honors vs. number of mathematics and statistics professors. The correlation between the honors per professor and department size is 0.60.

societies. We looked then at the Joint Mathematical Meetings (JMM), whose speakers are mainly selected by the American Mathematical Society and the Mathematical Association of America, and at the SIAM annual meeting. An anomaly is that the SIAM annual meeting was not run in two years in the past decade as a means to avoid conflict with important international meetings. We gathered data for JMM speakers for the years 2006–2015, while for the SIAM speakers we used the years 2006, 2008–2010 and 2014–2016. Again, these speakers are not limited to the departments being studied.

For funding, we restricted our data to funding from the Division of Mathematical Sciences (DMS) at the NSF. There are many other funding sources available to applied mathematicians and statisticians, but the nature of these sources vary considerably from one department to the next, according to the topics studied. The CAREER awards within the DMS were singled out as prestigious awards going to a small percentage of junior mathematicians and statisticians. This junior bias should help offset the senior bias expected to be seen in the selection of society fellows.

We also include a count of the number of active grants within the DMS. These data are easy to obtain from the NSF. Getting a CAREER award is far less common than getting an NSF award, so we divided the latter by ten. Including this scaling makes little difference in the ranking, but makes the table more informative. Again, there are grants in DMS going to departments that are not mathematics or statistics. We have not adjusted data for UNM to remove non-mathematics and non-statistics grants as it is not feasible to adjust all the peer institutions.

8.A.5. *PhD production.* Teaching PhD students is closely tied to research productivity. The relation is complex, however, as much research in the mathematical sciences does not depend on the labor of graduate students. In any case, the number of PhD degrees conferred per year per professor is a potential indicator of the nature of a mathematics or statistics department.

	Size of math and stats together	AMS size classification of public universities	Estimated PhDs per year	Estimate, Normalized per number of faculty	Number of PhDs per department websites	Number of PhDs, normalized
UNM main campus	29	M	5.35	0.18	6.2	0.21
Arizona State University	53	L	15.60	0.29	9	0.17
Florida International University	55	N/A				
New Mexico State University	21	S	1.95	0.09		
Oklahoma State University	42	S	1.95	0.05		
Texas A & M University	101	L	15.60	0.15	17	0.17
Texas Tech University	45	M	5.35	0.12		
The University of Tennessee	52	M	5.35	0.10		
The University of Texas at Arlington	23	S	1.95	0.08		
The University of Texas at Austin	66	L	15.60	0.24	16	0.24
The University of Texas at El Paso	28	N/A				
University of Arizona	59	M	5.35	0.09		
University of California-Riverside	35	S	1.95	0.06		
University of Colorado-Boulder	48	M	5.35	0.11		
University of Colorado-Denver	20	A				
University of Houston	44	M	5.35	0.12		
University of Iowa	48	L	15.60	0.33	12.2	0.25
University of Kansas	43	S	1.95	0.05		
University of Missouri-Columbia	46	M	5.35	0.12		
University of Nebraska-Lincoln	49	M	5.35	0.11		
University of Nevada-Las Vegas	29	S	1.95	0.07		
University of Oklahoma-Norman	32	S	1.95	0.06		
University of Utah	54	M	5.35	0.10		

Table 16. PhD degrees conferred annually, in raw numbers and per professor. Listed for almost all schools in a rough estimate based on the AMS survey. A more careful number is calculated and shown for a few schools. These are averages that include at least five years of data for other other schools and ten years of data for UNM.

The American Mathematical Society conducts an annual survey[23] and issues a report that categorizes public and private institutions according to the number of PhDs produced and other factors. In this report, based on data from 2015, 130 doctorate-granting public institutions are categorized.

- The Public Large Group (L) consists of the 26 departments with the highest annual rate of PhDs ranging between 7.0 and 24.2 per year.
- The Public Medium Group (M) consists of the 40 departments with annual rate of PhDs ranging between 3.9 and 6.8 per year.
- The Public Small Group (S) consists of the remaining 64 departments at public universities.

Taking the midpoints of the ranges of PhDs produced annually, we approximate the rate of PhD production for almost all our peer groups. This is shown in **Table 16**.

We were able to gather more exact data for most of the larger public institutions in our peer group, using information from their websites. Specifically, we checked online for alumni information for the large peer institutions. All had a listing of at least the last 5 years of their PhD graduates. Were UNM to be included in the list of these larger institutions, UNM would rank third, only outranked by the University of Texas at Austin and the University of Iowa. See the final column in **Table 16** for these data, normalized per professor.

[23] `http://www.ams.org/profession/data/annual-survey/groups`

8.A.6. *Conclusions.* On several measures, our department is competitive with many of the schools that have lighter teaching loads in mathematics, as is indicated in **Table 12**. By the honors per professor metric we are ahead of four schools in that category, and are only a little behind the University of Colorado at Boulder and the University of California at Riverside. U. C. Riverside has about the same student population as UNM, 20 percent more professors and a lighter teaching load, as indicated in **Tables 11** and **10**. At the Boulder campus the student population is only 40 percent larger, and yet they have 65 percent more professors and a lighter teaching load. The department has been productive in research in spite of the high teaching demands at UNM.

Criterion 9: Future Directions

The unit engages in strategic planning and prioritization in order to achieve its mission and vision.

9.A. **Summary of strengths and challenges.**

9.A.1. *Strengths.* Our strengths stem from our human resources. Faculty and staff strive for excellence in all endeavors. Criterion 5 in this self-study describes the composition, credentials and qualifications of the faculty. In particular, that section provides examples of external recognition, invitations to conferences, invited lectures, external funding, and teaching awards.

- Strengths in research
  (1) Applied mathematics research in numerical methods, scientific computing, partial differential equations, nonlinear waves, fluid dynamics, mathematical physics, and mathematical biology.
  (2) Pure mathematics research in algebra, differential and algebraic geometry, number theory, and operator theory and harmonic/Fourier analysis.
  (3) Statistics research in Bayesian methods with applications to biology and other fields, including strong collaborations with the Mind Institute and the UNM Hospitals.
  (4) Active seminar series in Applied Mathematics, Geometry, Analysis and Statistics. Hosting of the series Computational Mathematics at Sandia National Labs .
  (5) The Department has two American Mathematical Society Fellows, a Fellow of the Institute of Mathematical Statistics, a Fellow of the American Statistical Association, and 20 active grants.
- Strengths in teaching
  (1) Spectrum of courses serving many constituents. Courses range from pre-calculus service courses, calculus with various emphases for different majors, upper-division courses for engineers and scientists, undergraduate courses for our majors, graduate courses for our own students, as well as for engineers and scientists in other departments.
  (2) Excellence of instructors. Our faculty and graduate students are dedicated to teaching at all levels, and are winning teaching awards at all levels.
  (3) Successful graduates. Our M.S. and Ph.D. students have successful careers utilizing their training in mathematics and statistics.
  (4) External Funding. We have sought and received NSF funding to bolster the education and mentorship of undergraduate and graduate students, as well as post docs. Two sequential MCTP grants greatly expanded the educational experiences available to our students.
- Strengths in service
  (1) The Statistics Consulting Clinic improves statistical research across campus.
  (2) The UNM-PNM Statewide Mathematics Contest for Middle School and High School students has run for almost 50 years, with about 1000 students statewide participating per year.
  (3) The MCTP program has offered summer enrichment opportunities to students in the Southwest and research funding to undergraduate students.
  (4) Teachers' Circles provide speakers and activities for K-12 teachers. Illustrative Mathematics aid teachers developing materials to meet Common Core Standards.
  (5) The Department has hosted several conferences and seminars of benefit to the mathematical community at large such as the New Mexico Analysis Seminar, American Mathematical Society Sectional Meetings, and the Southwest Local Algebra Meeting.

9.A.2. *Challenges.* Our challenges mainly arise from supporting the myriad departmental activities with shrinking resources. We also face challenges related to retaining staff and faculty who are under-compensated compared with peer institutions. The turn-over rate in the department is large; in 2008 we had 28 tenure-stream faculty (26.3 FTE), we now have 29 (28 FTE), and in the interim we hired 12 faculty members. Tenure-stream faculty are applying and have applied for jobs elsewhere, successfully obtaining job offers at institutions that will provide a lower teaching load, better salaries, a larger faculty body, and/or better prepared students.

(1) Increased administrative burden without compensation. The University and the State are imposing more and more work, rules and policies that are time consuming and unfunded. Examples are state-wide course renumbering and documentation of assessment activities. At the same time, we have fewer staff and additional tasks such as maintaining web content fall to faculty.
(2) Inadequate faculty numbers to achieve goals. Twelve 300 plus mathematics courses and 4 statistics courses per year lack tenure stream faculty (see Criterion 2). These numbers will only increase since over the last 4 years MCTP postdocs taught 3 courses/year, and this grant is now ending. Additional hires are also needed to include tenure-stream faculty in teaching calculus and below. This would expose students to research and attract students to STEM fields. More important, faculty will be in a stronger position to redesign the curriculum in these courses.
(3) Inadequate staff to support missions. IT and administrative support staff have been cut and staff compensation is low.
(4) Inadequate operating budget. Travel funds and the colloquium budget have been cut or eliminated. Those without grants find it hard to travel to conferences and money from faculty with Simons grants cover the costs of colloquia. There is no equipment budget; whence it is difficult to upgrade computers, and we rely on surplussed equipment for many purposes. There is no budget for recruitment of graduate students.
(5) Restructuring the Department. In some sense, we are two departments: The lecturers and contingent faculty who cover service courses, and the research faculty. More of the research faculty should be involved in teaching and organizing the service courses, but we do not have enough research faculty members. The Department would like to move away from dependence on part-time, temporary instructors and hire Lecturers. Only recently has the University provided a career advancement path for Lecturers. The Department should make sure adequate support and polices are in place internally to support Lecturers.

9.B. **Strategic planning efforts.** The Department engages in several strategic planning efforts, as listed below. In some cases, more systematic and routine measures would be beneficial. A difficulty is that these duties fall to faculty who are already stretched thin. Some planning efforts are routine and handled through our committee structure. We also discuss some strategic planning in faculty meetings and within the executive committee. The graduate committee makes decisions about admission of graduate students and TAships. The undergraduate committee leads efforts in assessment and student learning outcomes. To further broaden faculty involvement in allocation and planning, the Chair might also meet yearly with each faculty member to develop an action plan for committee assignments, teaching assignments, and research goals (publications, conference participation, and external funding).

(1) Course assessment and data collection. Criteria 2-3 detail the enormous strides the Department has made since our last APR to document learning outcomes and institute systematic program and course assessments. Additional data related to grades, passing rates and success in follow-on courses helps us target resources. It has become easier to obtain data through requests to the administration but the onus is on the Department to construct analytical tools.

(2) Course coordination within the Department and with client departments. The Department is lucky to have a cohesive group of Lecturers who ably perform most of the course coordination for 100 level courses. Course coordination for Calculus and 300 plus courses is typically performed by tenure-stream faculty. Tenure-stream faculty handle much of the coordination with other departments on campus through meetings between interested faculty in the respective departments. This task would benefit from more routine meetings between our Undergraduate Committee and the corresponding committees in engineering and science departments. More attention should be paid to curricular changes in other departments and how those changes affect students' mathematics and statistics requirements.
(3) Strengthen ties to Los Alamos National Laboratory and Sandia National Labs. There are many common research interests between members of the Department and researchers at Sandia and Los Alamos. Typically, a few of our faculty have their work supported by contracts with the Labs. Several lab employees have held Lab-Research Professor or Adjunct appointments in the Department, and they contribute to research and educational missions. Dr. John Shadid (SNL) is currently a Lab Professor. For the last 3 semesters, with Dr. Shadid's help, we have have run the seminar series, 'Computational Mathematics at Sandia National Laboratories.' Several of our faculty have also been invited to speak at Sandia. These interactions introduce faculty and students to possible avenues for future collaboration. Several of us have been in discussions with staff from both labs and engineering faculty about joining efforts to form a Computational Fluid Dynamics graduate program at UNM. For some time, Los Alamos has been running summer schools for advanced undergraduate and graduate students in areas such as high performance computing. We are discussing partnering with Los Alamos, possibly running some of their summer programs in Albuquerque, in part to recruit talented students for our graduate programs.
(4) Provide mentoring to junior faculty. Each junior faculty member has an official mentor. The principal duty of the mentor is to guide faculty through the promotion and tenure process. Informally, many senior faculty have discussions, provide preliminary review of proposals to external funding agencies, review manuscripts prior to submission and observe teaching. The Department could be more systematic in providing this support. We note that the College provides junior faculty with a research semester prior to their tenure decision, and this is a valuable resource.
(5) Rethink the curriculum, at all levels. To better meet the goals of all students served by the Department, we need the time and resources to rethink and rejuvenate courses throughout the curriculum. Through course redesign, we might more efficiently deploy both our tenure-stream faculty and lecturers. Since only 6 percent of incoming freshman are Calculus ready, the most pressing priority is improving success of students in pre-calculus courses. We would like to revamp the curriculum with an eye toward shortening the time to graduation and minimizing student debt, while still providing quality education. Resources that would help toward this end would be a small amount of funding for a retreat dedicated to studying the issues and making recommendations. A course release to aid tenure-stream faculty participation is a necessity.
(6) Strategic plan for hiring. The current College administration has asked each year for a 5 year hiring plan. We have provided such plans and have preferences for areas of emphasis for new faculty. However, the budget cuts and dim prospects for hiring have led to minimal effort in producing these plans in recent years. The Department should consider appointing an *ad hoc* committee to prioritize areas of interest for the next 5 hires, say. Of course, the planning has to remain flexible in case there are losses in critical areas in the meantime.

9.C. **Strategic directions and priorities.**

(1) Faculty hires. At a bare minimum, an additional faculty in each area is required. The central role of mathematics and statistics as the gateway to success in science and engineering warrants improved staffing of our courses. Mathematics and statistics is also an essential component of core educational requirements, and students deserve stable staffing of these courses by Lecturers, aided by participation, and curriculum planning and development from tenure-stream faculty. In order to have participation of tenure-stream faculty in lower-division courses, more than the bare minimum is required. An estimate is six additional tenure-stream faculty. The Department should continue to shift from part-time, temporary instructors to Lecturers.
(2) Recruitment of graduate students. Our aim is to recruit 15 additional graduate students per year. The recruiting needs to be done without a budget. We have produced flyers that can be distributed electronically and in conjunction with University sponsored recruiting events. Additional TA lines would certainly aid recruiting efforts. We continue to pursue external funding in order to support additional RAs. As mentioned, we are looking to partner with Los Alamos National Laboratory to recruit students through their summer school programs. There is a high probability that these students would be supported by the Lab. The additional students will ensure that essential classes can run. Additional TA lines would help with lower division courses and grading.
(3) Lower teaching load. The teaching load of research active faculty is 2 courses per semester (two thirds of the teaching load for non-research active faculty). No teaching reduction is available for major research accomplishments, advisement of graduate students or other time-consuming duties associated with maintaining an active research group. The current teaching load is not compatible with a flagship university. Ten of our official peers have a lower teaching load. Moreover, it is increasingly difficult to attract and retain research faculty.
(4) Improve resources and support. The Department could use an additional staff member at the Administrative Assistant I or II level in the main office (see Criterion 6). We would also like to restore and improve IT support within the Department.
(5) Professional development and compensation. We would like to increase the opportunities for pedagogical training of TAs, Lecturers, and tenure-stream faculty. We should provide opportunities for professional development to faculty at all ranks. An area that could be supported better by the University is grant proposal submission and administration. Staff also need development paths and better compensation. Some faculty also feel compensation is lagging. Indeed, no money has been generally available for raises in the last couple of years, and future prospects would seem slim due to State budget cuts.

Reflective question.

Extension of 9B.. The MaLL has proven effective as a means of teaching Intermediate Algebra. Are there possibilities for extending the MaLL approach to other classes further downstream (e.g., College Algebra, Trigonometry, Pre-Calculus)? Please explain the issues you may have in implementing this extension.

It is certainly appropriate to augment instruction with a computer-aided segment. We have used and continue to use this approach in many classes. However, mathematical reasoning requires precise identification of assumptions, a clear statement of the conclusion, and a reasoned argument that connects the former to the latter. The ability to articulate this argument, both verbally and in writing, is essential to mastering mathematics, and is also a valuable life skill. To master this skill, it is necessary to practice in the presence of an expert who can provide a critique. At this time, there is no computer application that can teach this skill since the computer programs rely on multiple choice or simple, one-line, easily-graded answers. While we realize that the MaLL format does feature support from human instructors, its primary component is the computer segment. Therefore, we do not believe that it can serve as an effective way to teach subjects which, beyond mastery of rote skills, involve critical thinking.

Attachment: UNM Catalog 2016-2017 Course Descriptions in Mathematics and Statistics

UNM Catalog 2016-2017 Course Descriptions

Mathematics

Cf: `http://catalog.unm.edu//catalogs/2016-2017/courses/MATH/index.html`

MATH 101. Intermediate Algebra Part 1. (1) This course includes equations and inequalities, applications and problem solving with linear equations, linear functions and the graph of a line, percent, perimeters, areas of simple geometric shapes.

MATH 102. Intermediate Algebra Part 2. (1) This course includes quadratic equations, properties of exponents and scientific notation, simplifying polynomial expressions, factoring and introduction to functions.

MATH 103. Intermediate Algebra Part 3. (1) This course includes radical expressions and equations, rational expressions and equations, the exponential and logarithm functions.

MATH 107. Problems in College Algebra. (1) Study session for 121 with an emphasis on problem solving. (I)

MATH 110. Problems in Elements of Calculus. (1) Study session for 180 with an emphasis on problem-solving. (I)

MATH 111. Mathematics for Elementary and Middle School Teachers I. (3) Course offers an in-depth look at the representations of rational numbers, including base-ten and decimal numbers, integers, fractions, and arithmetic operations on these sets. Problem solving is emphasized throughout. (T)

MATH 112. Mathematics for Elementary and Middle School Teachers II. (3) This course develops basic geometric concepts including rigid transformations and congruence; dilations and similarity; length, area and volume; systems of measurement and unit conversions; connections to coordinate geometry. Problem solving is emphasized throughout. (T)

MATH 116. Topics in Pre-Calculus Mathematics. (1-6 to a maximum of 12) Selected topics from algebra, geometry and trigonometry. (I)

MATH 121. College Algebra. (3) Preparation for MATH 150 and 180. The study of equations, functions and graphs, especially linear and quadratic functions. Introduction to polynomial, rational, exponential and logarithmic functions. Applications involving simple geometric objects. Emphasizes algebraic problem solving skills. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics (NMCCN 1113). (I)

MATH 123. Trigonometry. (3) Definition of the trigonometric functions, radian and degree measure, graphs, basic trigonometric identities, inverse trigonometric functions, complex numbers, polar coordinates and graphs, vectors in 2 dimensions. May be taken concurrently with MATH 150. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics (NMCCN 1113). (I)

MATH 129. A Survey of Mathematics. (3) An introduction to some of the great ideas of mathematics, including logic, systems of numbers, sequences and series, geometry and probability. Emphasizes general problem-solving skills. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics. (I)

MATH 150. Pre-Calculus Mathematics. (3) In-depth study of polynomial, rational, exponential and logarithmic functions and their graphs. Includes the fundamental theorem of algebra, systems of equations, conic sections, parametric equations and applications in geometry. Exploration of the graphing calculator. May be taken concurrently with 123. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics. (I)

MATH 153. Precalculus and Trigonometry. (5) Algebraic expressions, algebraic equations, inequalities, functions, graphing. Exponential, logarithmic, and trigonometric functions. Complex numbers and vectors. Limits.

MATH 162. Calculus I. (4) Limits. Continuity. Derivative: definition, rules, geometric and rate-of-change interpretations, applications to graphing, linearization and optimization. Integral: definition, fundamental theorem of calculus, substitution, applications to areas, volumes, work, average. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics (NMCCN 1614). (I)

MATH 163. Calculus II. (4) Transcendental functions, techniques of integration, numerical integration, improper integrals, sequences and series, Taylor series with applications, complex variables, differential equations. (I)

MATH 180. Elements of Calculus I. (3) Limits of functions and continuity, intuitive concepts and basic properties; derivative as rate of change, basic differentiation techniques; application of differential calculus to graphing and minima-maxima problems; exponential and logarithmic functions with applications. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics (NMCCN 1613). (I)

MATH 181. Elements of Calculus II. (3) Includes the definite integral, multivariate calculus, simple differential equations, basic review of trigonometry and its relation to calculus. (I)

MATH 215. Mathematics for Elementary and Middle School Teachers III. (3) Algebra from the viewpoint of the elementary curriculum with emphasis on proportional and linear relationships. Also included: topics from probability and statistics with connections to other topics in the elementary curriculum. Problem solving is emphasized throughout. (T)

MATH 264. Calculus III. (4) Vector operations, vector representation of planes and curves, functions of several variables, partial derivatives, gradient, tangent planes, optimization, multiple integrals in Cartesian cylindrical and spherical coordinates, vector fields, line integrals and Green's theorem. (I)

MATH 305 / 507. Mathematics from a Historical Perspective. (3) A study of the historical development of topics in mathematics taken from geometry, algebra, trigonometry, number systems, probability, and/or statistics. Emphasis on connections to the high school curriculum. (T)

MATH 306 [306 / 506]. College Geometry. (3) An axiomatic approach to fundamentals of geometry, both Euclidean and non-Euclidean. Emphasis on historical development of geometry. (T)

MATH 311. Vector Analysis. (3) Vector algebra, lines, planes; vector valued functions, curves, tangent lines, arc length, line integrals; directional derivative and gradient; divergence, curl, Gauss' and Stokes' theorems, geometric interpretations.

MATH 312. Partial Differential Equations for Engineering. (3) Solution methods for partial differential equations; science and engineering applications; heat and wave equations, Laplace's equation; separation of variables; Fourier series and transforms; special functions.

MATH 313. Complex Variables. (3) Theory of functions of a complex variable with application to physical and engineering problems. Although not required, skill in vector analysis will be helpful in taking this course.

MATH 314. Linear Algebra with Applications. (3) Systems of linear equations, Gaussian elimination, matrix algebra, determinants. Vector spaces. Inner product spaces, orthogonality, least squares approximations. Eigenvalues, eigenvectors, diagonalization. Emphasis on concepts, computational methods, and applications.

MATH 316. Applied Ordinary Differential Equations. (3) Introduction to algorithmic theory of ordinary differential equations. Topics covered: elementary theory of ordinary differential equations, numerical methods, phase-plane analysis, and introduction to Laplace transformations. Third-level calculus is helpful for this class.

MATH 317. Elementary Combinatorics. (3) Basic enumeration including combinations, permutations, set and integer partitions, distributions, and rearrangements, binomial and multinomial theorems together with pigeon-hole and inclusion-exclusion principles and mathematical induction principles. Discrete probability, elementary ordinary generating functions, recurrence relations, and sorting algorithms.

MATH 319. Theory of Numbers. (3) Divisibility, congruences, primitive roots, quadratic residues, diophantine equations, continued fractions, partitions, number theoretic functions.

MATH 321. Linear Algebra. (3) Linear transformations, matrices, eigenvalues and eigenvectors, inner product spaces.

MATH 322. Modern Algebra I. (3) Groups, rings, homomorphisms, permutation groups, quotient structure, ideal theory, fields.

MATH 327. Introduction to Mathematical Thinking and Discrete Structures. (3) Course will introduce students to the fundamentals of mathematical proof in the context of discrete structures. Topics include logic, sets and relations, functions, integers, induction and recursion, counting, permutations and combinations and algorithms.

MATH 338 / 542. Mathematics for Secondary Teachers. (3) Topics from secondary mathematics presented from an advanced standpoint and designed to meet the needs of pre- and in-service teachers. Open only to prospective and in-service teachers of mathematics. (T)

MATH 339 / 543. Topics in Mathematics for Elementary and Middle School Teachers. (1-3, no limit) Presents mathematical topics of concern to elementary and mid-school teachers. Open only to in-service and prospective teachers. (T)

MATH 350 / 550. Topics in Mathematics for Secondary Teachers. (1-3, no limit) Presents mathematical topics of concern to secondary teachers. Open only to in-service and prospective teachers. (T)

MATH 356. Symbolic Logic. (4) This is a first course in logical theory. Its primary goal is to study the notion of logical entailment and related concepts, such as consistency and contingency. Formal systems are developed to analyze these notions rigorously.

MATH 375. Introduction to Numerical Computing. (3) An introductory course covering such topics as solution of linear and nonlinear equations; interpolation and approximation of functions, including splines; techniques for approximate differentiation and integration; solution of differential equations; familiarization with existing software.

MATH 391. Advanced Undergraduate Honors Seminar. (1-3 to a maximum of 8) Advanced problem solving. Especially recommended for students wishing to participate in the Putnam Intercollegiate Mathematical Competition.

MATH 393. Topics in Mathematics. (3, no limit) Selected topics from analysis, algebra, geometry, statistics, model building, interdisciplinary studies and problem solving.

MATH 401 / 501. Advanced Calculus I. (4) Rigorous treatment of calculus in one variable. Definition and topology of real numbers, sequences, limits, functions, continuity, differentiation and integration. Students will learn how to read, understand and construct mathematical proofs.

MATH 402 / 502. Advanced Calculus II. (3) Generalization of 401/501 to several variables and metric spaces: sequences, limits, compactness and continuity on metric spaces; interchange of limit operations; series, power series; partial derivatives; fixed point, implicit and inverse function theorems; multiple integrals.

MATH 412. Nonlinear Dynamics and Chaos. (3) Qualitative study of linear and nonlinear ordinary differential equations and discrete time maps including stability analysis, bifucations, fractal structures and chaos; applications to biology, chemistry, physics and engineering.

MATH 415. History and Philosophy of Mathematics. (3) A historical survey of principal issues and controversies on the nature of mathematics. Emphasis varies from year to year.

MATH 421. Modern Algebra II. (3) Theory of fields, algebraic field extensions and Galois theory for fields of characteristic zero.

MATH 422. Modern Algebra for Engineers. (3) Groups, rings and fields. (This course will not be counted in the hours necessary for a mathematics major.)

MATH 431 / 535. Introduction to Topology. (3) Metric spaces, topological spaces, continuity, algebraic topology.

MATH 439. Topics in Mathematics. (1-3, no limit)

MATH 441. Probability. (3) Mathematical models for random experiments, random variables, expectation. The common discrete and continuous distributions with application. Joint distributions, conditional probability and expectation, independence. Laws of large numbers and the central limit theorem. Moment generating functions.

MATH 462 / 512. Introduction to Ordinary Differential Equations. (3) Linear systems. Existence and uniqueness theorems, flows, linearized stability for critical points, stable manifold theorem. Gradient and Hamiltonian systems. Limit sets, attractors, periodic orbits, Floquet theory and the Poincare Map. Introduction to perturbation theory.

MATH 463 / 513. Introduction to Partial Differential Equations. (3) Classification of partial differential equations; properly posed problems; separation of variables, eigenfunctions and Green's functions; brief survey of numerical methods and variational principles.

MATH 464 / 514. Applied Matrix Theory. (3) Determinants; theory of linear equations; matrix analysis of differential equations; eigenvalues, eigenvectors and canonical forms; variational principles; generalized inverses.

MATH 466. Mathematical Methods in Science and Engineering. (3) Special functions and advanced mathematical methods for solving differential equations, difference equations and integral equations.

MATH 471. Introduction to Scientific Computing. (3) Parallel programming, performance evaluation. Error analysis, convergence, stability of numerical methods. Applications such as N-body problem, heat transfer, wave propagation, signal processing, Monte-Carlo simulations. C, C++, or FORTRAN skills required.

MATH 472 / 572. Fourier Analysis and Wavelets. (3) Discrete Fourier and Wavelet Transform. Fourier series and integrals. Expansions in series of orthogond wavelets and other functions. Multiresolution and time/frequency analysis. Applications to signal processing and statistics.

MATH 499. Individual Study. (1-3 to a maximum of 6) Guided study, under the supervision of a faculty member, of selected topics not covered in regular courses.

MATH 501 / 401. Advanced Calculus I. (4) Rigorous treatment of calculus in one variable. Definition and topology of real numbers, sequences, limits, functions, continuity, differentiation and integration. Students will learn how to read, understand and construct mathematical proofs.

MATH 502 / 402. Advanced Calculus II. (3) Generalization of 401/501 to several variables and metric spaces: sequences, limits, compactness and continuity on metric spaces; interchange of limit operations; series, power series; partial derivatives; fixed point, implicit and inverse function theorems; multiple integrals.

MATH 504. Introductory Numerical Analysis: Numerical Linear Algebra. (3) Direct and iterative methods of the solution of linear systems of equations and least squares problems. Error analysis and numerical stability. The eigenvalue problem. Descent methods for function minimization, time permitting.

MATH 505. Introductory Numerical Analysis: Approximation and Differential Equations. (3) Numerical approximation of functions. Interpolation by polynomials, splines and trigonometric functions. Numerical integration and solution of ordinary differential equations. An introduction to finite difference and finite element methods, time permitting.

MATH 507 / 305. Mathematics from a Historical Perspective. (3) A study of the historical development of topics in mathematics taken from geometry, algebra, trigonometry, number systems, probability, and/or statistics. Emphasis on connections to the high school curriculum.

MATH 510. Introduction to Analysis I. (3) Real number fields, sets and mappings. Basic point set topology, sequences, series, convergence issues. Continuous functions, differentiation, Riemann integral. General topology and applications: Weierstrass and Stone-Weierstrass approximation theorems, elements of Founier Analysis (time permitting).

MATH 511. Introduction to Analysis II. (3) Continuation of 510. Differentiation in $\mathbb{R}^n$. Inverse and implicit function theorems, integration in $\mathbb{R}^n$, differential forms and Stokes theorem.

MATH 512 / 462. Introduction to Ordinary Differential Equations. (3) Linear systems. Existence and uniqueness theorems, flows, linearized stability for critical points, stable manifold theorem. Gradient and Hamiltonian systems. Limit sets, attractors, periodic orbits, Floquet theory and the Poincare Map. Introduction to perturbation theory.

MATH 513 / 463. Introduction to Partial Differential Equations. (3) Classification of partial differential equations; properly posed problems; separation of variables, eigenfunctions and Green's functions; brief survey of numerical methods and variational principles.

MATH 514 / 464. Applied Matrix Theory. (3) Determinants; theory of linear equations; matrix analysis of differential equations; eigenvalues, eigenvectors and canonical forms; variational principles; generalized inverses.

MATH 519. Selected Topics in Algebra and Number Theory. (3, no limit)

MATH 520. Abstract Algebra I. (3) Theory of groups, permutation groups, Sylow theorems. Introduction to ring theory, polynomial rings. Principal ideal domains.

MATH 521. Abstract Algebra II. (3) Continuation of 520. Module theory, field theory, Galois theory.

MATH 530. Algebraic Geometry I. (3) Basic theory of complex affine and projective varieties. Smooth and singular points, dimension, regular and rational mappings between varieties, Chow's theorem.

MATH 531. Algebraic Geometry II. (3) Continuation of 530. Degree of a variety and linear systems. Detailed study of curves and surfaces.

MATH 532. Algebraic Topology I. (3) Introduction to homology and cohomology theories. Homotopy theory, CW complexes.

MATH 533. Algebraic Topology II. (3)

MATH 535 / 431. Foundations of Topology. (3) Basic point set topology. Separation axioms, metric spaces, topological manifolds, fundamental group and covering spaces.

MATH 536. Introduction to Differentiable Manifolds. (3) Concept of a manifold, differential structures, vector bundles, tangent and cotangent bundles, embedding, immersions and submersions, transversality, Stokes' theorem.

MATH 537. Riemannian Geometry I. (3) Theory of connections, curvature, Riemannian metrics, Hopf-Rinow theorem, geodesics. Riemannian submanifolds.

MATH 538. Riemannian Geometry II. (3) Continuation of MATH 537 with emphasis on adding more structures. Riemannian submersions, Bochner theorems with relation to topology of manifolds, Riemannian Foliations, Complex and Kaehler geometry, Sasakian and contact geometry.

MATH 539. Selected Topics in Geometry and Topology. (3, no limit)

MATH 540. Stochastic Processes with Applications. (3) Markov chains and processes with applications. Classification of states. Decompositions. Stationary distributions. Probability of absorption, the gambler's ruin and mean time problems. Queuing and branching processes. Introduction to continuous time Markov processes. Jump processes and Brownian motion.

MATH 542 / 338. Mathematics for Secondary Teachers. (3) Topics from secondary mathematics presented from an advanced standpoint and designed to meet the needs of pre- and in-service teachers. Open only to prospective and in-service teachers of mathematics.

MATH 543 / 339. Topics in Mathematics for Elementary and Middle School Teachers. (1-3, no limit) Presents mathematical topics of concern to elementary and mid-school teachers. Open only to in-service and prospective teachers. May be repeated for credit by permission of instructor.

MATH 549. Selected Topics in Probability Theory. (3, no limit)

MATH 550 / 350. Topics in Mathematics for Secondary Teachers. (1-3, no limit) Presents mathematical topics of concern to secondary teachers. Open only to in-service and prospective teachers. May be repeated for credit by permission of instructor.

MATH 551. Problems. (1-3, no limit)

MATH 557. Selected Topics in Numerical Analysis. (3, no limit) Possible topics include approximation theory, two point boundary value problems, quadrature, integral equations and roots of nonlinear equations.

MATH 561. Functions of a Complex Variable I. (3) Analyticity, Cauchy theorem and formulas, Taylor and Laurent series, singularities and residues, conformal mapping, selected topics.

MATH 562. Functions of a Complex Variable II. (3) The Mittag-Leffler theorem, series and product expansions, introduction to asymptotics and the properties of the gamma and zeta functions. The Riemann mapping theorem, harmonic functions and Dirichlet's problem. Introduction to elliptic functions. Selected topics.

MATH 563. Measure Theory. (3) Functions of one and several real variables, measure theory, starting with Lebesque measure and integration. Product measures. Measure on spaces of functions.

MATH 565. Harmonic Analysis. (3) Fourier analysis on the circle, real line and on compact and locally compact groups.

MATH 569. Selected Topics in Analysis. (3, no limit)

MATH 570. Singular Perturbations. (3) Singularly perturbed boundary value problems, layer type expansions and matching. Initial value problems and multiscaling methods for ordinary and partial differential equations. Phase plane and qualitative ideas. Applications. Perturbations of Hamiltonian systems.

MATH 572 / 472. Fourier Analysis and Wavelets. (3) Discrete Fourier and Wavelet Transform. Fourier series and integrals. Expansions in series of orthogond wavelets and other functions. Multiresolution and time/frequency analysis. Applications to signal processing and statistics.

MATH 576. Numerical Linear Algebra. (3) Selected advanced topics in numerical linear algebra.

MATH 578. Numerical Partial Differential Equations. (3) Introduction to the numerical analysis of partial differential equations.

MATH 579. Selected Topics in Applied Mathematics. (3, no limit)

MATH 581. Functional Analysis I. (3) Normed vector spaces, including Hilbert and Banach spaces. Linear operators on these spaces, with an emphasis on applications.

MATH 583. Methods of Applied Mathematics I. (3) Approximation in Hilbert spaces, basic operator theory, integral equations, distribution theory, Green's functions, differential operators, boundary value problems and nonlinear problems.

MATH 584. Methods of Applied Mathematics II. (3) Eigenfunction expansions for ordinary and partial differential operators, Euler-Lagrange equations, Hamilton's principle, calculus of variations, brief complex variable theory, special functions, transform and spectral theory, asymptotic expansions.

MATH 598. Practicum. (1-6 to a maximum of 6) Practicum involves a project of an applied nature which may be done in conjunction with an industrial laboratory, a research institution or another department of the University. It is expected the student will become acquainted with a field of application in science or engineering and complete a project of use and interest to workers in that field. A final written report is required.

MATH 599. Master's Thesis. (1-6, no limit) Offered on a CR/NC basis only.

MATH 605. Graduate Colloquium. (1 to a maximum of 4)

MATH 639. Seminar in Geometry and Topology. (1-3, no limit)

MATH 649. Seminar in Probability and Statistics. (1-3, no limit)

MATH 650. Reading and Research. (1-6 to a maximum of 12)

MATH 669. Seminar in Analysis. (1-3, no limit)

MATH 679. Seminar in Applied Mathematics. (1-3, no limit)

MATH 689. Seminar in Functional Analysis. (1-3)

MATH 699. Dissertation. (3-12, no limit)

Statistics

Cf: `http://catalog.unm.edu//catalogs/2016-2017/courses/STAT/index.html`

STAT 145. Introduction to Statistics. (3) Techniques for the visual presentation of numerical data, descriptive statistics, introduction to probability and basic probability models used in statistics, introduction to sampling and statistical inference, illustrated by examples from a variety of fields. Meets New Mexico Lower-Division General Education Common Core Curriculum Area II: Mathematics (NMCCN 1113). (I)

STAT 279. Topics in Introductory Statistics. (1 to 3 to a maximum of 3)

STAT 345. Elements of Mathematical Statistics and Probability Theory. (3) An introduction to probability including combinatorics, Bayes' theorem, probability densities, expectation, variance and correlation. An introduction to estimation, confidence intervals and hypothesis testing.

STAT 427 / 527. Advanced Data Analysis I. (3) Statistical tools for scientific research, including parametric and non-parametric methods for ANOVA and group comparisons, simple linear and multiple linear regression, and basic ideas of experimental design and analysis. Emphasis placed on the use of statistical packages such as Minitab and SAS.

STAT 428 / 528. Advanced Data Analysis II. (3) A continuation of 427 that focuses on methods for analyzing multivariate data and categorical data. Topics include MANOVA, principal components, discriminant analysis, classification, factor analysis, analysis of contingency tables including log-linear models for multidimensional tables and logistic regression.

STAT 434 / 534. Contingency Tables and Dependence Structures. (3) This course examines the use of log-linear models to analyze count data. It also uses graphical models to examine dependence structures for both count data and measurement data.

STAT 440 / 540. Regression Analysis. (3) Simple regression and multiple regression. Residual analysis and transformations. Matrix approach to general linear models. Model selection procedures, nonlinear least squares, logistic regression. Computer applications.

STAT 445 / 545. Analysis of Variance and Experimental Design. (3) A data-analytic course. Multifactor ANOVA. Principles of experimental design. Analysis of randomized blocks, Latin squares, split plots, etc. Random and mixed models. Extensive use of computer packages with interpretation, diagnostics.

STAT 453 / 553. Statistical Inference with Applications. (3) Transformations of univariate and multivariate distributions to obtain the special distributions important in statistics. Concepts of estimation and hypothesis testing in both large and small samples with emphasis on the statistical properties of the more commonly used procedures, including student's t-tests, F-tests and chi-square tests. Confidence intervals. Performance of procedures under non-standard conditions (i.e., robustness).

STAT 461 / 561. Probability. (3) Mathematical models for random experiments, random variables, expectation. The common discrete and continuous distributions with application. Joint distributions, conditional probability and expectation, independence. Laws of large numbers and the central limit theorem. Moment generating functions.

STAT 470 / 570. Industrial Statistics. (3) Basic ideas of statistical quality control and improvement. Topics covered: Deming's 14 points and deadly diseases, Pareto charts, histograms, cause and effect diagrams, control charts, sampling, prediction, reliability, experimental design, fractional factorials, Taguchi methods, response surfaces.

STAT 472 / 572. Sampling Theory and Practice. (3) Basic methods of survey sampling; simple random sampling, stratified sampling, cluster sampling, systematic sampling and general sampling schemes; estimation based on auxiliary information; design of complex samples and case studies.

STAT 474 / 574. Biostatistical Methods: Survival Analysis and Logistic Regression. (3) A detailed overview of methods commonly used to analyze medical and epidemiological data. Topics include the Kaplan-Meier estimate of the survivor function, models for censored survival data, the Cox proportional hazards model, methods for categorical response data including logistic regression and probit analysis, generalized linear models.

STAT 476 / 576. Multivariate Analysis. (3) Tools for multivariate analysis including multivariate ANOVA, principal components analysis, discriminant analysis, cluster analysis, factor analysis, structural equations modeling, canonical correlations and multidimensional scaling.

STAT 477 / 577. Introduction to Bayesian Modeling. (3) An introduction to Bayesian methodology and applications. Topics covered include: probability review, Bayes' theorem, prior elicitation, Markov chain Monte Carlo techniques. The free software programs WinBUGS and R will be used for data analysis.

STAT 479. Topics in Statistics. (3, no limit) Modern topics not covered in regular course offerings.

STAT 481 / 581. Introduction to Time Series Analysis. (3) Introduction to time domain and frequency domain models of time series. Data analysis with emphasis on Box-Jenkins methods. Topics such as multivariate models; linear filters; linear prediction; forecasting and control.

STAT 495. Individual Study. (1-3 to a maximum of 6) Guided study, under the supervision of a faculty member, of selected topics not covered in regular course offerings.

STAT 520. Topics in Interdisciplinary Biological and Biomedical Sciences. (3, no limit) Varying interdisciplinary topics taught by collaborative scientists from UNM, SFI, and LANL.

STAT 527 / 427. Advanced Data Analysis I. (3) Statistical tools for scientific research, including parametric and non-parametric methods for ANOVA and group comparisons, simple linear and multiple linear regression and basic ideas of experimental design and analysis. Emphasis placed on the use of statistical packages such as Minitab and SAS. Course cannot be counted in the hours needed for graduate degrees in Mathematics and Statistics.

STAT 528 / 428. Advanced Data Analysis II. (3) A continuation of 527 that focuses on methods for analyzing multivariate data and categorical data. Topics include MANOVA, principal components, discriminate analysis, classification, factor analysis, analysis of contingency tables including log-linear models for multidimensional tables and logistic regression.

STAT 534 / 434. Contingency Tables and Dependence Structures. (3) This course examines the use of log-linear models to analyze count data. It also uses graphical models to examine dependence structures for both count data and measurement data.

STAT 540 / 440. Regression Analysis. (3) Simple regression and multiple regression. Residual analysis and transformations. Matrix approach to general linear models. Model selection procedures, nonlinear least squares, logistic regression. Computer applications.

STAT 545 / 445. Analysis of Variance and Experimental Design. (3) A data-analytic course. Multifactor ANOVA. Principles of experimental design. Analysis of randomized blocks, Latin squares, split plots, etc. Random and mixed models. Extensive use of computer packages with interpretation, diagnostics.

STAT 546. Theory of Linear Models. (3) Theory of the Linear Models discussed in 440/540 and 445/545. Linear spaces, matrices, projections, multivariate normal distribution and theory of quadratic forms. Non-full rank models and estimability. Gauss-Markov theorem. Distribution theory for normality assumptions. Hypothesis testing and confidence regions.

STAT 547. Multivariate Analysis and Advanced Linear Models. (3) Hotelling T2, multivariate ANOVA and Regression, classification and discrimination, principal components and factor analysis, clustering, graphical and computational techniques, topics in linear models.

STAT 553 / 453. Statistical Inference with Applications. (3) Transformations of univariate and multivariate distributions to obtain the special distributions important in statistics. Concepts of estimation and hypothesis testing in both large and small samples with emphasis on the statistical properties of the more commonly used procedures, including student's t-tests, F-tests and chi-square tests. Confidence intervals. Performance of procedures under non-standard conditions (i.e., robustness).

STAT 556. Advanced Statistical Inference I. (3) Theory and methods of point estimation, sufficiency and its applications.

STAT 557. Advanced Statistical Inference II. (3) Standard limit theorems, hypothesis testing, confidence intervals and decision theory.

STAT 561 / 461. Probability. (3) Mathematical models for random experiments, random variables, expectation. The common discrete and continuous distributions with application. Joint distributions, conditional probability and expectation, independence. Laws of large numbers and the central limit theorem. Moment generating functions.

STAT 565. Stochastic Processes with Applications. (3) Markov chains and processes with applications. Classification of states. Decompositions. Stationary distributions. Probability of absorption, the gambler's ruin and mean time problems. Queuing and branching processes. Introduction to continuous time Markov processes. Jump processes and Brownian motion.

STAT 569. Selected Topics in Probability Theory. (3, no limit)

STAT 570 / 470. Industrial Statistics. (3) Basic ideas of statistical quality control and improvement. Topics covered: Deming's 14 points and deadly diseases, Pareto charts, histograms, cause and effect diagrams, control charts, sampling, prediction, reliability, experimental design, fractional factorials, Taguchi methods, response surfaces.

STAT 572 / 472. Sampling Theory and Practice. (3) Basic methods of survey sampling; simple random sampling, stratified sampling, cluster sampling, systematic sampling and general sampling schemes; estimation based on auxiliary information; design of complex samples and case studies.

STAT 574 / 474. Biostatistical Methods: Survival Analysis and Logistic Regression. (3) A detailed overview of methods commonly used to analyze medical and epidemiological data. Topics include the Kaplan-Meier estimate of the survivor function, models for censored survival data, the Cox proportional hazards model, methods for categorical response data including logistic regression and probit analysis, generalized linear models.

STAT 576 / 476. Multivariate Analysis. (3) Tools for multivariate analysis including multivariate ANOVA, principal components analysis, discriminant analysis, cluster analysis, factor analysis, structural equations modeling, canonical correlations and multidimensional scaling.

STAT 577 / 477. Introduction to Bayesian Modeling. (3) An introduction to Bayesian methodology and applications. Topics covered include: probability review, Bayes' theorem, prior elicitation, Markov chain Monte Carlo techniques. The free software programs WinBUGS and R will be used for data analysis.

STAT 579. Selected Topics in Statistics. (3, no limit)

STAT 581 / 481. Introduction to Time Series Analysis. (3) Introduction to time domain and frequency domain models of time series. Data analysis with emphasis on Box-Jenkins methods. Topics such as multivariate models; linear filters; linear prediction; forecasting and control.

STAT 586. Nonparametric Curve Estimation and Image Reconstruction. (3) Nonparametric regression, density estimation, filtering, spectral density estimation, image reconstruction and pattern recognition. Tools include orthogonal series, kernels, splines, wavelets and neural networks. Applications to medicine, engineering, biostatistics and economics.

STAT 590. Statistical Computing. (3) A detailed examination of essential statistical computing skills needed for research and industrial work. Students will use S-Plus, Matlab and SAS to develop algorithms for solving a variety of statistical problems using resampling and simulation techniques such as the bootstrap, Monte Carlo methods and Markov chain methods for approximating probability distributions. Applications to linear and non-linear models will be stressed.

STAT 595. Problems. (1-3, no limit)

STAT 599. Master's Thesis. (1-6, no limit)

STAT 605. Graduate Colloquium. (1 to a maximum of 4) Students present their current research.

STAT 649. Seminar in Probability and Statistics. (1-3, no limit)

STAT 650. Reading and Research. (1-6 to a maximum of 12)

STAT 699. Dissertation. (3-12, no limit)

Attachment: 2006-2016 MS and PhD graduates in Mathematics and Statistics

2006-2016 MS and PhD graduates in Math and Stat

María Cristina Pereyra, Graduate Committee Chair

February 23, 2017

Contents

1 Summary: 2006-2016 MS and PhD in Math and Stats

The numbers in what follows refer to a 10 year window from Fall 2006 till Summer 2016 for the MS, and Summer 2006-Summer 2016 for PhDs. We have made our best efforts to identify all MS and PhD alumni in Mathematics and Statistics. We have used data provided by the Alumni Office (Thank you Maria Wolfe), data from the department (spreadsheets maintained by Ana Parra, data base created by Sterling Coke in Summer 2009 with help from Roxanne Littlefield, graduation ceremony leaflets, and data from 2006-09 from Graduate Chair's records). All together we have identified 156 MS, 66 PhDs. We have also collected a list of 119 publications from the PhD students in the window which corresponds to research done while graduate students or soon after they graduated. (Refer to Sections 2, 3, and 4 for the raw data.)

The next Section presents a digest of the raw data in Sections 2, 3, and 4, based on the numbers as of 10/9/16. The rationale behind this detective work was to be able to argue that by an large our MS and PhD graduates are working in jobs related to their degrees. The data confirms this assertion.

- Of the 156 MS alumni in record for the period Fall 2006-Summer 2016 we could not track down the whereabouts of 31 students. Three students moved on to do things unrelated to math or stat. All the others, 122 students (78%), are working in areas related to their expertise whether doing research, teaching, working in industry, financial or government institutions, or went on to pursue PhDs or other degrees in related areas.

- Of the 66 PhD alumni in record for the period Summer 2006- Summer 2016 we could not track out the whereabouts of only 2 students. Among the remaining ones, one is no longer working in mathematics. All the other 63 students (96%) are working in areas related to their expertise in mathematics or statistics whether doing research, teaching, working in industry or financial institutions.

1.1 Statistics by Gender, Origin, Speciality

As of 10/09/16, the MS data is the most inaccurate (Section 2). The PhD data is almost complete (Section 3). There are 156 MS and 66 PhD students recorded in the 2006-2016 window considered.

- **Statistics by Gender and Origin**
  - **MS/156:** 63 female (40% female), 25 Hispanic Origin (16% hispanic), 2 African origin (1.3%)
  - **PhD/66:** 20 female (30% female), 13 Hispanic Origin (20% hispanic), 1 Native American, 21 Asian origin (32% other origins), 21 US citizens (32% US citizens).
- **Statistics by Speciality: Mathematics (Applied and Pure), Statistics**
  - **MS/156:** 88 Mathematics (60 Applied Math, 28 Pure Math[1]), 68 Statistics.
    56% Mathematics (39% Applied Math, 18% Pure Math), 43% Statistics.
    - **Mathematics/88:** 30 female (48% of female, 34% of mathematics students), 18 Hispanic (72% of Hispanics, 21% of mathematics students).
      - Applied/60: 22 female (35% of female, 37%of applied students),
        14 Hispanic (54% of Hispanics, 23% of applied students),
        1 African origin (50% of African origin, 1.7% of applied students). .
      - Pure/28: 8 female (13% of female, 29% of pure students),
        4 Hispanics (17% of hispanics, 14% of pure students).
    - **Statistics/68:** 33 female (52% of female, 49% of statistics students),
      7 Hispanic (29% of Hispanics, 10% of statistics students),
      1 African origin (50% of African origin, 1.5% of statistics students).
  - **PhD/66:** 44 Mathematics (23 Applied Math, 21 Pure Math), 22 Statistics.
    67% Mathematics (35% Applied, 32% Pure), 33% Statistics.
    About a third per group. On average we are producing between 6-7 students per year.
    - **Mathematics/44:** 15 female (75% of female, 34% of mathematics students),
      11 Hispanics (85% of Hispanics, 25% of mathematics students),
      1 Native American (100% of Native American, 2.3% of mathematics students),
      8 Southeast Asian origin (38% of Southeast Asian, 18% of mathematics students),
      16 US citizens (76% of US citizens, 36% of mathematics students).
      - Applied/23: 11 female (55% of female, 48% of applied students),
        5 Hispanics (39% of Hispanics, 22% of applied students),
        1 Native American (100% of Native American, 4.3% of applied students),
        5 Southeast Asian origin (24% of Southeast Asian, 22% of applied students),
        7 US citizens (33% of US citizens, 30% of applied students).
      - Pure/21: 4 female (20% of female, 19% of pure students),
        6 Hispanics (46% of Hispanics, 29% of pure students),
        3 Southeast Asian origin (14% of Southeast Asian and of pure students),
        9 US citizens (43% of US citizens and of pure students).
    - **Statistics/22:** 5 female (25% of female, 23% of statistics students),
      2 Hispanics (15% of hispanics, 9% of statistics students),
      13 Southeast Asian origin (62% of Southeast Asian, 59% of statistics students),
      5 US citizens (24% of US citizens, 23% of statistics students).

[1] Three female students got a degree in Applied Math but they did their MS Thesis with Blair and Pereyra.

1.2 Employment 2006-2016 MS alumni

We summarize the employment data collected for our MS alumni, the raw data is in Section 2.

- MS Alumni are currently or have been Assistant or Associate Professors in Honduras (Universidad Nacional Autónoma) and USA (Fairfield University, CT; Utah Valley University, Sonoma State University).

- MS Alumni hold or have held postdoctoral positions in Australia (U. New South Wales), Chile, Germany (Technishe U. Darmstadt), Finland (U. Helsinki), UK (Oxford University), and the USA (UC San Francisco School of Medicine; U. Tennessee Health Science Center; Columbia University; U. Arizona; U. Michigan; GATech; U. Notre Dame; U. Illinois at Urbana-Champaign; UC Santa Barbara, Sandia National Labs; Virginia Commonwealth U.).

- MS Alumni are currently or have been researchers at National Laboratories, National Agencies, university laboratories (Sandia National Labs; Los Alamos National Labs.; Air Force Kirkland Laboratory; US Geological Survey; National Security Agency; US Army; US Census Bureau, Washington D.C.; British Columbia Centre for Excellence, Vancouver, Canada; MIT Lincoln Laboratory; Center for Computational Biology and Bioinformatic, Indiana U. School of Medicine; US Corps of Engineers, Santa Fe, NM; Department of Defense; UNM Comprehensive Cancer Center; UNM Health Science Center; CS at UNM).

- MS Alumni are currently or have been working in Industry in Canada (Statistics Canada), Czech Republic (MSD Prague), and the US (Google, CA; Apple, CA; Boeing, WA; Aetna, CA; SAS; STATin MED Research, Ann Arbor, MI; HyperComp; EI Americas Security Analytics; Global Supply Chain Logistics; VISA, San Francisco, CA; Business Insights DAQRY; Pillar Technology, OH; Overlook Systems Technologies Inc; Geisenberg Health System, PA; Mosaic Data Science; Walmart, AK; Abbye Labs -pharmaceutical-; Mountain Vector Energy; Innovasic Inc, Albuquerque, NM; Epic Systems, Wisconsin).

- MS Alumni are currently or have been working in financial institutions in Canada (TD Bank Group Toronto; Bank of Canada, Toronto), UK (Lloyd Banking Group, London), and the US (Freddy Mac, Bethesda, MD; Interthinx, AML Analytics; Financial Services Professional, Albuquerque, NM; Fidelity Investments; Camelot Integrated Solutions).

- MS Alumni are currently or have been Instructors/Faculty at Community Colleges (Central New Mexico Community College (CNM); San Juan College; Lakeland Community College; Napa Valley College; El Camino College; Santa Rosa Junior College, CA; Gavilan College, CA), or Lecturers/Visiting Teaching Assistant Professors at Universities (UNM, UNM Valencia campus; UNM Gallup, UT El Paso), or K-12 teachers (Valley HS, Atrisco Heritage HS, both in Albuquerque, NM).

- MS Alumni went on to pursue PhD degrees in Applied Math (U. British Columbia, Canada; UNM, UT El Paso; UT Austin); Pure Math (UNM); Statistics (Rice U.; Purdue U.; University of Arizona; UC Irvine; U. South Carolina; Clemson U., SC; Florida State University); Biostatistics (University of Arizona); Math Education (University of Michigan); Medical School (UNM); Neuroscience (Yale University); Physics (Cornell University); Economics (Rutgers University); Optical Sciences (University of Arizona).

- Some of our 2006-2016 MS alumni are: Founder ULE Partners and a book author; Analyst at University of Southern California; pursuing MA in Linguistics; Analyst Programmer at Geospacial and Population Studies at UNM; Sport Statistician at UNM; Student Coordinator and Counselor for an Aviation Company in Canada.

- Of the 156 MS alumni in record for the period Fall 2006-Summer 2016 we could not track down the whereabouts of 31 students. Three students moved on to do things unrelated to math or stat. All the others, 122 students (78%), are working in areas related to their expertise whether doing research, teaching, working in industry, financial or government institutions, or went on to pursue PhDs or other degrees in related areas.

1.3 Employment 2006-2016 PhD alumni

We summarize the employment data collected for our PhD alumni, the raw data is in Section 3.

- PhD Alumni are currently or have been Assistant or Associate Professors in Austria (Karl-Franzens-Universität Graz), Brazil (Universidade Federal do Rio Grande do Sud, Universidade Federal de Pelotas), Canada (University of Toronto Mississauga), Honduras (Universidad Nacional Autónoma), Mexico (Instituto Tecnológico de Estudios Superiores de Monterrey), Peru (Pontificia Universidad Católica de Peru), Japan (Okinawa Institute of Science and Technology Graduate University), Korea (Keimyung University, USA (U. Alabama, Tuscaloosa; UNM -Math and Stat, Internal Medicine, and Biostatistics in School of Medicine-; Notre Dame U.; San Diego State U.; Central Michigan U.; Earlham College; Sonoma State University; Swarthmore College; California Lutheran University; Southern Methodist University; UC Riverside).
- PhD Alumni hold or have held postdoctoral positions in Australia (Australian National University, University of Queensland), Chile (Pontificia Universidad Católica de Chile), Germany (Technishe U. Darmstadt), Israel (Hebrew U., Jerusalem), Korea (Inha University), Sweden (Uppsala University), Switzerland (ETH Zürich), USA (Duke U., NIH, NIEHS; U. Missouri at Columbia, Baylor U., UNM, Rice U., Indiana U.; U. Arizona; U. Michigan; GATech; U. Notre Dame; ICERM at Brown University; UCLA; IPAM; U. Illinois at Urbana-Champaign; Stony Brooks University; UC Santa Barbara, Sandia National Labs;).
- PhD Alumni are currently or have been researchers at National Laboratories or agencies (Sandia National Labs, Los Alamos National Labs., Air Force Kirkland Laboratory, US Geological Survey)
- PhD Alumni are currently or have been working in Industry (Monsanto; AMGEN Inc CA; Boeing, Seattle, WA; SAS; HyperComp; Eli Lilly and Company, IN; Walmart, AK; Abbye Labs -pharmaceutical-; TECH-X, Boulder, CO).
- PhD Alumni are currently or have been working in financial institutions (Interthinx, EY Americas Security Analytics Leader; Camelot Integrated Solutions).
- PhD Alumni are currently or have been Instructors/Faculty at Community Colleges (Central New Mexico Community College (CNM); Pueblo Community College, CO; Southwest Houston Community College, TX; Yuba College, CA; Los Rios Community College, CA; Santa Rosa Junior College, CA; Gavilan College, CA), or Lecturers/Visiting Teaching Assistant Professors at Universities (UNM, UNM Valencia campus; Ohio U. in Athens, U. of Delaware)
- One of our 2006-2016 PhD alumni is a Psycometrician for Albuquerque Public Schools (APS), another one is no longer doing mathematics instead she is Student Coordinator and Counselor for an Aviation Company in Canada. One of our students in unemployed but has submitted research proposals to the Air Force with a Mechanical Engineering Professor at UNM.
- Of the 66 PhD alumni in record for the period Summer 2006- Summer 2016 we could not track out the whereabouts of only 2 students. Among the remaining ones, one is no longer working in mathematics. All the other 63 students (96%) are working in areas related to their expertise in mathematics or statistics whether doing research, teaching, working in industry or financial institutions.

1.4 PhD Alumni Publications

Publications by the 66 PhD alumni in the window (Summer 2006-Summer 2016) analyzed. Only 8 students are not expected to publish anything related to their dissertation, 5 have not yet published but are preparing submissions. The rest, 53/66 or 80% of them have published. We have in record 119 articles (9 appeared in Conference Proceedings, 5 are to appear/accepted for publication, 2 have been submitted for publication, 2 are posted in the arXiv but not yet submitted, these numbers may need revision from the raw data), that leaves about 100 publications in peer reviewed journal or about 2 peer reviewed publications per student who published. Some of the students have become well-known researchers on their own we are not recording all their publications, only the ones resulting from work done while graduate students at UNM. The raw data is in Section 4.

- Math: 77 pubs (65%)
  - Applied Math: 45 pubs (38%)
  - Pure Math: 27 pubs (23%)
  - Math Education: 5 pubs (4%)
- Statistics: 42 pubs (35%)

The journals include

- **Applied:** Nature, J. Fluid Mech., Physical Review A, Physica D, Phys. Rev. Accel. Beams (PRAB), Optics Communications, Studies in applied Math., JETP Letters, Nonlinearity, New Journal of Physics, PLoS One, Bull. of Mathematical Biology, J. of Physical Oceanography, Math. Comp. Modeling, J. Chem. Phys., Int. J. Mult. Comp. Eng., Oceanic Manifestations of Global Changes, , Phys. of Plasmas, IEEE/ASME J. Microelectromechanical Systems, J. Comp. Physics, Fluid Dyn. Res., Phys. Fluids., Cold Reg. Sci. Technol., J. Inequalities and Special Functions, J. Geophysical Research, Computer Physics Communications, Inverse Problems, Mathematical and Computer Modeling,

- **Pure:** Journal of Algebra, Journal of Number Theory, Journal of Functional Analysis, Transactions of the American Mathematical Society, Geometriae Dedicata, Math. Res. Lett., Pacific Journal of Mathematics, Rocky Mountain Journal of Mathematics, Indiana University Mathematics Journal, Publicationes Matematicas, Selecta Mathematica, Journal of Commutative Algebra, Annals of Global Analysis and Geometry, Experimental Mathematics, Communications in Pure and Applied Analysis, Communications in Algebra.

- **Stat:** J. Royal Statistical Soc.; J. Amer. Stat. Assoc.; The American Statistician; J. Risk and Reliability; Communications in Statistics, Theory and Methods; J. Quality Technology; International Statistical Review; Applied Stochastic Models in Business and Industry; Quality Engineering; Public Health Nutrition; Gynecology Oncology; Cancer Epidemiology Biomarkers & Prevention; Human Brain Mapping; Emviromental and Ecological Statistics; Open J. Ecology; Australian and New Zealand J. Statistics; Reliability Engineering Advances; Blood; Theoretical Population Biology; Technometrics; Psychological Services; International J. Business Performance and Supply Chain Modeling; Southern Medical Journal; Communications in Statistics-Simulations and computations; Bayesian Analysis; Advances in Econometrics; J. Statistical Theory and Practice; Computational Statistics & Data Analysis; J. Statistical Computation and Simulation.

- **Math Ed:** Notices Amer. Math. Soc., Creative Education.

2 Raw Data: 10 year window MS graduates

F=Female (M=Male when foreign name makes it hard to know and we have identified gender), H=Hispanic, NA= Native American, A= Asian origin, AA=African origin, US=US citizen.

1. Fall 2006, Ignacio Rozada (H), MS in Applied Math. Mathematical Modeler at British Columbia Centre for Excellence in HIV/AIDS Vancouver, CA. 2012 PhD in Applied Math at University of British Columbia, Vancouver, CA.
2. Fall 2006, Hugh Smith (US), MS in Applied Math (Thesis?). Now?
3. Fall 2006, David Worth (US), MS in Pure Math (Thesis, Loring). Now?
4. Fall 2006, Xichun (Tracy) Cui (F, A), MS in Statistics. Pharmaceutical Professional, Orange County, CA.
5. Fall 2006, Nina Greenberg(F, US), MS in Statistics. Lecturer in Statistics at UNM.
6. Fall 2006, Alvaro Nosedal-Sanchez (H), MS in Statistics. 2011 PhD in Statistics from UNM. Assistant Professor at U. Toronto Mississauga, CA.
7. Fall 2006, Valerie Peters (Hines) (F, US), MS in Statistics. Analytics Storyteller at Google, San Francisco, CA.
8. Fall 2006, William Vasquez (H), MS in Statistics. Associate Professor, Fairfield University, CT.
9. Fall 2006, Alejandro Villagran-Hernandez (H), MS in Statistics. 2009 PhD in Statistics from UNM. Data Scientist at Boeing, Seattle, WA.

10. Spring 2007, Alejandro Acuña (H), MS in Applied Math. Full Time Faculty at Central New Mexico Community College (CNM).
11. Spring 2007, Shadi Naderi (F), MS in Applied Math. 2011 PhD in Applied Math from UNM. Researcher at Air Force Kirkland Laboratory.
12. Spring 2007, Yan (Cindy) Qiu (F, A), MS in Applied Math. 2010 PhD in Applied Math from UNM. Sr. Data Scientist at Interthinx. MS in Economics from UNM.
13. Spring 2007, Paul Delgado (H, US), MS in Pure Math (Thesis, Umland). NSF LSAMP Fellow at University of Texas El Paso (UTEP) since 2012. Lecturer of Mathematics at UTEP 2008-2015.
14. Spring 2007, Adam Ringler (US), MD in Pure Math. 2009 PhD in Pure Math. Physical Scientist at USGS.
15. Spring 2007, Eric Baldwin (US), MS in Statistics. Programmer/Analyst at Group Health Research Institute Greater Seattle Area
16. Spring 2007, Dong Li (M, A), MS in Statistics. Now?

17. Summer 2007, Huynh Dinh (A), MS in Applied Math (Thesis, Stone). Full Time Faculty at CNM.
18. Summer 2007, Christopher Donahue (US), MS in Applied Math (Thesis, Aceves/Hyman (LANL)). PhD in Neuroscience, Yale University. Currently postdoctoral scholar, Gladstone Institutes, University of California San Francisco School of Medicine.

19. Summer 2007, Christin Gunning (F, US), MS in Applied Math (Thesis, Embid). now? Taught at CNM.

20. Summer 2007, Qiao Liang (F, A), MS in Applied Math (Thesis, Sulsky). now? Grandini's wife.

21. Summer 2007, Jonathan Berman (US), MS in Statistics. Founder of ULE Partners, Writer, Mathematician, Teacher, Author of the upcoming book "The Unlocked Soul" Boulder, Colorado.

22. Summer 2007, Zazil Colin (US), MS in Statistics. Now at Informatics Consultant at Aetna, Walnut Creek, CA. Financial Services Professional Albuquerque, NM.

23. Summer 2007, Xiangjin Shen (F, A), MS in Statistics. Senior Economist at Bank of Canada Ottawa, Ontario, Canada. Graduate student in Economics at Rutgers University (2008-11).

24. Summer 2007, Lucinda Sidow (F, US), MS in Statistics (Thesis, Huzurbazar). now?

25. Summer 2007, Ning Tang (M, A), MS in Statistics. Senior Analyst, AML Analytics, TD Bank Group Toronto, Ontario, Canada. 2011 PhD in Statistics from Rutgers University.

26. Summer 2007, Ren Yuang (F, A), MS in Statistics. now?

27. Fall 2007, Ivana Gorgievska (F), MS in Applied Math. Math Instructor at Santa Rosa Junior College. Lecturer at UNM (11-13), Assistant Professor at Lakeland Community College (08-11). PTI at CNM (08).

28. Fall 2007, Hyeonju Kim (F, A), MS in Applied Math (Thesis, Steinberg). Postdoc at the University of Tennessee Health Science Center Greater, NYC. 2015 PhD in Statistics from University of Arizona.

29. Fall 2007, Daishu Komagata (US), MS in Applied Math (Thesis, Embid). PTI at UNM, also instructor at CNM.

30. Fall 2007, Carsten Steinebach, MS in Applied Math. Software Engineer at Google. since 2013. Before Forecast and Strategic Analyst at Interthinx.

31. Fall 2007, Rong Li (F, A), MS in Statistics. At a University in China.

32. Fall 2007, Jason Lucero (H, US), MS in Statistics. Quantitative Analyst Professional at Freddie Mac Bethesda, Maryland.

33. Fall 2007, Phuong Vo (F?, A), MS in Statistics. now?

34. Spring 2008, Ling Xu (F, A), Applied Math. 2012 PhD in Applied Math from UNM. Postdoc U. Michigan. Postdocs at GATech and Notre Dame University.

35. Summer 2008, Ian Sorensen (US), MS in Applied Math (Thesis, Nitsche). Assistant Professor at Utah Valley University until death in 2015.

36. Summer 2008, Hector Chang (H), MS in Pure Math. 2013 PhD in Applied Math from UT Austin. Ritt Assistant Professor at Columbia University since 2013.

37. Summer 2008, Kourosh Raeen, MS in Pure Math (Thesis, Pereyra). Instructor at Santa Rosa Junior College since 2009 and at Napa Valley College.

38. Fall 2008, Jaime Hernandez (H, US), MS in Applied Math. From "Applied Research Mathematician" to "Global Network Exploitation Vulnerability Analyst" at NSA in Washington D.C.

39. Fall 2008, Jessica Phillips (F, US), MS in Pure Math (Thesis, Umland). Teaches at CNM.

40. Fall 2008, Shaohua Feng (F, A), MS in Statistics. now?

41. Fall 2008, Qiang Fu (M, A), MS in Statistics. now?

42. Spring 2009, Timothy Middleton (US), MS in Pure Math (Thesis, Umland). now?

43. Spring 2009, Israel Vaughn (US), MS in Pure Math. 2016 PhD in Optical Sciences, University of Arizona. Postdoctoral Research Associate Level A, University of New South Wales, Canberra, Australia.

44. Spring 2009, Raisa Slepoy (F, US), MS in Statistics. Mathematical Statistician at US Census Bureau, Washington D.C.

45. Summer 2009, Precious Andrew (F, US), MS in Applied Math (Thesis, Stone). Part Time Instructor at UNM.

46. Summer 2009, Henry Moncada (H). MS in Applied Math (Thesis, Wearing). PhD student in Computational Science Program at UT El Paso.

47. Summer 2009, Peterson Moyo (AA). MS in Applied Math (Thesis, Embid). Pursuing PhD in Math at UNM since S16. Teaching in Malawi (2009-15).

48. Summer 2009, Etsuko Nonaka (F), MS in Applied Math (Thesis with distinction, Wearing). 2014 PhD in Ecology and Evolutionary Biology from Umea University, Sweden. Postdoctoral Research Fellow at the Unviersity of Helsinki.

49. Summer 2009, Alex Castrounis (US), MS in Statistics (Bedrick). Technical product leader of customer-centric, enterprise-level cloud, software, and data solutions, Chicago, IL (Linkedin).

50. Summer 2009, Xun Huang (F, A), MS in Statistics. now?

51. Summer 2009, Joshua Neil (US), MS in Statistics. 2011 PhD in Statistics. EY Americas Security Analytics Leader.

52. Summer 2009, Summer H. Williams (F?, US), MS in Statistics (Thesis, Huzurbazar).

53. Fall 2009, Sze-Wing Wong (F, A), MS in Statistics. US Census Bureau.

54. Spring 2010, David Bizzozero (H, US), MS in Applied Math. 2015 PhD in Applied Math from UNM. Postdoc at Technische University Darmstadt, Germany.

55. Spring 2010, Mohammad Hattab, MS in Stat. 2013 PhD in Statistics. Postdoc in School of Pharmacy at Virginia Commonwealth University.

56. Spring 2010, Aaron Mora (H, US), MS in Applied Math (Thesis, Embid). Now?

57. Spring 2010, Lang Zhou (A), MS in Applied Math. 2013 MS in Statistics, 2016 PhD in Statistics at UNM. Senior Research Statistician at Abbvie.

58. Summer 2010, Laurel Christensen (F, US) , MS in Applied Mathematics. Online Mathematics Instructor at UNM at the MaLL.
59. Summer 2010, Kendra Lesser (F, US), MS in Applied Math. 2014 PhD in CS from UNM. Marie Curie Researcher in CS at Oxford University since 2014.
60. Summer 2010, Bea Yu (F, A, US), MS in Applied Math (Thesis with distinction, Wearing/Storlie). Associate Technical Staff at MIT Lincoln Laboratory since 2010.
61. Summer 2010, Juan Du (F, A), MS in Statistics. Sr. Statistical Programmer, TEam Leader at STATinMED Research, Ann Arbor, MI.
62. Summer 2010, Lauren Wilson (F, US), MS in Statistics. Statistician, Technical Staff at Sandia National Laboratories.

63. Fall 2010, Allen Joseph (US), MS in Applied Math (Thesis, Embid). Private company in Portland Oregon.
64. Fall 2010, Sergey Dyachenko, MS in Applied Math. 2014 PhD in Applied Math from UNM. Postdoc at University of Illinois at Urbana-Champaign.
65. Fall 2010, Martha Byrne (F, US), MS in Pure Math. 2014 PhD in Math from UNM. Faculty at Sonoma State University since F16.

66. Spring 2011, Svetlana Moiseeva (F), MS in Applied Math (Thesis, Embid). Operations Consultant - Global Supply Chain Logistics.
67. Spring 2011, Daniel Topa (US), MS in Applied Math. Currently working for Engineer Research and Development Center-Army, Vicksburg, MS. Mathematical Physicist at Los Alamos National Laboratory.
68. Spring 2011, John Ash (US), MS in Pure Math. Now?
69. Spring 2011, Yan Dong (F, A), MS in Statistics. 2015 PhD in Statistics from UNM. Research Associate at Center for Computational Biology and Bioinformatics, Indiana University School of Medicine.
70. Spring 2011, Peter Lee (US), MS in Statistics. Now?
71. Spring 2011, William Wadsworth (US), MS in Statistics. Now Senior Electrical Engineer at US Army Corps of Engineers Santa Fe, New Mexico. PhD Statistics student at Rice University, Houston, TX.
72. Spring 2011, Brandy DiMaggio (F, US), MS in Statistics. Sr Manager, Business Insights at DAQRI.

73. Summer 2011, Ming Gong (A), MS in Applied Math. 2015 PhD in Applied Math from UNM. Post doc at UC Santa Barbara (Math Dept).
74. Summer 2011, Pedro Madrid Ramirez (H), MS in Applied Math. 2013 PhD in Applied Math from UNM. Faculty at Universidad Autónoma de Honduras.
75. Summer 2011, Denis Sylantev, MS in Applied Math. PhD Candidate in Applied Math at UNM, expected S17.

76. Summer 2011, Shuxin Wang (F), MS in Applied Math. 2013 PhD in Applied Math from UNM. Student Coordinator and Counselor at Montair Aviation at Red Deer Base, Alberta, CA.
77. Summer 2011, Dow Inouye, MS in Pure Math. now?
78. Fall 2011, Alan Falleur (US), MS in Applied Math. Now?
79. Fall 2011, Jeremiah Johnson (US), MS in Applied Math (Thesis, Nitsche). Pursuing Medical School at UNM.
80. Fall 2011, Sahitya Konda (F, A), MS in Applied Math. 2015 PhD in Applied Math from UNM. Data Scientist at Camelot Integrated Solutions.
81. Fall 2011, Paula Weber (F, US), MS in Applied Math (Thesis with distinction, Wearing). Contractor at Sandia National Laboratories.
82. Fall 2011, Candace (Sanchez) Oluwasanni (F, H, US), MS in Pure Math (Thesis, Umland). Now?
83. Fall 2011, Laurie Price (F, US), MS in Pure Math (Thesis, J. Vassilev). MA candidate in Linguistics at UNM since 2013.
84. Fall 2011, Fletcher Christensen (US), MS in Statistics. 2015 PhD in Statistics from UC Irvine.
85. Fall 2011, Shen-Yang Wang (A), MS in Statistics. PhD candidate in Statistics at University of South Carolina (expected to graduate in 2016).
86. Spring 2012, Dominic Fanelli (US), MS in Applied Math. Professor in El Camino College.
87. Spring 2012, Erik Texeira (H, US), MS in Applied Math. Now?
88. Spring 2012, Matthew Dahlgren (US), MS in Pure Math. K12 Teacher for 4 years. Pursuing PhD in Math Education at University of Michigan since F16.
89. Spring 2012, Jaroslaw Kania, MS in Pure Math. Back in Poland. Part Time Instructor, School of Math Science & Engineering, CNM.
90. Spring 2012, David Weirich (US), MS in Pure Math. PhD candidate in Pure Math at UNM. Software Artisan at Pillar Technology Columbus, OH since May 2016.
91. Summer 2012, Elizabeth Kapiloff (F, US), MS in Applied Math. Now?
92. Summer 2012, David Glavin (US), MS in Statistics (Thesis, Umland). Student Affairs and Research Analyst at University of Southern California.
93. Fall 2012, Andrea Smith (F, US), MS in Applied Math (Thesis, Loring). Job?
94. Fall 2012, Craig Vanderploeg (US), MS in Applied Math (Thesis, Korotkevitch). Now?
95. Spring 2013, Cesar Alvarado (H), MS in Applied Math. PhD Candidate in Applied Math at UNM.

96. Spring 2013, Adeline Kornelus (F), MS in Applied Math. PhD Candidate in Applied Math at UNM.
97. Spring 2013, Matthew Arnold (US), MS in Pure Math. Now?
98. Spring 2013, Jonathan Schauble (US), MS in Pure Math. Now?
99. Spring 2013, Lang Zhou (A), MS in Statistics. 2016 PhD in Statistics from UNM. Sr. Researcher at Abbyie Laboratories.
100. Summer 2013, Ambrose Quintana (H, US), MS in Applied Math (Thesis, Lau). Systems Analyst at Overlook Systems Technologies, Inc.
101. Summer 2013, Dusty Brooks (F, US), MS in Pure Math (Thesis, Blair). Currently a Researcher at Sandia National Labs. K12 teacher at Valley HS, Albuquerque, NM.
102. Summer 2013, Benjamin Works (US), MS in Pure Math. Now?
103. Fall 2013, Kenneth Anglin (H, US), MS in Applied Math. Beloved instructor of Mathematics at CNM.
104. Fall 2013, Gregory Morre (US), MS in Pure Math. 2016 PhD in Pure Math. Instructor at Santa Rosa Junior College, CA.
105. Fall 2013, Fredy Vives Romero (H), MS in Pure Math. 2016 PhD in Pure Math. Assistant Professor at Universidad Autónoma de Honduras.
106. Fall 2013, Mohammad Arbabshirani, MS in Statistics. Machine learning and Computational Scientist at Geisinger Health System Danville, PA. 2014 PhD en Electric and Electronic Engineering from UNM.
107. Fall 2013, Gregory Lambert (US), MS in Statistics (Thesis, Sonksen). Data Scientist at Apple, Cupertino, CA.
108. Fall 2013, Rebecca Lilley (F, US), MS in Statistics (Thesis, Christensen). Maybe this is her: Operations Research Analyst at Kirtland Air Force Base Albuquerque, NM.
109. Fall 2013, Claire Longo (F, US), MS in Statistics. Statistician and Data Scientist at Mosaic Data Science, Reston, VA.
110. Fall 2013, John Pesko (US), MS in Statistics. PhD in Statistics candidate at UNM. RA at UNM Comprehensive Cancer Center.
111. Fall 2013, Elliot Smith (US), MS in Statistics. Data Scientist at VISA, San Francisco, CA.
112. Spring 2014, Christopher Zapotocky (US), MS in Applied Math. Now Engineering???
113. Spring 2014, Timothy Greenman (US), MS in Pure Math. Teacher at Atrisco Heritage HS, APS.
114. Spring 2014, Huan Jiang (F, A), MS in Statistics. PhD candidate in Statistics at UNM.
115. Spring 2014, Ilona Klosterman (F), MS in Statistics. Now?
116. Spring 2014, Kathryn Lott (F, US), MS in Statistics. Now?

117. Spring 2014 Mary Paiz (F, US), MS in Statistics. Statistician, Technical Staff at Sandia National Laboratories.

118. Spring 2014, Kyle Rechard (US), MS in Statistics. PhD Student in Statistics at Clemson University, SC.

119. Spring 2014, Yonghua Wei (M, A), MS in Statistics. Received PhD in Statistics in Sum 15. Sr. Statistical Analyst at Walmart, AK.

120. Summer 2014, Aziz Asadollahi, MS in Applied Math. PhD Candidate in Civil Engineering at University of Minnesota-Twin Cities, MN. 2014 MS in Civil Engineering at UNM.

121. Summer 2014, Kaylee Tejeda (H, US), MS in Applied Math (Thesis, Lau). Instructor at CNM, Rio Rancho Campus.

122. Summer 2014, Abraham Macias (H, US), MS in Statistics. Now Statistical Consultant, Dallas, TX. Statistician/Data Analyst El Paso, TX.

123. Fall 2014, Nuriye Atasaver (F), MS in Applied Math (Thesis, Pereyra). Currently a PTI in the Dept. Math and Stat at UNM.

124. Fall 2014, Evan Dye (US), MS in Applied Math (Thesis, Appelö). Works in the CS dept. at UNM as a researcher.

125. Fall 2014, Bose Falk (US), MS in Statistics (Thesis, Zhang). Data Scientist at MSD Prague, Czech Republic.

126. Spring 2015, Craig Hatch, MS in Applied Math. Adjunct Faculty at ITT Technical Institute, Albuquerque, NM since Summer 2016 (however it just closed...) Operations Research Analyst, Department of Defense, Albuquerque, NM.

127. Spring 2015, Karen Sorensen-Unru (F, US), MS in Applied Math (passed two quals at PhD level), Currently Lecturer in Dept. Math and Stat at UNM.

128. Spring 2015, John Tennison (US), MS in Applied Math. Interface analyst at a medical records company called Epic Systems in Wisconsin since graduation. Prior he was a HS teacher and per email on 12/4/16 to Monika, he wants to return to the world of Mathematics, specifically teaching. He is looking at applying for a variety of high school and community college teaching positions, in Wisconsin, New Mexico, and elsewhere.

129. Spring 2015, Katherine Cauthen (F, US), MS in Statistics. Technical Staff at Sandia National Laboratories.

130. Spring 2015, Brian Michelsen (US), MS in Statistics. Now?

131. Spring 2015, Ayan Zeng (F, A), MS in Statistics. Now?

132. Summer 2015, Anthony Ortiz (H, US), MS in Applied Math. Working at Boeing, Albuquerque, NM???

133. Summer 2015, Tamara Armoush (F), MS in Statistics. Credit Analyst London, UK since Fall 2016. Credit Risk Analyst, Lloyds Banking Group, London, UK (2015-16). Sport Statistician at UNM (2014-15).

134. Summer 2015, Nathaniel Crouse (US), MS in Statistics. Analyst Programmer III at Geospacial and Population Studies at UNM.
135. Summer 2015, Yuridia Leyva (F, H, US), MS in Statistics (Thesis, Erkhardt). Research Scientist at the UNM Health Sciences Center.
136. Fall 2015, Angel Poling (F, US), MS in Applied Math. Mathematics Instructor (PTI) at UNM.
137. Fall 2015, Paige Mankey (F, US), MS in Pure Math (Thesis, J. Vassilev). Technical Project Manager at Mountain Vector Energy.
138. Fall 2015, Andrea Walker (F, US), MS in Pure Math. Sandia National Laboratories.
139. Fall 2015, Basim, Alsaedi, MS in Statistics. Returned to Australia or to Saudi Arabia???
140. Fall 2015, Sara Bredin (F, US), MS in Applied Statistics. PhD student in Biostatistics at University of Arizona.
141. Fall 2015, Xin Wang (F, A), MS in Applied Statistics. Trying to get in Statistics PhD program at UNM.
142. Spring 2016, Adam Frederickson (US), MS in Applied Math. He is an Applied Math PhD student of Lau at UNM.
143. Spring 2016, Wilmer Rios-Aguilar (H), MS in Applied Math. Software engineer Innovasic Inc.
144. Spring 2016, Cameron Lavigne (F, US), MS in Pure Math (passed quals at PhD level). Job ?
145. Spring 2016, Christopher Parzick (US), MS in Pure Math (passed quals at PhD level). Currently in Physics PhD program at Cornell University.
146. Spring 2016, Olayan Albalawi (M), MS in Statistics. Now?
147. Spring 2016, Xichen Li (F, A), MS in Statistics. Currently an Statistics PhD student.
148. Spring 2016, Roland Moore (AA), MS in Statistics. Pursuing a PhD in Stats at FSU, Florida.
149. Spring 2016, Olga Vitkovskaya (F), MS in Statistics. Taking courses at UNM.
150. Spring 2016, Miao Yu (F, A), MS in Statistics. Job??
151. Spring 2016, Zhanna Galoshinka (F), MS in Applied Statistics. Research Specialist, UNM Comprehensive Cancer Center.
152. Spring 2016, Alvaro Ulloa (H), MS in Applied Statistics (Thesis, Erckhardt). Pursuing PhD in ECE at UNM.
153. Summer 2016, Sara Mehraben (F), MS in Applied Math (Thesis, Pereyra). Currently a PTI in the Dept. Math and Stat at UNM.
154. Summer 2016, Fred Kaul (US), MS in Pure Math (Thesis, Zinchenko). Currently Instructor of Math at San Juan College, NM.
155. Summer 2016, Andisheh Dadashi (F), MS in Statistics. Visiting Lecturer II at UNM Gallup.
156. Summer 2016, Mina Lee (F, A), MS in Statistics (Thesis, Degnan). Compliance Analyst at Fidelity Investments, Albuquerque, NM

3 Raw Data: 10 year window PhD graduates as of Sep 2016

F = Female, H=Hispanic, NA=Native American, AA=African origin, A=Asian, US=US citizen. Dissertation Advisor in parenthesis.

1. Summer 2006, Huining Kang (A), PhD in Statistics (Bedrick). Associate Professor of Internal Medicine, UNM Comprehensive Cancer Center.
2. Summer 2006, Tatiana Marquez Lago (F, H), PhD in Applied Math (Steinberg). Assistant Professor and Head of the Integrative Systems Biology Unit at Okinawa Institute of Science and Technology Graduate University, Japan, since 2011. Postdoctoral research at The University of Queensland, Australia, and senior postdoctoral research at ETH Zürich, Switzerland.
3. Summer 2006, Andrey Sobol, PhD in Applied Math (Ellison). Job?? He was employed by TECH-X in Boulder for several years after graduating.
4. Summer 2006, Mingan (Mike) Yang (A), PhD in Statistics (Christensen/Hanson). Currently Assistant Professor of Epidemiology and Biostatistics at San Diego State University. Before Assistant Professor of Statistics at Central Michigan University. Postdoctoral Research Fellow, Duke University & NIEHS, NIH.
5. Spring 2007, Daniel Briand (US), PhD in Statistics (Huzurbazar). Manager Sandia National Laboratories till retirement.
6. Spring 2008, Oleksandra Beznosova (F), PhD in Pure Math (Pereyra). Assistant Professor of Mathematics at University of Alabama since 2014. Postdoc Fellow at University of Missouri at Columbia and Assistant Research Professor at Baylor University.
7. Spring 2008, Ralph Gomez (H, US), PhD in Pure Math (Boyer). Assistant Professor at Swarthmore College since 2012. Visiting Assistant professor at Swarthmore College (08-10), Assistant Professor at California Lutheran university (10-12).
8. Summer 2008, Jaime Cuadros (H), PhD in Pure Math (Boyer). Associate Professor of Mathematics (Profesor Ordinario Auxiliar) in Pontificia Universidad Católica de Peru
9. Summer 2008, Jessica Deshler (F, US), PhD in Applied Math (Umland), Associate Professor of Mathematics in West Virginia University since 2015. US Fulbright Scholar, Visiting Lecturer Central European University, Budapest, Hungary 2015-16. She has received over 2M in education grants from NSF, MSP and MAA.
10. Summer 2008, Oksana Guba (F), PhD in Applied Math (Lorenz). Contractor with Sandia National Laboratories. Postdoctoral Fellow at Sandia National Laboratories 09-12, postdoc at UNM, PTI at UNM.
11. Fall 2008, Daniele Grandini, PhD in Pure Math (Galicki). Instructor at Virginia Commonwealth University since 2014. Visiting Assistant Professor at UC Riverside, Postdoctoral Fellow at UNM.
12. Fall 2008, Chen Meng (F, A), PhD in Statistics (Salter). Statistician at Monsanto.

13. Fall 2008, Dariusz Panek, PhD in Pure Math (Pereyra). Now Teaching Faculty at University of Delaware. Visiting Assistant Professor/Instructor at Ohio University at Athens till Spring 2016.

14. Fall 2008, Kara Peterson (F, US), PhD in Applied Math (Sulsky). Senior member of the technical staff in the Computational Mathematics Department at Sandia National Laboratories.

15. Fall 2008, Gowri Srinivasan (F, A), PhD in Applied Math (Aceves). Staff Member Theoretical Division at Los Alamos National Laboratories.

16. Fall 2008, Wenxia Ying (F, A), PhD in Statistics (Huerta). Currently Biostatistics Manager at AMGEN INC. CA

17. Spring 2009, David Collins (US), PhD in Statistics (Huzurbazar). Scientist in the Statistical Sciences group, Los Alamos National Laboratories

18. Spring 2009, Adam Ringler (US), PhD in Pure Math (Nakamaye). Physical Scientist Northwest Region at US Geological Survey.

19. Spring 2009, Alejandro Villagran-Hernandez (H), PhD in Statistics (Huerta). Data Scientist at Boeing, Seattle since 2015. Assistant Professor of Statistics, University of Connecticut (11-13). Postdoc at Rice University (09-11).

20. Spring 2009, Min Zhu (F, A), PhD in Statistics (Bedrick). Statistical programmer, SAS.

21. Summer 2009, Pavlo Cherepanov, PhD in Applied Math (Lorenz). Current Job? Visiting Lecturer at Dept. Math and Stat at UNM.

22. Fall 2009, Erik Erhardt (US), PhD in Statistics (Bedrick). Associate Professor in Statistics at UNM since F16. MIND Institute at UNM 09-10.

23. Fall 2009, Yizhou Jiang (A), PhD in Statistics (Bedrick). Biostatistics Sr. Manager at Amgen.

24. Fall 2009, Siu Kei Sun (A), PhD in Statistics (Christensen). Financial analyst in Hong Kong.

25. Spring 2010, Klaus Heineman, PhD in Applied Math (Ellison). Postdoc and Research Assistant Professor in Math and Stat Department at UNM.

26. Summer 2010, Dae-Won Chung (A), PhD in Pure Math (Pereyra). Assistant Professor of Mathematics at Keimyung University, Republic of Korea. Postdoctoral Fellow in Applied Math at Inha University, Republic of Korea 12-14. Postdoctoral Fellow at UNM.

27. Summer 2010, Justin Pati (US), PhD in Pure Math (Boyer). Algorithm Developer in Uppsala, Sweden (Linkedin). Postdoc Fellow at Uppsala University, Sweden 10-12.

28. Summer 2010, Yan (Sindy) Qiu (F, A), PhD in Applied Math (Lorenz). Sr. Data Scientist at Interthinx, a subsidiary of First American Financial Corporation (Linkedin) MS in Economics from UNM.

29. Summer 2010, Richard Warr (US), PhD in Statistics (Huzurbazar). Professor of Aerospace Studies at Central Washington University Dayton, Ohio.

30. Spring 2011, Flor Espinoza Hidalgo (F, H), PhD in Applied Math (Steinberg). Adjunct Research Assistant at Mind Research Network at UNM since F15. Assistant Professor at Kennesaw State University, GA (2012-2015).

31. Spring 2011, Alvaro Nosedal-Sanchez (H), PhD in Statistics (Storlie/Christensen). Assistant Professor (Teaching Stream), Dept. of Mathematical and Computational Sciences,, University of Toronto Mississauga, Canada. Postdoc at Indiana University of Pensylvania and at UNM.

32. Summer 2011, Shadi Naderi (F), PhD in Applied Math (Nitsche). Researcher at Air Force Kirkland Research, computational scientist conducting research on modeling and simulation of fiber amplifiers and lasers.

33. Summer 2011, Joshua Neil (US), PhD in Statistics (Storlie). EY Americas Security Analytics Leader. (Linkedin)

34. Fall 2011, Jean Moraes, PhD in Pure Math (Pereyra). Adjunct Professor (Assistant Professor) at Universidade Federal du Rio Grande do Sul, Instituto de Mátematica, Porto Alegre, Brasil, since Jan 2013. Adjunct Professor, Universidade Federal de Pelotas, Centro de Engenharias, 2012.

35. Fall 2011, Alexey Sukhinin, PhD in Applied Math (Aceves). Research Scientist Vermont University. Visiting Assistant Professor at Southern Methodist University.

36. Fall 2011, Gregory Von Winckel (US), PhD in Applied Math (Coutsias). Senior Member of Technical Staff at Sandia National Laboratories (since 2014). Director of Research Skinfrared LLC, Abq, NM (2013-14). Research Associate Professor in ECE at UNM (2012-13). Assistant Professor at Karl-Franzens-Universität Graz, Austria (2011-12).

37. Spring 2012, Arnab Saha (A), PhD in Pure Math (Buium). Postdoctoral Fellow at Australia National University since F12.

38. Summer 2012, Xi (Ronald) Chen (A), PhD in Applied Math (Appelö/Hagstrom). Currently employed by HyperComp. Postdoc at University of Arizona 12-13.

39. Summer 2012, Ling Xu (F, A), PhD in Applied Math (Nitsche), Postdoc Fellow at University of Michigan, Ann Arbor since F15. Postdoc Fellow at GATech 12-14, University of Notre Dame (14-15).

40. Fall 2012, Yong Lin (A), PhD in Statistics (Christensen). Research Scientist at Eli Lilly and Company, Indianapolis since 2013. (Linkedin)

41. Summer 2013, Taylor Dupuy (US), PhD in Pure Math (Buium). Visiting Assistant Professor at University of Vermont since Jan 2016. Postdoc fellow at UCLA, IPAM and Hebrew University, Jerusalem, Israel.

42. Summer 2013, Christopher Inbody (US), PhD in Pure Math (Boyer). Currently unemployed, he has an NRC proposal for work on Satellite attitude control for AFRL still pending a final decision, and he is planning a similar proposal with AFOSR in the spring joint with Chris Hall (Mechanical Engineering Department at UNM).

43. Summer 2013, Michael Payne (US), PhD in Applied Math (Lorenz). Faculty at Pueblo Community College, CO.

44. Summer 2013, Shuxin Wang (F, A), PhD in Pure Math (Blair). (No longer doing Math) Student Coordinator and Counselor at Montair Aviation at Red Deer Base, Alberta, CA. Went to Canada, was pursuing a degree in Statistics.

45. Fall 2013, Mohammad Hattab, PhD in Statistics (Christensen). Postdoc in School of Pharmacy at Virginia Commonwealth University since 2014. Postdoc at UNM 13-14.

46. Fall 2013, Pedro Madrid (H), PhD in Applied Math (Sulsky). Faculty at Universidad Nacional Autónoma de Honduras (UNAH). Postdoctorate at Department of Structural and Geotechnical Engineering, Biomedical Engineering Group, Pontificia Universidad Católica de Chile

47. Fall 2013, Jason Terry (NA, H, US), PhD in Applied Math (Lorenz). Full Time Instructor of Math at Central New Mexico Community College, since 2012. PTI at UNM.

48. Spring 2014, Martha Byrne (F, US), PhD in Pure Math (Nakamaye/Umland). Faculty at Sonoma State University since F16. Visiting Assistant Professor position at Earlham College in Indiana 14-16.

49. Spring 2014, Candelario Castañeda (H), PhD in Pure Math (Boyer). Profesor de Cátedra, Instituto Tecnológico de Estudios Superiores de Monterrey, campus Guadalajara, México.

50. Spring 2014, Alfonso Heras-Llanos (H), PhD in Pure Math (Buium). Assistant Professor of Mathematics at UNM Valencia.

51. Spring 2014, Cristina Toropu (F), PhD in Pure Math (Buium). Instructor of Mathematics at Southwest Houston Community College.

52. Spring 2014, Xueqin (Shelly) Wang (F, A), PhD in Statistics (Sonksen/Umland). Psychometrician for Albuquerque Public Schools.

53. Spring 2014, Bryan White (US), PhD in Pure Math (J. Vassilev). Instructor at Yuba College and Los Rios Community College System, in Sacramento Area, CA.

54. Fall 2014, Sergei Dyachenko, PhD in Applied Math (Korotkevitch/Lushinikov). Currently ICERM Postdoc at Brown University. Postdoc at University of Illinois at Urbana-Champaign (14-16).

55. Fall 2014, Michelle Hatch Hummel (F, US), PhD in Applied Mathematics (Coutsias). Postdoctoral Fellow at Sandia National Laboratories since May 2015. Postdoc in Applied Math at Stony Brook University.

56. Fall 2014, Fares Qeadan, PhD in Statistics (Christensen). Assistant Professor in Biostatistics in UNM School of Medicine since F14.

57. Spring 2015, Yan Dong (F, A), PhD in Statistics (Christensen/Guindani). Research Associate at Center for Computational Biology and Bioinformatics, Indiana University School of Medicine.

58. Spring 2015, Maozhen Gong (A), PhD in Statistics (Huerta). Visiting Assistant Professor at Notre Dame University.

59. Summer 2015, Sahitya Konda (F, A), PhD in Applied Math (Lorenz). Data Scientist at Camelot Integrated Solutions.

60. Summer 2015, Ming Gong (A), PhD in Applied Math (Sulsky). Post doc at UC Santa Barbara (Math Dept).

61. Summer 2015, Yonghua Wei (A), PhD in Statistics (Huerta). Sr. Statistical Analyst at Walmart, AK, since F15.

62. Fall 2015, David Bizzozero (H, US), PhD in Applied Math (Ellison/Lau). Post-doc at the Computational Electromagnetic Laboratory of the Technische University Darmstadt, Germany.

63. Spring 2016, Lang Zhou (A), PhD in Statistics (Lu/Zhang). Sr. Researcher at Abbyie Laboratories (Pharmaceutical) since 2016.

64. Spring 2016, Erik Medina (H, US), PhD in Pure Math (Buium). Assistant Professor in Gavilan College, Gilroy, CA.

65. Summer 2016, Gregg Morre (US), PhD in Pure Math (J. Vassilev). Instructor at Santa Rosa Junior College, CA.

66. Summer 2016, Freddy Vides Romero (H), PhD in Pure Math (T. Loring). Assistant Professor in Department of Applied Mathematics and Computer Science at Universidad Nacional Autónoma de Honduras, Tegucigalpa.

We expect 8 students to graduate with PhDs in Spring 2017, 3 in Pure Mathematics, 3 in Applied Mathematics, 2 in Statistics.

4 Raw Data: Graduate Student's Publications in 2006-2016 window

* PhD Alumni

1. A. Aceves, R. Chen*, Y. Chung, T. Hagstrom and M. Hummel*, (2011) *Modeling supercontinuum generation in fibers with general dispersion characteristics.* Discrete and Continuous Dynamical Systems, Series S, V. 4(5) 957-973.

2. G. Bassi, J.A. Ellison, K. Heinemann*, R. Warnock *Microbunching Instability in a Chicane: Two-Dimensional Mean Field Treatment.* Phys. Rev. ST Accel. Beams 12, 080704 (2009).

3. G. Bassi, J.A. Ellison, K. Heinemann*, R. Warnock, *Transformation of phase space densities under the coordinate changes of accelerator physics.* Phys. Rev. ST Accel. Beams 13, 104403 (2010).

4. Beznosova, O.*, *Linear bound for the dyadic paraproduct on weighted Lebesgue space $L^2(w)$*, J. Funct. Anal. 255 (2008), no. 4, 994–1007.

5. Beznosova, O.*, Moraes, J.* and Pereyra, M. C. , *Sharp bounds for t-Haar multipliers on L^2. Harmonic analysis and partial differential equations*, 45–64, Contemp. Math., 612, Amer. Math. Soc., Providence, RI, 2014.

6. Beznosova, O.*, Chung D.*, Moraes, J.*, and Pereyra, M. C., *On Two Weight Estimates for Dyadic Operators.* To appear in Volume II in Honor of Cora Sadosky, AWM-Springer Series.

7. B.E. Billinghurst, J. C. Bergstrom, C. Baribeau, T Battern, L. Dallin, T.E. May, J. M. Vogt, W. A. Wurtz, R. Warnok, D. A. Bizzozero*, S. Kramer, *Observation of wakefields and resonance in coherent synchrotron radiation.* Phys. Rev. Lett. 114, 204801 (2015)

8. D. A. Bizzozero*, J. A. Ellison, K. A. Heinemann, S. R. Lau, *Paraxial approximation in CSR modeling using the discontinuous Galerkin method.* Proceedings of FEL13, NY, NY.

9. D. A. Bizzozero*, J. A. Ellison, K. A. Heinemann, S. R. Lau, *Rapid evaluation of two-dimensional retarded time integrals.* Submitted J. Comput. and Appl. Math.

10. D. A. Bizzozero*, R. Warnock, J. A. Ellison, *Modeling CSR in a Vacuum Chamber by Partial Fourier : Analysis and the Discontinuous Galerkin Method.* Published in Proceedings of FEL14, Basel, Switzerland.

11. Boyer, C. and Pati, J.*, *On the Equivalence Problem for Toric Contact Structures on S^3-bundles over S^2.* Pacific J. Math. 267 (2014) 277–324.

12. Briand, D.* and Huzurbazar, A.V. (2008). *Bayesian Reliability Applications of a Combined Lifecycle Failure Distribution.* Journal of Risk and Reliability, 222(4), 713–720.

13. Buium, A. and Saha, A.*, *The first p-jet space of an elliptic curve: global functions and lifts of Frobenius.* Mathematical Research Letters, Volume 21 (2014) Number 4, 677–689. DOI: http://dx.doi.org/10.4310/MRL.2014.v21.n4.a4

14. Buium, A. and Saha, A.*, *Hecke operators on differential modular forms mod p.* J. Number Theory, Volume 132, Issue 5 (2012) 966–997.

15. Buium, A. and Saha, A.*, *The ring of differential Fourier expansions.* J. Number Theory, Volume 132, Issue 5 (2012) 896–937.

16. Castañeda, C. *The topology of Lrns bundles over Riemann Surfaces.* Submitted in 2016 to Rocky Mountain J. Math.

17. O. Chalus, A. Sukhinin*, A. Aceves and J.C. Diels, (2008), *Propagation of non- diffracting intense ultraviolet beams.* Optics Communications 281 3356-3360.

18. Christensen, R. and Lin, Y.* (2015). *Lack-of-fit tests based on partial sums of residuals.* Communications in Statistics, Theory and Methods, **44**, 2862–2880.

19. Christensen, R. and Lin, Y.* (2013). *Linear Models That Allow Perfect Estimation.* Statistical Papers, **54**, 695–708.

20. Christensen, R. and Sun, S. K.* (2010). *Alternative Goodness-of-Fit Tests for Linear Models*, Journal of the American Statistical Association, **105**, 291–301.

21. Chung, D.*, *Sharp estimates for the commutators of the Hilbert, Riesz transforms and the Beurling-Ahlfors operator on weighted Lebesgue spaces.* Indiana U. Math. J. 60 (2011), no. 5, 1543–1588.

22. Chung, D.*, *Weighted norm inequalities for the multivariable dyadic paraproducts.* Pub. Mat. 55 (2011), 475–499.

23. Chung, D.*, Pereyra, M.C., Pérez, C., *Sharp bounds for general commutators on weighted Lebesgue spaces.* Trans. Amer. Math. Soc. 364 (2012), 1163–1177.

24. Collins, D.*, Freels, J.; Huzurbazar, A.; Weaver, B.; Warr, R. (2013) *Accelerated Test Methods for Reliability Prediction.* Journal of Quality Technology, 45(3), 244–259. Recipient of the 2014 Lloyd Nelson Award from ASQ.

25. Collins, D*., Warr, R.*, and Huzurbazar, A. (2013). *An Introduction to Statistical Flowgraphs for Engineering Systems.* Journal of Risk and Reliability, Proceedings of the Institute of Mechanical Engineers, Part O, Volume 227, Issue 5, 461–470.

26. Collins, D.* and Huzurbazar, A. (2013). *Multistate Stochastic Processes: A Statistical Flowgraph Perspective.* International Statistical Review, Vol.81, iss.1, p.78–106, 2013.

27. Collins, D.* and Huzurbazar, A. (2011). *Prognostic Models Based on Statistical Flowgraphs.* Applied Stochastic Models in Business and Industry, 28(2):141–151.

28. Collins, D.*, Anderson-Cook, C., and Huzurbazar, A. (2011). *System Health Assessment.* Quality Engineering, 23, 142–151.

29. Collins, D.*, and Huzurbazar, A.V. (2008). *System Reliability and Safety Assessment Using Nonparametric Flowgraph Models*, .Journal of Risk and Reliability, 222(4), 667–674.

30. L. S. Cook, B. L Moon, Y. Dong*, H. K. Neilson. *Reliability of self-reported sun exposure in Canadian women using lifetime vitamin D questionnaire.* Public Health Nutrition. July 2013

31. L. S. Cook, H. Nelson, C. Stidley, Y. Dong*, P. Round, E. Amankwah, A. M. Magliocco, C. M. Friedenreich. *Endometrial Cancer and a Family History of Cancer.* Gynecologic Oncology. August 2013

32. L. S. Cook, Y. Dong*, P.Round, Xun Huang, Anthony M. Magliocco, and Christine M. Friedenreich. *Hormone Contraception before the First Birth and Endometrial Cancer Risk.* Cancer Epidemiology Biomarkers & Prevention, Dec. 2013

33. Cuadros, J.* (2015) *Null Sasaki eta-Einstein Structures in 5-Manifolds.* Geometriae Dedicata, 169 (1), 343–359.

34. Deshler, J.*, (2009). *A Two-Semester Observational Study of Teaching Practices in Multi-Section Undergraduate Mathematics Courses.* Proceedings from the 12th Annual Conference on Research in Undergraduate Mathematics Education, Raleigh, NC

35. Deshler, J.M.* & Burroughs, E.A.*, (2013). *Teaching Mathematics with Women in Mind.* The Notices of the American Mathematical Society, 60 (9)

36. Dupuy, T.*, *Positivity and Lifts of the Frobenius.* Math. Res. Lett. 21 (2014) no. 02: 1–7.

37. Dupuy, T.* and Buium, A., *Arithmetic Differential Cocycles on GL_n I: differential cocycles.* To appear Journal of Algebra.

38. Dupuy, T.* and Buium, A., *Arithmetic Differential Cocycles on GL_n III: Galois theory.* Selecta Mathematica (2015): 1–24.

39. Dupuy, T.* and Buium, A., *Arithmetic Differential Equatoiuns on GL_n, II: arithmetic Lie-Cartan Theory.* Selecta Mathematica (2015): 1–82. Positivity and Lifts of the Frobenius Math. Res. Lett. 21 (2014) no. 02: 1–7.

40. Dupuy, T.* and Weirich, D.*, *Average Bits of 3^n in Binary, Wieferich primes and a Conjecture of Erdos.* Journal of Number Theory 158, January (2016): 268–280.

41. S.A. Dyachenko*, P.M. Lushnikov, and A.O. Korotkevich. *Branch cuts of Stokes wave on deep water. Part I: Numerical solution and Padé approximation*, Studies in Applied Mathematics, DOI: 10.1111/sapm.12128 (2016).

42. S.A. Dyachenko*, P.M. Lushnikov, and A.O. Korotkevich. *The complex singularity of a Stokes wave*, JETP Letters **98**, 675-679 (2014).

43. S.A. Dyachenko*, P.M. Lushnikov, and N. Vladimirova. *Logarithmic scaling of the collapse in the critical Keller-Segel equation*, Nonlinearity, **26**, 3011-3041 (2013).

44. S.A. Dyachenko, P.M. Lushnikov and N. Vladimirova. *Logarithmic-type Scaling of the Collapse of Keller-Segel Equation.* AIP Conf. Proc. **1389**, 709-712 (2011).

45. J. A. Ellison and K. Heinemann*, *Polarization Fields and Phase Space Densities: Stroboscopic Averaging and the Ergodic Theorem.* Physica D 234,131-149 (2007).

46. J. A. Ellison and K. Heinemann*, M. Vogt, M. Gooden, *Planar undulator motion excited by a fixed traveling wave: Quasiperiodic averaging, normal forms and the FEL pendulum.* Phys. Rev. ST Accel. Beams 16, 090702 (2013).

47. J. A. Ellison, A.V. Sobol* and M. Vogt, *A New Model for the Collective Beam-Beam Interaction.* New Journal of Physics 9, 32 (2007) 20 pages.

48. Erdei E., Sheng H., Maestas E., Mackey A., White K. A., Li L., Dong Y.*, Taylor J., Berwick M., Morse D.E. *Self-reported ethnicity and genetic ancestry in relation to oral cancer and pre-cancer in Puerto Rico.* PLoS One. Aug. 2011

49. Erdei E., Luo L., Sheng H., Maestas E., White K. A., Mackey A., Dong Y.*, Berwick M., Morse D.E. *Cytokines and tumor metastasis gene variants in oral cancer and pre-cancer in Puerto Rico.* PLoS One. Nov. 2013

50. Erhardt, E.B.* , Rachakonda, S., Bedrick, E.J., Allen, E.A., Adali, T. and Calhoun, V.D. (2011). *Comparison of Multi-Subject ICA Methods for Analysis of fMRI Data. Human Brain Mapping*, 32 (12), 2075–2095. PMID 21162045.

51. Erhardt, E. E.* and Bedrick, E.J. (2013). *A Bayesian Framework for Stable Isotope Mixing Models*, Environmental and Ecological Statistics 20: 377–397.

52. Erhardt, E. E. and Bedrick, E.J. (2014). *Inference for Stable Isotope Mixing Models: A Study of the Diet of Dunlin.* Journal of the Royal Statistical Society, Series C (Applied Statistics), 63, 579–593.

53. Erhardt, E. and Bedrick, E.J. (2014). *Stable Isotope Sourcing Using Sampling.* Open Journal of Ecology, 4, 289–298.

54. F. A. Espinoza*, M. J. Wester, J. M. Oliver, B. S. Wilson, N. Andrews, D. S. Lidke and S. L. Steinberg, *Insights Into Cell Membrane Microdomain Organization from Live Cell Single Particle Tracking of the IgE High Affinity Receptor FcϵRI of Mast Cells.* Bulletin of Mathematical Biology 74 (8), 1857–1911 (2012).

55. F. A. Espinoza*, J. M. Oliver, B. S. Wilson and S. L. Steinberg, *Using Hierarchical Clustering and Dendrograms to Quantify the Clustering of Membrane Proteins.* Bulletin of Mathematical Biology. DOI 10.1007/s11538- 011-9671-3 (2012).

56. Fuller, E.J. & Deshler, J.M.*, (2013). *The Effect of a New Placement Process on Student Success in First-Semester Calculus.* Creative Education, 4 (9)

57. Fuller, E., Deshler*, J., Kuhn, B. & Squire, D., (2012). *Developmental Student Success in Courses from College Algebra to Calculus.* Proceedings from the 24th Annual International Conference on Technology in Collegiate Mathematics, Orlando, FL

58. Gibbons, C.; Jeffries, J.; Mayes, S.; Raicu, C.; Stone, B.; White, B.* *Non-simplicial decompositions of Betti diagrams of complete intersections.* J. Commut. Algebra 7 (2015), no. 2, 189–206.

59. Gómez, R. R.*, *Lorentzian Sasaki-Einstein Metrics on Connected Sums of* $S^2 \times S^3$. Geom. Dedicata 150 (2011), 249–255.

60. Grandini, D.*, *Quaternionic-Kaehler Reductions of Wolf Spaces.* Annals of Global Analysis and Geometry 32 (2007), 225-252.

61. Guba, O.*, Lorenz, J., and D. Sulsky: *On Well–Posedness of the Viscous–Plastic Sea–Ice Model*, J. of Physical Oceanography, Vol. 43 (10), pp. 2194–2209 (2013).

62. Guba, O.*, Lorenz, J.: *Continuous Spectra and Numerical Eigenvalues.* Math. Comp. Modelling, **54**, (2011), pp. 2616–2622.

63. Hattab, M. W.* and Christensen, R. (2016). *Lack-of-fit tests based on sums of ordered residuals.* Australian and New Zealand Journal of Statistics, under revision.

64. K. Heinemann*, D. Barber, J. A. Ellison, M. Vogt, *A unified treatment of spin-orbit systems using tools distilled from the theory of principal bundles.* Submitted to Phys. Rev. Accelerator and Beamns (PRAB) (reviewed and in revision, request to separate in two parts, this is the first).

65. Huzurbazar, A.V., Briand, D.*, and Cranwell, R.M. (2008). *Statistical Reliability with Applications to Defense.* In Reliability Engineering Advances, Hayworth, G. (ed.). USA: Nova Science Publishers.

66. Kang, H.*, Chen, I.M., Wilson, C.S., Bedrick, E.J., Harvey, R.C., Atlas, S.R., Dev- idas, M., Mullighan, C.G., Wang, X., Murphy, M., Ar, K., Wharton, W., Borowitz, M.J., Bowman, W.P., Bhojwani, D., Carroll, W.L., Camitta, B.M., Reaman, G.H., Smith, M.A., Downing, J.R., Hunger, S.P., and Willman, C.L. (2010). *Gene Expres- sion Classiers for Relapse-Free Survival and Minimal Residual Disease Improve Risk Classication and Outcome Prediction in Pediatric B-precursor Acute Lymphoblastic Leukemia.* Blood, 115(7), 1394–1405.

67. L. S. Kubatko and C. Meng*. 2010. *Accomodating hybridization in a multilocus phylogenetic framework* (Chapter 6, pgs. 99-113). Estimating Species Trees: Practical and Theoretical Aspects, edited by L. L. Knowles and L. S. Kubatko, Wiley-Blackwell, 2010.

68. Leier, A, Marquez-Lago, T.T.*, Burrage, K. (2008) *Generalized binomial tau-leap method for biochemical processes incorporating both delay and intrinsic noise.* J. Chem. Phys. 128, 205107. ** Research article selected for JCP focus in Biochemical Physics, Volume 2, Issue 5.

69. Leier, A, Marquez-Lago, T.T.*, Burrage, K., Burrage, P. (2008) *Modelling intrinsic noise and delays in chemical kinetics of coupled autoregulated oscillating cells.* Int. J. Mult. Comp. Eng., Vol. 6, Issue 1: 77-86. ** Research article selected for JCP focus in Biochemical Physics, Volume 1, Issue 9.

70. Levy, G., M. Coon, G. Nguyen, K. Peterson*, and D. Sulsky, (2008), *A new paradigm for data assimilation*, In Proceedings of the 9th Pan Ocean Remote Sensing Conference (PORSEC 2008) - Oceanic Manifestation of Global Changes, p. 34. Published by South China Sea Institute of Oceanology, Chinese Academy of Sciences Copyright ©PORSEC2008, Guangzhou, China.

71. T.A. Loring and F. Vides*, *On Matrix Schrödinger Unitary Groups in Particular Representations of Finite Dimensional Quantum Dynamical Systems.* Available at arXiv:1102.4391 [math.QA]

72. T.A. Loring and F. Vides*, *Estimating Norms of Commutators.* Experimental Mathematics, 24(1):106-122, 2015

73. T.A. Loring and F. Vides*. *Local Matrix Homotopies and Soft Tori.* Available at arXiv:1605.06590 [math.OA]

74. P.M. Lushnikov, S.A. Dyachenko* and N. Vladimirova. *Beyond leading-order logarithmic scaling in the catastrophic self-focusing of a laser beam in Kerr media*, Physical Review A, **88**, 013845 (2013).

75. P.M. Lushnikov, H.A. Rose, D.A. Silantyev*, and N. Vladimirova, *Vlasov multi-dimensional model dispersion relation*, Phys. of Plasmas **21**, 072103 (2014).

76. P. J. Madrid*, D. Sulsky and R. A. Lebensohn *Uncertainty Quantification in Prediction of the In-Plane Young's Modulus of Thin Films with Fiber Texture*, IEEE/ASME Journal of Microelectromechanical Systems, **23**(2) (2014).

77. Marquez-Lago, T.T.*, Burrage, K. (2007) *Binomial tau-leap spatial stochastic simulation algorithm for applications in chemical kinetics.* J. Chem. Phys. 127, 104101.

78. C. Meng* and L.S. Kubatko. 2009. *Detecting hybrid speciation in the presence of incomplete lineage sorting using gene tree incongruence: A model*, Theoretical Population Biology 75:35-45.

79. Moraes, J.* and Pereyra, M. C. *Weighted estimates for dyadic paraproducts and t-Haar multipliers with complexity (m,n).* Publ. Mat. 57 (2013), 265–294.

80. Morre, G.*, J. Vassilev, *Star, semistar and standard operations: a case study.* J. Algebra 455 (2016), 20–234.

81. J. Neil*, C. Hash, A. Brugh, M. Fisk, C. B. Storlie *Scan statistics for the online detection of locally anomalous subgraphs.* Technometrics 55 (4), 403–414.

82. J. Neil*, C. Storlie, C. Hash, A. Brugh, *Statistical detection of intruders within computer networks using scan statistics.* Imperial College Press (year??).

83. J. Neil*, B. Uphoff, C. Hash, C. Storlie, *Towards improved detection of attackers in computer networks: New edges, fast updating, and host agents.* Resilient Control Systems (ISRCS), 2013 6th International Symposium on, 218–224.

84. M. Nitsche, H. D. Ceniceros, A. L. Karniala and S. Naderi*, *High order quadratures for the evaluation of interfacial velocities in axi-symmetric Stokes flows.* J. Comp. Physics 229 (18), 63180–6342 (2010).

85. M. Nitsche and L. Xu*, *Circulation shedding in viscous starting flow past a flat plate.* Fluid Dyn. Res. 46, 061420, 12pp (2014), doi:10.1088/0169-5983/46/6/061420.

86. Nosedal-Sanchez, A.*, Storlie, C. B., Lee, T. C.M., and Christensen, Ronald (2012). *Reproducing Kernel Hilbert Spaces for Penalized Regression: A tutorial,* The American Statistician, **66**, 50–60.

87. J. Oetzel, B. Duran, J. Lucero, and Y. Jiang* (UNM), D. K. Novins, S. Manson, J. Beals, and the AI-SUPERPFP Team *Rural American Indians? Perspectives of Obstacles in the Mental Health Treatment Process in Three Treatment Sectors.* Psychological Services, Vol. 3, No. 2, 117?128 (2006).

88. K. Peterson*, H. Schreyer and D. Sulsky, *Decohesion with Refreezing*, Cold Reg. Sci. Technol., doi:10.1016/j.coldregions.2011.08.002 **76-77**:44-51 (2012)

89. K. Peterson* and D. Sulsky, *Evaluating Deformation in the Beaufort Sea Using a Kinematic Crack Algorithm with RGPS Data,* In: Remote sensing of the Changing Oceans, Eds: Tang, D., Gower, J., Levy, G., et al., Science Press/Springer ISBN 978-3-642-16540-5 (2011).

90. K. Peterson* and D. Sulsky, *Towards a New Elastic-Decohesive Model of Arctic Sea Ice*, Physica D, doi:10.1016/j.physletb.2003.10.071 (2012).

91. K. Peterson*, D. Sulsky, and H. Schreyer, *Numerical MPM Solution of Sea Ice Dynamics with an Elastic-Decohesive Constitutive Model*, Proceedings of the Sixteenth (2006) International Offshore and Polar Engineering Conference, San Francisco, CA 26 May - 2 June, 2006, **1**:569.

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93. Qiu, Y.*, Lorenz, J.: *A nonlinear Black–Scholes equation.* International Journal of Business Performance and Supply Chain Modelling, **1**, No. 1, (2009), pp. 33–40.

94. S. B. Rodriguez, F. A. Espinoza*, S. L. Steinberg, M. S. El-Genk, *Towards a Unified Swirl Vortex Model.* 42nd AIAA Fluid Dynamics Conference and Exhibit, June 2012, Chapter DOI: 10.2514/6.2012-3354.

95. Sealey, V., Deshler, J.* & Toth, K., (2012). *First Semester Calculus Students' Understanding of the Intermediate Value Theorem.* In (Eds.) S. Brown, S. Larsen, K. Marrongelle and M. Oehrtman, Proceedings from the 15th Annual Conference on Research in Undergraduate Mathematics Education, Portland, OR

96. J. Sexton, C. Storlie, J. Neil*, A. Kent, *Intruder detection based on graph structured hypothesis testing.* Resilient Control Systems (ISRCS), 2013 6th International Symposium on, 86–91.

97. Soto Mas F., Jacobson H. E., Dong Y.* *Health Literacy level of Hispanic College Students.* Southern Medical Journal. July 2013.

98. Shu Min, Zhang J. J., Dong Y.*, Zhang Z. P. *Significance of increased carotid intima median thickness (CIMT) with coexisting carotid plaques in cerebral white matter lesions in elders.* Journal of Huazhong University of Science Technology, Medical Sciences. Epub. Feb. 2013.

99. G. Srinivasan*, A. B. Aceves, D. M. Tartakovsky, (2008) *Nonlinear localization of light in disordered fiber arrays.* Phys Rev A 77, 063806.

100. D. Sulsky and Ming Gong*, *Improving the Material Point Method*, Lecture Notes in Applied and Computational Mechanics, eds. Kerstin Weinberg and Anna Pandolfi, Springer, Vol. 81, pp. 217-240 (2016).

101. D. Sulsky, H. Schreyer, K. Peterson*, M. Coon and R. Kwok, *Using the Material-Point Method to Model Sea Ice Dynamics*, Journal of Geophysical Research, **112**: C02S90, doi:10.1029/2005JC003329 (2007).

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104. Villagran, A.*, Huerta, G., Jackson, C.S. and Sen, M.K. (2008). *Computational approaches for Parameter Uncertainty Estimation in Climate Models.* Bayesian Analysis, Vol. 3, 823–850.

105. Villagran, A.* and Huerta, G. (2006). *Bayesian Inference on Mixture-of-Experts for Estimation of Stochastic Volatility.* Econometric Analysis of Financial and Economic Time Series/Part B. Advances in Econometrics. Volumes to Honor Engle and Granger, Vol. 20, 277–296.

106. G. Von Winckel, A Borzi, *QUCON: A fast Krylov-Newton code for dipole quantum control problems.* Computer Physics Communications 181 (12), 2158-2163 (2010)

107. G. Von Winckel*, A. Borzi, *Computational techniques for a quantum control problem with H1-cost.* Inverse Problems 24 (3), 034007 (2008).

108. G. Von Winckel*, S. Krishna, E. A. Coutsias *Spectral element modeling of semiconductor heterostructures.* Mathematical and Computer Modelling 43 (5), (2006) 582–591.

109. R. L. Warnock, D. Bizzozero*, *Efficient computation of cherent synchrotron radiation in a rectangular chamber.* To be published Phys. Rev. Accelerator and Beams (PRAB).

110. Wang, Shuxin*, *Well-posedness and ill-posedness for the nonlinear beam equation.* To appear in Communications in Pure and Applied Analysis, available at arXiv:1306.6411v1

111. Warr, R.*, and Huzurbazar, A. (2010). *Expanding the Statistical Flowgraph Model Using Any Distribution*, Journal of Statistical Theory and Practice, 4(4), 529–539.

112. Wei, Y.* and Huerta, G. (2016). *Dynamic Generalized Extreme Value Modeling via Particle Filters.* Communications in Statistics-Simulation and Computation. Accepted for Publication. doi:10.1080/03610918.2016.1202275

113. White, B.*, *Star Operations on Numerical Semigroup Rings*, to appear in Comm. Alg.

114. L. Xu* and M. Nitsche, *Start-up vortex flow past an accelerated flat plate.* Phys. Fluids 27, 033602, 18pp, (2015), doi: 10.1063/1.4913981.

115. L. Xu* and M. Nitsche, *Scaling behaviour in impulsively started viscous flow past a finite flat plate.* J. Fluid Mech. 756, 689-715 (2014), doi:10.1017/jfm.2014.451.

116. Yang, M.*, Hanson, T., and Christensen, R.(2008). *Nonparametric Bayesian estimation of a bivariate density with interval censored data.* Computational Statistics & Data Analysis, **52**, 5202–5214.

117. Ying, W.*, Huerta, G., Steinberg, S. and Zuniga, M. (2009). *Time Series Analysis of Particle Tracking Data for Molecular Motion on the Cell Membrane.* Bulletin of Mathematical Biology, Vol. 71, No. 8, 1967–2024.

118. Guoyi Zhang, Fletcher Christensen* and Wei Zheng, *Nonparametric Regression Estimators in Complex Surveys,* Journal of Statistical Computation and Simulation, Volume 85, Issue 5, pages 1026-1034, 2015.

119. Guoyi Zhang, Maozhen Gong* and Yang Cheng, *Adjusted Confidence Band for Complex Survey Data,* Communications in Statistics-Simulation and Computation, Accepted on 6 Jan, 2014, probable date of publication: 2016.

Attachment: Lecturer vitas

Timothy Berkopec-CV
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- M.S (Ph.D ABD)., Mathematics; University of Illinois, Urbana, IL; May 1984.
- M.S., Theoretical and Applied Mechanics; University of Minnesota, Minneapolis, MN; June 1978.
- B.S., Mathematics; Carnegie-Mellon University; Pittsburgh, PA; May 1976.

Appointments

- 2012-Present: Lecturer in Mathematics at UNM.
- 2005-2012: Part Time Instructor in Mathematics at UNM.
- 1995-2005: Engineer, MZA Associates, Albuquerque, NM.
- 1987 - 1993: Optical Systems Engineer, United Technologies Optical Systems, Albuquerque, NM.
- 1985 - 1987: Associate Staff Member, The BDM Corporation, Albuquerque, NM.

Most relevant publications

- Carroll, R. and Berkopec, T., *Generating Functions in Transmutation Theory*, Funkcialaj Ekvacioj, vol 29, Dec., 1986.
  Berkopec, T., and Bush, K.., *Heterodyne Global Piston Sensor Model Verification*, UTNM-86R-972203-3, Dec., 1987.
- Grover D., Eaton F., Berkopec T., *ABLACT Atmospheric Metrology*, Proc. SPIE Vol. 3706 p 42- 53., Airborne Laser Advanced Technology, Todd D. Steiner, Paul H. Merritt Eds., 1999.
- Brown T., Berkopec T., *Adaptive Optics Performance Comparisons for Various Phase Reconstruction Algorithms*, Proc. SPIE Vol. 3381 p. 135-146, Airborne Laser Advanced Technology, Todd D. Steiner, Paul H. Merritt Eds., 1998.
- Berkopec, T.. *Imaging Through a Thermally Bloomed Environment*, AFRL Technical Report, May 2005, AFRL-DE-TR-2005-1084.
- Brown, T., Berkopec, T., *Adaptive optics performance comparisons for various phase reconstruction algorithms*, Proc. SPIE Vol. 3381, p. 136- 146, Airborne Laser Advanced Technology, Todd D.Steiner; Paul H. Merritt; Eds.,1998.
- Berkopec, T., Lakey J., Pereyra M.C., and Tymes, N., *Multiwavelets and EP denoising*, In "Wavelets: Applications in Signal and Image Processing IX", Andrew F. Laine; Micheal A. Unser; Akram Aldroubi; Eds. Proc. SPIE Vol. 4478, p. 230-241, 2001.

Research grants or Contracts

- N/A

Main synergistic/service activities

- Spring 2013-Present: Coordinator for Math 123 (Trigonometry), and Math 150 (Precalculus).

- Fall 2012: Coordinator of Math 120 (College Algebra).
- During the summers of 2014 and 2015, I was part of a team that worked through the OSET office on creating a redesign course, now MATH 153 that combines MATH 150 and MATH 123 into a single course. This was part of a team effort. This course is now being taught by the math department and evaluated for its effectiveness

Postdoctoral and Ph.D. advisees:

- NA

Jurg Bolli-CV

Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- 1977 to 1984: University of Zürich, Switzerland: M.S. in Applied Mathematics. (Diplom in Mathematik) Thesis: Systems of Volterra Integro-Differential Equations under the supervision of Prof. H.R. Schwarz (in German). Minors in Applied Physics and Theoretical Physics

Appointments

- 12/2012 to present: UNM, Department of Mathematics and Statistics: Lecturer II and Director of Precalculus, supervising all Adjunct Faculty and Teaching Assistants, and dealing with student and instructor issues in all 100- and 200-level Math courses. Teaching load of 4 classes per semester (1 course release per semester for the Director position).
- 1/2000 to 12/2012: UNM, Department of Mathematics and Statistics: Lecturer II and Coordinator for Math 123 Trigonometry and Math 150 Pre-Calculus; from fall semester of 2008 to 12/2012: additionally coordinator for Math 180 (Elements of Calculus) and Math 181 (Elements of Calculus 2). Teaching load of 4 classes per semester (1 course release per semester for the coordinator work).
- 1/1987 to 12/1999: UNM, Department of Mathematics and Statistics: Part-time mathematics instructor, coordinator for a variety of classes.

Distinction and Awards

- 1993: Outstanding Part-Time Instructor, UNM, Department of Mathematics and Statistics

Most relevant publications

- NA

Research grants or Contracts.

- NA

Main synergistic/service activities

- Fall 2013, Fall 2014, Fall 2015: Chair of search committees to hire Adjunct Faculty; each time the department hired quite a few new part-time instructors.
- Summer 2015: Chair of search committee to hire a lecturer for Math Education; the department hired Karen Sorensen-Unruh for this position
- Fall 2014 through Spring 2016: Member of the College Assessment Review Committee CARC under Todd Ruecker, Dept. of English. The committee met 5-6 times per semester discussing how assessment can be implemented. On June 25, 2015 I led a meeting (only half a day, the other half was covered by K. Champine) at the UNM Assessment Connections Retreat organized by Dr. Neke Mitchell, Office of Assessment, Academic Affairs Division. Instructors from all branch campuses of UNM discussed and finalized Student Learning

Outcomes (SLO) for the Math 111, 112, 215, 129, 145, 150, 180 classes. These agreed upon SLOs will be used at all UNM campuses

- Between 2007 and September 2009 I was on the Executive Committee under Kris Galicki, and then Monika Nitsche

Postdoctoral and Ph.D. advisees:

- NA

Karen Champine
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- M.S. Pure Mathematics, University of New Mexico, Albuquerque, NM, December 1997
- B.S. Mathematics, University of New Mexico, Albuquerque, NM, August 1991
- B.A. Economics, University of New Mexico, Albuquerque, New Mexico, May 1989

Appointments

- Full-Time Senior Faculty Lecturer UNM Department of Mathematics and Statistics.

Distinction and Awards

- Teaching Award UNM Department of Mathematics and Statistics, Spring 2011.

Most relevant publications

- N/A.

Research grants or Contracts.

- N/A.

Main synergistic/service activities

- Senior Faculty Lecturer, University of New Mexico, Dept. of Mathematics and Statistics.
- Course Coordinator for UNM?s Qualitative Analysis course, MATH129
- Teaching Enhancement Committee, University of New Mexico, 1/2015 - present
- NM-Higher Education Department, Common Course Numbering Committee, 2016
- Executive Committee, Department of Mathematics and Statistics, University of New Mexico, AY 2016-2017
- Secretary, School Board Governing Council, Bataan Military Academy, 2/2013 ? 7/2016.

Postdoctoral and Ph.D. advisees:

- NA.

Derek Martinez
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- B.S., Mathematics, minor in classical guitar performance, UNM 1997
- M.S., Mathematics, UNM 1999
- Ph.D., Mathematics, UNM. (algebraic geometry)
- Dissertation Advisor: Professor Alexandru Buium

Appointments

- Full Time Instructor: Central New Mexico Community College, Fall 2004-Spring 2012
- Senior Lecturer, Mathematics: UNM, Fall 2012-Present

Distinction and Awards

- Outstanding Faculty Member of the Year, CNM 2011 ($1000)
- Arts and Sciences Weber Teaching Award, UNM 2014 ($1000)
- UNM Teaching Fellow, 2015-2016 Academic Year ($2000 and course release for spring 2016)

Most relevant publications

- NA

Research grants or Contracts.

- NA

Main synergistic/service activities

- Math 121 and 153 Coordinator, UNM
- Coordinator of ExceedU Math Mini Courses (2014-Present)
- Chair of Course Redesign Committees for Math 121 and Math 153
- Participated in Higher Ed Study: PARCC Assessments (2015)

Postdoctoral and Ph.D. advisees:

- NA

Summary of research experience

Beginning in fall 2015, as part of the UNM Teaching Fellows program, I have been researching how to teach math students metacognitive strategies for self-assessment and regulation. The results will be presented in a public talk in late September 29th.

Nina Greenberg
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- M.S. Statistics, University of New Mexico, December 2006.
- Secondary Teacher Certification - Biology, University of Phoenix, June 2002.
- M.S. Marine Science, Moss Landing Marine Labs ? San Jose State Univ., Dec. 1992
- B.A. Biology, University of Colorado, Boulder, May 1985
- B.S. Journalism, University of Colorado, Boulder, May 1985

Appointments

- Full-time Senior Faculty Lecturer, University of New Mexico, Dept. of Mathematics and Statistics.
- Temporary Part-Time Biostatistician ECHO (Extension for Community Healthcare Outcomes) - Pain Group UNM School of Medicine and DHA (Defense Health Agency) Grant

Distinction and Awards

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Most relevant publications

- Katzman JG, Fore C, Bhatt S, Greenberg N, Griffin Salvador J, Comerci GC, Camarata C, Marr L, Monette R, Arora S, Bradford A, Taylor D, Dillow J, Karol S. Evaluation of American Indian Health Service Training in Pain Management and Opioid Substance Use Disorder. Am J Public Health (2016) Aug;106(8):1427-9.
- Greenberg N, Garthwaite RL, Potts DC. 1996. Allozyme and morphological evidence for a newly introduced species of Aurelia in San Francisco Bay, California. Marine Biology (1996) 125:401-410.

Research grants or Contracts.

- Data analyses with Dr. Joanna Katzman and Dr. Clifford Qualls for a medical provider virtual education intervention study with ECHO-pain and the Department of Health Administration, ongoing.
- Data analyses with Dr. Joanna Katzman for a prospective study on co-prescribing of Naloxone in patients receiving medication assisted treatment, ongoing.
- Research and Data Analyses, with Dr. Kristine Tollestrup, Dr. Floyd Frost, and Dr. Betty Skipper, on modifiable factors associated with years of potential life lost and malignant breast cancer in women, ongoing.

Main synergistic/service activities

- Senior Faculty Lecturer, University of New Mexico, Dept. of Mathematics and Statistics.
- Course Coordinator for UNM?s Introductory Statistics course, STAT145.

Karen Sorensen-Unruh
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- MS Applied Mathematics, University of New Mexico, Albuquerque, NM (2015)
- MA Teaching, Trinity University, San Antonio, TX (1999)
- BS Chemistry, Trinity University, San Antonio, TX (1998)

Appointments

- Lecturer, Math Education Course Coordinator, Department of Mathematics and Statistics, UNM (2015 - present)
- Graduate TA, Department of Mathematics and Statistics, UNM (2013-2015)
- Math and Science Teacher, Menaul School, Albuquerque, NM (2004 -2012)

Distinction and Awards

- NSF - Mentoring Through Critical Transition Points Graduate Student Fellow
- Phi Kappa Phi Honor Society
- Kappa Delta Pi - International Education Honor Society
- Phi Beta Kappa

Most relevant publications

- C. Ting, K. Sorensen-Unruh, M. Stevens, A. Frischknecht, Nonequilibrium simulations of model ionomers in an oscillating electric field, Journal of Chemical Physics, 145 (2016), 044902; also available online from http://dx.doi.org/10.1063/1.4959120—http://dx.doi.org/10.1063/1.4959120.
- P. Villers, R.K. Rowe, K.A. Nixon, K.E. Unruh, Methods and apparatus for collection of optical reference measurement for monolithic sensor. US Patent Application 20050007582.
- K.A. Nixon, et. al, Novel Spectroscopy-based technology for biometric and liveness verification. In Proceedings of SPIE Biometric Technology for Biometric Identification, 5404 (2004), pp. 287-295.
- N.S. Mills, J.L. Malandra, E.E. Burns, A. Green, K.E. Unruh, D.E. Kadlecek, J.A. Lowery, Dications of fluorenylidenes: conformational and electronic effects of the paratropicity/antiaromaticity of fluorenyl cations with cyclic substituents. Journal of Organic Chemistry, 62 (1997), pp. 9318-9322.

Research grants or Contracts.

- Participated in MATH 123/150 Course Reform and MATH 121 Course Reform funded by “Gateway Science and Math Course Reform” UNM STEM Gateway program (U.S. Department of Education TITLE V grant, 2011-2016).

Main synergistic/service activities

- MaLL (Math Learning Lab) Advisory Committee at UNM.

Summary of research experience

Graduate level internship related to molecular dynamics simulations at Sandia National Laboratory under the direction of Dr. Christina Ting. Research and development activities related to biometric technology at Lumidigm, Inc. in Albuquerque, NM. Research and development activities related to biomedical devices at InLight Solutions in Albuquerque, NM. Undergraduate research in organic chemistry under the direction of Dr. Nancy Mills.

Attachment: Tenure-stream faculty vitas

Daniel Appelö
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

2001–2006 Ph.D. Numerical Analysis, Royal Institute of Technology, Stockholm, Sweden. *Absorbing Layers and Non-Reflecting Boundary Conditions for Wave Propagation Problems.* Advisor: Prof. Gunilla Kreiss.

2001–2003 Licenciates degree in Numerical Analysis, Royal Institute of Technology, Stockholm, Sweden. *Non-reflecting Boundary Conditions for Wave Propagation Problems.* Advisor: Prof. Gunilla Kreiss.

1996–2001 M.S. Electrical Engineering, Royal Institute of Technology, Stockholm, Sweden.

Appointments

2016– Associate Professor in Applied Mathematics, The University of New Mexico Albuquerque, USA.

2011–2016 Assistant Professor in Applied Mathematics, The University of New Mexico, Albuquerque, USA.

2008–2011 Postdoctoral scholar in Mechanical Engineering, California Institute of Technology, Pasadena, USA. Advisor: Tim Colonius.

2008–2009 Postdoctoral scholar in Applied Computational Mathematics, California Institute of Technology, Pasadena, USA. Advisor: Oscar Bruno.

2006–2008 Postdoctoral fellow, Center for Applied and Scientific Computing, Lawrence Livermore Nat. Lab., Livermore, USA. Advisor: Anders Petersson.

2006–2006 Hans Werthen Prize postdoctoral scholar, The University of New Mexico, Albuquerque, USA. Advisor: Thomas Hagstrom.

2001–2006 Graduate student in Numerical Analysis, Royal Institute of Technology, Stockholm, Sweden.

Distinction and Awards

2006 Hans-Werthen Prize 2006. This is a prize for doing a postdoc, awarded to one Swedish junior applied mathematician per year. The prize was ∼ $20,000

2001 & 2004 Generalgirektör Waldemar Borgeman prize

2002 & 2005 Erik Petersohns minnesfond prize

2004 & 2005 Stiftelsen Lars Hiertas minne prizeThe three above prizes (six awards) tallied $20000 and supported extended research visits (3-6 months), trips to conferences and salary

Most relevant publications

- Appelö, Hagstrom & Kreiss, Perfectly matched layers for hyperbolic systems: general formulation, well-posedness, and stability, SIAM Journal on Applied Mathematics, 67, 1, 1-23, 2006.
- Appelö & Petersson, A stable finite difference method for the elastic wave equation on complex geometries with free surfaces, Communications in Computational Physics, 5, 1, 84-107, 2009.

- Appelö & Kreiss, A new absorbing layer for elastic waves, Journal of Computational Physics, 215, 2, 642-660, 2006.
- Appelö & Colonius, A high-order super-grid-scale absorbing layer and its application to linear hyperbolic systems, Journal of Computational Physics, 228, 11, 4200-4217, 2009.
- Ting, Appelö & Wang, Minimum energy path to membrane pore formation and rupture, Physical review letters, 106, 16, 168101, 2011.
- Appelö, Banks, Henshaw & Schwendeman, Donald W, Numerical methods for solid mechanics on overlapping grids: Linear elasticity, Journal of Computational Physics, 231, 18, 6012-6050, 2012.
- Hagstrom & Appelö, Automatic symmetrization and energy estimates using local operators for partial differential equations, Communications in Partial Differential Equations, 32, 7, 1129-1145, 2007.
- Appelö & Hagstrom, A General Perfectly Matched Layer Model for Hyperbolic-Parabolic Systems, SIAM Journal on Scientific Computing, 31, 5, 3301-3323, 2009.
- Chen, Appelö & Hagstrom, A hybrid Hermite-discontinuous Galerkin method for hyperbolic systems with application to Maxwell's equations, Journal of Computational Physics, 257, 501-520, 2014.
- Appelö & Petersson, A fourth-order accurate embedded boundary method for the wave equation, SIAM Journal on Scientific Computing, 34, 6, 2982-3008, 2012.

Research grants or Contracts.

$258,196 Hybrid Hermite-Discontinuous Galerkin Methods with Applications to Elastic and Electromagnetic Waves. PI Daniel Appelö, NSF (DMS-1319054), 09/15/2013 - 08/31/2017, $258,196 ($179,963 direct, $78,233 indirect)

$40,369 **ARRA** Caltech Subaward: CR: Simulation and analysis of Jet Noise. PI Daniel Appelö, NSF / Caltech, 06/01/2012 - 05/31/2014, $40,369 ($26,734 direct, $13,635 indirect)

Perfectly Matched Layers for Parabolic Perturbations of Hyperbolic Systems: Hans-Werthen Prize 2006. $\sim \$20,000$.

Main synergistic/service activities

2016/17 Faculty Senator

2016/17 Member of the UNM-PNM Mathematics contest committee

2015/– Member of CARC Internal Advisory Board

2015/16 Member of the Undergraduate committee.

2014/15 Member of the NSF CC IIE Campus Networking Infrastructure grant Research Network Faculty Advisory Committee.

From Calculus to Waves Outreach to Undergraduates at Navajo Technical University Crownpoint NM, Nov 2015

2014–2016 Organizer of the Applied Math. Seminar.

Postdoctoral and Ph.D. advisees:

- Xi Chen, Numerical and Analytical Studies of Electromagnetic Waves: Hermite Methods, Supercontinuum Generation, and Multiple Poles in the SEM, 2012
- Adeline Kornelus; Spring 2017 (Anticipated); Hermite Methods for Non-linear Conservation Laws.
- Oleksii Beznosov; Fall 2018 (Anticipated); No working title yet.

Summary of research experience

My primary research interest is the development and analysis of fast, stable and accurate numerical algorithms for approximation of partial differential equations arising in engineering and natural sciences. Another research topic I have focused on is the development of artificial boundary conditions that are required to solve time dependent partial differential equations on unbounded domains. I have also worked on inter-disciplinary projects developing both numerical methods and physical models.

Arbitrary order methods based on Hermite interpolation

Over the last few years a significant part of my research has been on so called Hermite methods. Hermite methods are general purpose nodal based polynomial methods that use the solution and its derivatives as degrees of freedom. The methods have exceptional resolving power, excellent explicit time stepping properties and very high computation to communication ratio compared to traditional method-of-lines discretizations. The high computation to communication ratio makes them ideally suited for parallel implementation on distributed, shared or hybrid memory computers.

Hermite-Taylor methods were introduced by Goodrich, Hagstrom and Lorenz in 2005, [7], where the basic convergence theory was worked out for hyperbolic systems. Since 2006 I have, together with Tom Hagstrom, developed and extended Hermite methods to many new applications, some of which are implemented in the open source library `CHIDES` [1] and summarized in the review paper [8].

Discontinuous Galerkin methods for wave equations in second order form

In [4] we develop discontinuous Galerkin methods that are derived directly from the energy density $E = \mathbf{v}^2/2 + P(\mathbf{u}, \nabla\mathbf{u}, \mathbf{x})$ consisting of the sum of the kinetic energy $\mathbf{v}^2/2$ and the potential energy P. Here $\mathbf{v}$ is the time derivative of the solution $\mathbf{u}$, i.e. $\mathbf{u}_t = \mathbf{v}$ and the wave equation governing $\mathbf{u}$ can be identified as the Euler-Lagrange equation $\mathbf{u}_{tt} = \mathbf{v}_t = \delta P$, where δP is the variational derivative of P.

To obtain a method that preserves the energy properties of the continuous problem we test the equation $\mathbf{u}_t = \mathbf{v}$ (in the dG sense) using the, admittedly unconventional, test quantity $\delta P(\phi)$. Here ϕ is a test function in the same space as the approximation to $\mathbf{u}$. This novel formulation results in a provably stable method that naturally incorporates a variety of straightforward, mesh-independent flux choices, including upwind, central and alternating fluxes. The construction of our dG method only requires the knowledge of the potential energy P (which may be non-linear) and is therefore easily extended to other problems, for example to the elastic wave equation, see [3, 9].

Numerical methods for elastic waves

We have also developed numerical methods and massively parallel software for seismic modeling. The basis of these methods is the "bullet-proof" explicit finite difference discretization for the elastic wave equation with free surfaces on curvilinear grids [5]. For the method in [5], using summation by parts techniques, we could prove that the fully discrete approximation preserved a discrete energy to machine precision for media with arbitrarily-varying physical properties. Stability for such media is critical in seismic applications where the material properties vary wildly. The open source massively parallel 3D code, developed in collaboration with Dr. Anders Petersson and Dr. Björn Sjögreen, is routinely used on thousands of cpus (the largest computation during my tenure at LLNL used 32,768 cpus and 26.3 billion grid points) by seismologists at LLNL.

Compact finite difference embedded boundary methods

Finite difference discretizations with the boundary embedded in a Cartesian grid provide an alternative to body-fitted overset-grid methods, finite-element and finite-volume methods for handling complex geometries. Embedded boundary methods, being based on structured Cartesian grids, are highly efficient both in terms of operations and required memory per degree of freedom. They are also well suited for massively parallel computers as they are easy to load balance and scale to thousands of cores. Another advantage is that the geometry can be represented in a lower dimension and only local information such as the location and the normal of the boundary are required to enforce the boundary conditions, no costly (parallel) grid generation is needed.

References

[1] D. Appelö and T. Hagstrom, *CHIDES: The Charles Hermite Interpolation Differential Equation Solver*, http://www.chides.org.

[2] D. Appelö and T. Hagstrom, *On advection by Hermite methods*, Pacific Journal Of Applied Mathematics **4** (2011), no. 2, 125–139.

[3] D. Appelö and T. Hagstrom, *An energy-based discontinuous Galerkin discretization of the elastic wave equation in second order form*, Submitted to CMAME, 2015.

[4] D. Appelö and T. Hagstrom, *A new discontinuous Galerkin formulation for wave equations in second order form*, Siam Journal On Numerical Analysis 2015.

[5] D. Appelö and N. A. Petersson, *A stable finite difference method for the elastic wave equation on complex geometries with free surfaces*, Communications in Computational Physics **5** (2009), no. 1, 84–107.

[6] D. Appelö and N. A. Petersson, *A fourth-order embedded boundary method for the wave equation*, SIAM Journal on Scientific Computing **34** (2012), no. 6, 2982–3008.

[7] J. Goodrich, T. Hagstrom, and J. Lorenz, *Hermite methods for hyperbolic initial-boundary value problems*, Math. Comp. **75** (2006), 595–630.

[8] T. Hagstrom and D. Appelö, *Solving PDEs with Hermite Interpolation*, Springer Lecture Notes in Computational Science and Engineering, 2015.

[9] K. Virta and D. Appelö, *Formulae and software for particular solutions to the elastic wave equation in curved geometries*, submitted to Journal of Computational Physics, 2015.

Matthew Blair
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., Mathematics, University of Washington, 2005. Advisor: Hart Smith.
- B.S., Mathematics, Michigan State University, 2000.

Appointments

- Associate Professor, Dept. of Mathematics & Statistics, UNM, 2012-present.
- Assistant Professor, Dept. of Mathematics & Statistics, UNM, 2007-2012 (spent first year on leave).
- Visiting Assistant Professor, Dept. of Mathematics, University of Rochester, 2007-2008.
- FRG Postdoctoral Fellow, Dept. of Mathematics, Johns Hopkins University, 2006-2007 (3 semesters).
- Postdoctoral Fellow, Mathematical Sciences Research Institute, Workshop on Nonlinear Dispersive Equations, Fall 2005.

Distinction and Awards

- Teaching Award, "Graduate Instructor of the Year", Dept. of Mathematics & Statistics, University of New Mexico.

Most relevant publications

- Blair, M.D.; *Strichartz and localized energy estimates for the wave equation in strictly concave domains*, to appear, American Journal of Mathematics.
- Blair, M.D.; Ford, G.A.; Marzuola, J.L. *L^p-bounds on spectral clusters associated to polygonal domains*, to appear, Revista Matemática Iberoamericana.
- Blair, M.D.; Sogge, C.D. *Refined and microlocal Kakeya-Nikodym bounds for eigenfunctions in two dimensions*, Analysis & PDE, 8 (2015), no. 3, 747-764.
- Blair, M.D.; Sogge, C.D. *On Kakeya-Nikodym averages, L^p-norms and lower bounds for nodal sets of eigenfunctions in higher dimensions*, Journal of the European Mathematical Society, 17 (2015), no. 10, 2513-2543.
- Blair, M.D.; *On refined local smoothing estimates for the Schrödinger equation in domains*, Communications in Partial Differential Equations, 39 (2014), no. 5, 781-805.
- Blair, M.D.; *L^q bounds on restrictions of spectral clusters to submanifolds for low regularity metrics*. Analysis & PDE, 6 (2013), 1263-1288.
- Blair, M.D.; Ford, G.A.; Marzuola, J.L. *Strichartz estimates for the wave equation on flat cones*, International Mathematics Research Notices, 2013 (2013), 562-591.
- Blair, M.D.; Smith, H.F.; Sogge, C.D. *Strichartz estimates and the nonlinear Schrödinger equation on manifolds with boundary*, Mathematische Annalen, 354 (2012), 1397-1430.
- Blair, M.D.; Smith, H.F.; Sogge, C.D. *Strichartz estimates for the wave equation on manifolds with boundary*, Annales de l'Institut Henri Poincaré, Analyse Non Linéaire, 26 (2009), 1817-1829.
- Blair, M.D.; *Spectral cluster estimates for metrics of Sobolev regularity*, Transactions of the American Mathematical Society, 361 (2009), 1209-1240.

Research grants or Contracts.

- NSF Award, Analysis program, " Dispersion in Harmonic Analysis: Geometry and Boundary Conditions", DMS-1565436.
- NSF conference grant, co-PI, "New Mexico Analysis Seminar 2014-2016", DMS-1400429 (PI: C. Pereyra, other co-PI's: N. Michalowski, A. Skripka, M. Zinchenko).
- NSF Award, Analysis program, "Fourier Analysis on Bounded and Exterior Domains", DMS-1301717.
- NSF Award, Analysis program, "Fourier Analysis on Bounded and Exterior Domains", DMS-1001529.
- NSF Award, Analysis program, "Fourier Analysis on Bounded Domains", DMS-0801211.

Main synergistic/service activities

- Chair of the Undergraduate committee, Fall 2015-Present. Specific accomplishments include:
  - Developed student learning outcomes and an assessment plan to comply with University requirements. Began data collection for assessment reports.
  - Assisted in resolving pure math group concerns about major requirements.
  - Reevaluated prerequisites for some 300 level courses, leading to some significant changes that will improve student preparedness.
  - Assisted academic advisors in pairing students and faculty advisors.
- Undergraduate Committee member, 2008-09, 2010-14
- Member of the Tenure and Promotion committee 2013-14 and 2015-2016, writing committee reports for Maxim Zinchenko (Tenure) and Anna Skripka (Mid-Pro) in the fall of 2013 and reports for Anna Skripka (Tenure) in fall of 2015.
- Served on 3 recent NSF panels, reviewing standard grant proposals in the Analysis division.
- Member of the Executive committee 2013-14:
  - Organized meetings of the pure math group.
  - Oversaw Efroymson budget for the pure math group.
  - Assisted in faculty evaluations.
- Writer and grader of qualifying exams.
- Schedule advising for undergraduate and graduate students.
- Referee for Advances in Mathematics, American Journal of Mathematics, Communications in Mathematical Physics, Analysis & PDE, Forum Mathematicum, Journal of the Australian Mathematical Society, Journal of Mathematical Analysis and Applications, Journal of Differential Equations and others.

Postdoctoral and Ph.D. advisees:

- Shuxin Wang, Ph.D. student, graduated in Spring 2013.
  Dissertation title: *Well-Posedness and Ill-Posedness for the Nonlinear Beam Equation.*
- Chamsol Park, Ph.D. student, in progress.
- Committee member for Daewon Chung, Jean Moraes (UNM) and Jin-Cheng Jiang, Peng Shao (Johns Hopkins University).

Summary of research experience

My research seeks to provide a rigorous mathematical foundation for understanding many of the important equations in physics and engineering. Specifically, I am interested in equations which model sound and light waves. A large portion of my work has focused on understanding how the presence of a hard surface affects the development of these waves. For example, if one listens to the symphony in an auditorium, the sounds heard are affected by the manner in which the sound waves reflect off of the walls. In this sense, it can be important to understand how the shape of the hall influences its acoustics. Mathematically, this phenomenon can be studied by considering what is known as a boundary value problem for these equations. Such problems are ubiquitous in mathematics, physics, and engineering, and hence it is important to gain a strong mathematical foundation for understanding the behavior of solutions. My work also has connections with nonlinear formulations of these equations, where various types of instabilities can further complicate matters. A second aspect of my research seeks to understand the link between geometry and the behavior of vibrational modes. This is closely related to so-called Chladni plates, where one vibrates a metal plate with sand on it and studies the patterns formed by the accumulation of sand, corresponding to the lines on which the plate does not move (so called "nodal lines"). Here it is interesting to consider how the shape of the plate influences the patterns that evolve and to estimate their length. These investigations are closely related to themes in quantum chaos and semiclassical analysis.

The equations which model waves are examples of differential equations, where the solution that one seeks is actually a function depending on time and position. The character of these equations is such that the derivatives (or rates of change) of the solutions in certain directions must satisfy certain relations. Hence the mathematical foundation of these equations connect with a field of pure mathematics known as real analysis. Real analysis has its origins in providing rigor to the core theorems of calculus. More generally though, its aim is to provide the groundwork for understanding functions of real variables and the operations on them, such as differentiation, integration, and others. An active field within real analysis is Fourier analysis. This field, which originated in the work of Joseph Fourier on heat transfer, seeks to represent and understand general functions as a sum or integral of trigonometric functions or perhaps other families of functions with a convenient structure. This type of analysis has proven to be effective for studying waves as well.

An underlying theme in my research lies in measuring how solutions to these wave equations can concentrate. One typically expects that the energy in solutions to higher dimensional wave equations should disperse, causing the amplitude of the wave to decay as time evolves. However, in the presence of hard surfaces like those described above or in the presence of anisotropic media, the paths of least action may develop caustics, leading to a refocusing of energy. One means of understanding and measuring this phenomena is to consider estimates of L^p type, where mathematically, one considers the integral of a function (such as the amplitude of the wave) raised to the p-th power. Such estimates have roots in Fourier analysis, where there are connections with classical problems concerning the Fourier transform. Since then, these L^p inequalities have shown to have broad applications, such as understanding the instabilities forming in nonlinear wave equations and estimating the length of nodal sets in standing waves/vibrational modes.

Alexandru Buium
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. from the University of Bucharest, Romania, 1983.

Appointments

- 1999-present: Professor, University of New Mexico, Albuquerque, USA.
- 1998-1999: Professor, University of Illinois, Urbana-Champaign, USA.
- 1997-1998: Professor, University of New Mexico, Albuquerque, USA.
- 1995-1997: Associate Professor, University of New Mexico, Albuquerque, USA.
- 1983-1995: Researcher at the Institute of Mathematics of the Romanian Academy, Bucharest, Romania.

Distinction and Awards

- Humboldt Fellow (1992/93)
- Member of the Institute for Advanced Study, Princeton (1993/94)
- Fellow of the AMS (class of 2016)

Most relevant publications

- A. Buium, Intersections in jet spaces and a conjecture of S.Lang, Annals of Math. 136 (1992), 583-593.
- A. Buium, On a question of B.Mazur, Duke Math. J., 75, 3, (1994), 639-644.
- A. Buium, Differential characters of abelian varieties over p-adic fields, Invent. Math., 122, 2, (1995), 309-340.
- A. Buium, Geometry of p-jets, Duke Math. J., 82, 2, (1996), 349-367.
- A. Buium, Differential subgroups of simple algebraic groups over p-adic fields, Amer. J. Math. 120 (1998), 1277-1287.
- A. Buium, Differential Modular Forms, Crelle J., 520 (2000), 95-167.
- A. Buium, B. Poonen, Independence of points on elliptic curves arising from special points on modular and Shimura curves, I: global results, Duke Math. J., 147, 1 (2009), 181-191.
- A. Buium, S. Simanca, Arithmetic partial differential equations I, Advances in Math. 225 (2010), 689-793.
- A. Buium, Yu. I. Manin, Arithmetic differential equations of Painlevé VI type, in: Arithmetic and Geometry, London Mathematical Society Lecture Note Series: 420, L. Dieulefait, G. Faltings, D. R. Heath-Brown, Yu. V. Manin, B. Z. Moroz and J.-P. Wintenberger (eds), Cambridge University Press, 2015, pp. 114-138.
- A. Buium, T. Dupuy, Arithmetic differential equations on GL_n, II: arithmetic Lie-Cartan theory, arXiv:1308.0744, Selecta Math. 22, 2, (2016), 447-528.

Research grants or Contracts.

- NSF Grant DMS 9500331, 1995-1998: Differential algebra and diophantine geometry (University of New Mexico).

- NSF Grant DMS 9730183/9996078, 1998-2001: Arithmetic analogue of differential algebraic geometry (University of New Mexico and University of Illinois).
- NSF Grant DMS 0096946, 2001-2004: Fermat adeles and differential modular forms (University of New Mexico), $ 144,000.
- NSF Grant DMS 0552314, 2006-2009: Fermat quotients, correspondences, and uniformization (University of New Mexico), $ 112, 100.
- NSF Grant DMS 0852591, 2009-2012: Arithmetic Differential Equations (University of New Mexico), $ 140,980.
- NSF Grant DMS 0852591 (extension), 2012-2013: Arithmetic Differential Equations (University of New Mexico).
- Simons Foundation, Collaboration Grant for Mathematicians, award number 311773, 2014-2019: Arithmetic Differential Geometry (University of New Mexico), $35,000.

Main synergistic/service activities

- I co-organized a conference at IHES celebrating Galois (2011).

Postdoctoral and Ph.D. advisees:

- Christine Hurlburt (PhD 1999),
- Mugurel Barcau (PhD 2001),
- Ken Zimmerman (PhD 2003),
- Derek Martinez (PhD 2004),
- Andrey Glubokov (PhD 2005),
- Arnab Saha (PhD 2012),
- Taylor Dupuy (PhD 2013),
- Cristina Toropu (PhD 2014),
- Alfonso Heras (PhD 2014),
- Erik Medina (PhD 2016);
- no postdocs.

Summary of research experience

My PhD thesis contained results in the theory of projective surfaces. Then my research moved its focus on Diophanitine problems over function fields. My first significant result in this area was the proof of the Geometric Lang Conjecture (Annals of Math 1992) about intersections of subvarieties of Abelian varieties with subgroups of finite rank (in case everything is defined over a function field). Subsequently this led me to find effective bounds for these intersections (Duke Math Journal 1993, 1994) in the spirit of the (still open) conjecture of Mazur. The above results used the differential equations relevant to algebraic geometry. Beginning with my paper in Inventiones 1995 I started to develop an arithmetic analogue of differential equations with applications to number theory. In my theory usual differentiation of functions

$$f(x) \mapsto \frac{df}{dx}(x)$$

is replaced by the operation

$$n \mapsto \frac{dn}{dp} := \frac{n - n^p}{p}$$

where p is a prime. I developed this idea in a series of papers culminating with a research monograph (AMS, 2005). After that my work was devoted to developing an arithmetic analogue of differential geometry; I wrote a series of papers on this subject culminating with a research monograph (submitted). The conclusion of this latter theory is the surprising fact that the integers possess a non-trivial curvature.

A detailed description of my research can be found on my web page:
www.math.unm.edu/˜ buium

Jehanzeb Hameed Chaudhry
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., Computer Science, August 2011
  University of Illinois at Urbana-Champaign,Urbana, IL
  Advisor: Prof. Luke Olson in the Scientific Computing Group
  Dissertation title: Finite Element Methods for Implicit Solvent Models
- B.S., Computer Systems Engineering, May 2003
  Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Pakistan

Appointments

- Assistant Professor, August-2015 – Present
  Department of Mathematics and Statistics
  The University of New Mexico, Albuquerque, NM
- Postdoctoral Researcher, September 2014 – August-2015
  Scientific Computing, Florida State University, Tallahassee, FL
  Appointment in lab of Prof. Max Gunzburger
- Postdoctoral Researcher, August 2011 – August 2014
  Mathematics, Colorado State University, Fort Collins, CO
  Appointment in lab of Prof. Donald Estep

Most relevant publications

- J. H. Chaudhry, D. Estep, S. Tavener, V. Carey, and J. Sandelin. A posteriori error analysis of two stage computation methods with application to efficient discretization and the Parareal Algorithm. *SIAM Journal on Numerical Analysis* (Accepted, 2016)
- J. H. Chaudhry, D. Estep, V. Ginting, J. N. Shadid, and S. Tavenver. Adjoint based a posteriori analysis of IMEX time integration schemes for partial differential equations. *Computer Methods in Applied Mechanics and Engineering* (2015)
- J. H. Chaudhry, D. Estep, V. Ginting, and S. Tavener. A posteriori analysis for iterative solvers for nonautonomous evolution problems. *SIAM/ASA J. Uncertainty Quantification*, 3:434 (2015)
- V. Carey, J. H. Chaudhry, D. Estep, V. Ginting, A. Johansson, M. Larson, and S. Tavenver. Adaptive finite element solution of multiscale PDE-ODE systems. *Computer Methods in Applied Mechanics and Engineering* (2015)
- J. H. Chaudhry, K. Liu, K. Liu, T. A. Manteuffel, L. N. Olson, and L. Tang. Enhancing least-squares finite element methods through a quantity-of-interest. *SIAM Journal on Numerical Analysis* (2014)
- J. H. Chaudhry, J. Comer, A. Aksimentiev, and L. N. Olson. A stabilized finite element method for modified Poisson-Nernst-Planck equations to determine ion flow through a nanopore. *Communications in Computational Physics* (2014)
- J. H. Chaudhry, D. Estep, V. Ginting, and S. Tavenver. A posteriori analysis of an iterative multi-discretization method for reaction-diffusion systems. *Computer Methods in Applied Mechanics and Engineering* (2013)

- J. H. Chaudhry, S. D. Bond, and L. N. Olson. A weighted adaptive least-squares finite element method for the Poisson-Boltzmann equation. *Applied Mathematics and Computation* (2012)
- J. H. Chaudhry, S. D. Bond, and L. N. Olson. Finite element approximation to a finite-size modified Poisson-Boltzmann equation. *Journal of Scientific Computing* (2011)
- S. D. Bond, J. H. Chaudhry, E. C. Cyr, and L. N. Olson. A first-order system least-squares finite element method for the Poisson-Boltzmann equation. *Journal of Computational Chemistry* (2010)

Research grants or Contracts.

- Sandia National Laboratories: Laboratory Directed Research and Development (LDRD) Funding under Academic Alliance Program FY2016 $47K$. Title of Project: Adjoint based analysis and verification for Implicit-Explicit Schemes for Shock-Hydrodynamics (with John Shadid and Tim Wildey at SNL).

Main synergistic/service activities

- Member of department scheduling committee
- SIAM UNM Student Chapter Faculty Advisor

Summary of research experience

My research focuses on developing and analyzing numerical methods for the simulation of complex real-world systems. My research experience spans computational mathematics and its applications to real-world **multi-scale and multi-physics** problems such as biomolecular electrostatics, electrical activity of the heart, chemical reactions and hyperbolic conservation laws. Multi-physics systems involve simulation of multiple physical models, often operating at different scales, and are of widespread importance in science and engineering. The main development tools used in my research are adjoint based ***a posteriori* error estimation**, the **least-squares finite element method** and **reduced order modeling**. These are powerful tools for the development and analysis of numerical methods for a variety of scientific and engineering problems.

Specifically, my research has targeted the following challenging problems:

- Design of a novel adaptive refinement scheme based on "mesoscale" regions for efficient discretization of two stage numerical methods
- Analysis of the parallel-in-time Parareal algorithm
- Quantification of the error in computing the cumulative distribution function of a quantity of interest on stochastic domains
- Design and analysis of a hierarchical reduced order modeling method based on proper orthogonal decomposition
- Analysis of multi-scale solvers for multi-physics systems
- Analysis of methods employing truncated iteration
- Analysis of multi-step and multi-stage Implicit-Explicit (IMEX) methods
- Design and analysis of methods to solve systems modeling the electrical activity in the heart
- Design and analysis of a least-squares finite element method incorporating a quantity-of-interest
- Design and analysis of stabilized methods for nonlinear partial differential equations in molecular biology

By tackling directly the complex issues associated with these solution techniques, my research produced new and reliable error estimates for these widely used methods. The estimates derived in this research provide guidance for choosing values of numerical parameters needed to obtain a desired accuracy.

My **goal** as a researcher is to develop a strong research group which explores the challenges in computational science and applies these ideas to high-impact application areas like multi-physics systems simulated using parallel space-time techniques. My research has numerous scientific and engineering applications. Research in my area is actively funded by government agencies, national labs and other research institutes.

Ronald Christensen
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., Statistics, University of Minnesota, 1983.
- M.S., Statistics, University of Minnesota, 1976.
- B.A., Mathematics, University of Minnesota, 1974.

Appointments

- 1994- Professor, Department of Mathematics and Statistics, University of New Mexico.
- 1988-1994 Associate Professor, Department of Mathematics and Statistics, University of New Mexico.
- 1982-1988 Assistant Professor, Department of Mathematical Sciences, Montana State University.
- 1994 Visiting Professor, Department of Mathematics and Statistics, University of Canterbury, Chch., N.Z.
- 1987 Visiting Assistant Professor, Department of Theoretical Statistics, University of Minnesota.

Distinctions and Awards

- Seymour Geisser Distinguished Lecturer, School of Statistics, University of Minnesota, 2015.
- Editor-Elect and Editor, *The American Statistician*, 2011-2014.
- Chair-Elect, Chair, Past Chair, Section on Bayesian Statistical Sciences, American Statistical Association, 2007-2009.
- Erskine Fellow, Department of Mathematics and Statistics, University of Canterbury, Chch., N.Z., 2008.
- Fellow of the Institute of Mathematical Statistics, 1998.
- Fellow of the American Statistical Association, 1996.
- Phi Beta Kappa, 1974.

Publications (most cited on Google Scholar)

- Christensen, Ronald (2015). *Analysis of Variance, Design, and Regression: Linear Modeling for Unbalanced Data*, Second Edition. Chapman and Hall/CRC Pres, Boca Raton, FL.
- Christensen, Ronald (2011). *Plane Answers to Complex Questions: The Theory of Linear Models*, Fourth Edition. Springer-Verlag, New York.
- Christensen, Ronald, Johnson, Wesley, Branscum, Adam, and Hanson, Timothy E. (2010). *Bayesian Ideas and Data Analysis: An Introduction for Scientists and Statisticians*. Chapman and Hall, Boca Raton.
- Jones, Geoffrey, Johnson, Wesley O., Hanson, Timothy E., and Christensen, Ronald (2010). "Identifiability of Models for Multiple Diagnostic Testing in the Absence of a Gold Standard." *Biometrics*, **66**, 855-863.

- Christensen, Ronald (2005). "Testing Fisher, Neyman, Pearson, and Bayes." *The American Statistician*, **59**, 121-126.
- Christensen, Ronald (2001). *Advanced Linear Modeling: Multivariate, Time Series, and Spatial Data, Nonparametric Regression, and Response Surfaces*, Second Edition. Springer-Verlag, New York.
- Christensen, Ronald (1997). *Log-linear Models and Logistic Regression*, Second Edition. Springer-Verlag, New York.
- Bedrick, Edward J., Christensen, Ronald, and Johnson, Wesley (1996). "A new perspective on priors for generalized linear models." *Journal of the American Statistical Association*, **91**, 1450-1460.
- Christensen, Ronald, Pearson, Larry M., and Johnson, Wesley (1992). "Case deletion diagnostics for mixed models." *Technometrics*, **34**, 38-45.
- Berry, Donald A. and Christensen, Ronald (1979). "Empirical Bayes estimation of a binomial parameter via mixtures of Dirichlet processes." *Annals of Statistics*, **7**, 558-568.

Research grants or Contracts.

- Principal Investigator, NASA PURSUE Grant, 1999.
- Project Director, NSF Grant DMS-9625897, 1996-1998.
- Project Director, NSF SCREMS Grant DMS-9005939, 1990-1992.

Main synergistic/service activities

- 1998-2001, 2003-2007 Founding Director, Statistics Clinic, University of New Mexico.
- Editor-Elect and Editor, *The American Statistician*, 2011-2014.
- Chair-Elect, Chair, Past Chair, Section on Bayesian Statistical Sciences, American Statistical Association, 2007-2009.

Ph.D. advisees:

- Michael Fugate, 1998, jt. with Ed Bedrick.
- Ziqin Han, 2000.
- Steven Gilbert, 2003, jt. with Ed Bedrick.
- Mingan Yang, 2006, jt. with Tim Hanson.
- Siu Kai Sun, 2010.
- Yong Lin, 2012.
- Mohammad Hattab, 2013.
- Fares Qeadan, 2014.

James H. Degnan
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. Statistics, May, 2005, University of New Mexico, Dept. of Mathematics and Statistics, Advisor: Laura S. Kubatko, Dissertation: Gene tree distributions under the coalescent process
- M.S. Statistics, May, 2001, University of New Mexico
- B.S. Mathematics, May, 1999, University of New Mexico
- B.A. Philosophy, May, 1997, University of New Mexico

Appointments

- 1/2014 – Assistant Professor, University of New Mexico, Department of Mathematics and Statistics
- 1/2012 – 12/2013, Senior Lecturer, University of Canterbury, Department of Mathematics and Statistics
- 9/2008 – 12/2011, Lecturer, University of Canterbury, Dept. of Mathematics and Statistics
- 7/2007 – 9/2008, Postdoctoral Fellow, Univeristy of Michigan, Dept. of Human Genetics
- 7/2005 – 6/2007, Research Fellow, Harvard School of Public Health, Dept. of Biostatistics

Distinction and Awards

- College Early Career Researcher Award, University of Canterbury, 2010
- Visiting Research Fellow, Statistical and Applied Mathematical Sciences Institute (SAMSI), North Carolina, January 2009
- PhD awarded with distinction, UNM, 2005
- WNAR student paper competition, winner: Best Presentation, 2004
- Gwen J. Barrett scholarship (UNM), 1995

Most relevant publications

- 2016. ES Allman, JH Degnan, and JA Rhdoes. Species tree inference from gene splits by Unrooted STAR methods. *IEEE/ACM Transactions in Computational Biology and Bioinformatics*, in press, DOI:10.1109/TCBB.2016.2604812. Preprint available at arXiv:1604.05364.
- 2016. T Stadler, JH Degnan, and NA Rosenberg. Does gene tree discordance explain the mismatch between macroevolutionary models and empirical patterns of tree shape and branching times? *Systematic Biology* 65:628–639.
- 2015. JH Degnan and JA Rhodes. There are no caterpillars in a wicked forest. *Theoretical Population Biology*, in press.
- 2015. S Zhu, JH Degnan, SJ Goldstien, and B Eldon. Hybrid-Lambda: simulation of multiple merger and Kingman gene genealogies in species networks and species trees. *BMC Bioinformatics* 16:292
- 2014. M DeGiorgio and JH Degnan. Robustness to divergence time underestimation when inferring species trees from gene trees. *Systematic Biology* 63: 66-82.
- 2013. JH Degnan. Anomalous unrooted gene trees. *Systematic Biology* 62:574-590.

- 2013. ES Allman, JH Degnan, JA Rhodes. Species tree inference by the STAR method, and generalizations. *J. Computational Biology* 20: 50–61.
- 2012. JH Degnan, NA Rosenberg, T Stadler. A characterization of the set of species trees that produce anomalous ranked gene trees. *IEEE-ACM Transactions in Bioinformatics and Computational Biology* 9: 1558–1568.
- 2012. JH Degnan, NA Rosenberg, T Stadler. The probability distribution of ranked gene trees on a species tree. *Mathematical Biosciences* 235: 45–55.
- 2012. T Stadler, JH Degnan. A polynomial time algorithm for calculating the probability of a ranked gene tree given a species tree. *Algorithms for Molecular Biology* 7:7.

Research grants or Contracts.

- Modeling gene trees in species trees and networks, sole PI, Marsden Fast-Start (Royal Society of New Zealand), 2010-2012, NZ$282,000 (~US$211,000 equivalent)
- Collaborative Research: Mathematical and computational analysis for species tree inference, PIs: Elizabeth S. Allman (U. Alaska), James H. Degnan (UNM), John A. Rhodes (U. Alaska), Noah A. Rosenberg (Stanford), NSF (DMS – NIGMS), 9/1/2015-8/31/2019, $1,557,057 ($355,910 to UNM)

Main synergistic/service activities

- Member of the American Statistical Association, Society for Systematic Biology
- Editorial board member, Systematic Biology, 2008–2013; Theoretical Population Genetics, 2014–present
- Associate editor, BMC Evolutionary Biology, 2014-
- Vice President, Albuquerque Chapter of the American Statistical Association, 2015–2016
- I have refereed over 70 journal articles and for the National Science Foundation
Service at UNM:
- Director of UNM Statistics Consulting Clinic (starting January 2015)
- Co-writer and/or grader for qualifying exams since August 2016
- Research Allocations Committee (2 year appointment starting Fall 2014)
- Participated in Mentoring through Critical Transition Points (MCTP) program, 2014
- PhD Dissertation Committee member for Gregory Morre (UNM, Pure Math), Yonghua Wei (UNM, Statistics)
- PhD Dissertation Committee member (external) for Carlos Alberto Carrion Bonilla and Bryan McLean(UNM, Biology)
- PhD Dissertation Committee member (external) for Charles Havlik (New Mexico State University, Department of Agriculture)
- Masters thesis committee member for Yingzhe Cheng (UNM, Statistics)

Postdoctoral and Ph.D. advisees:

- Ayed Alanzi, 2016–, PhD student, UNM, "Approximate Bayesian inference of rooted species trees from unrooted gene trees", expected graduation: Spring 2017
- Huan Jiang, 2016–, PhD student, UNM, "Modeling trait evolution with gene tree estimation error and/or multiple gene trees", expected graduation: Spring 2017
- Sha Zhu (Joe) 2010-2013, PhD Student, "Stochastic tree models and probabilistic modelling of gene trees of given species networks", co-superivsed with Mike Steel

Summary of research experience

My research has been primarily applying statistical and probabilistic methods to questions in evolutionary biology and genetics. In particular I have worked in human genetics and in applying ideas from population genetics to phylogenetics, the goal of which is to find evolutionary trees (like family trees) that show which species are most closely related. My work has been particularly successful in terms of its impact on other researchers on understanding relationships between gene trees and species trees, the design of simulation studies for methods of inferring species trees, and in giving theoretical justification to methods for inferring species trees. Particularly influential papers in this area are Degnan and Salter (2005), Degnan and Rosenberg (2006), Kubatko and Degnan (2007), Degnan et al. (2009), and Allman et al. (2011).

A major contribution in my research has been the derivation of the probabilities of gene-tree topologies given a fixed species tree under the multispecies coalescent. Although small examples with 3, 4, and 5 species were published in earlier papers (Pamilo and Nei, 1988; Rosenberg 2002), this problem was not solved for arbitrary numbers of species until I derived the probability in my dissertation (Degnan, 2005; see also Degnan and Salter, 2005 and Degnan 2010). There are many applications in phylogenetics for having this distribution, including inferring species trees and proving that methods of inferring species trees that are not likelihood based either are or are not statistically consistent.

Recently, I have worked on extending these probability models to cases where species hybridize. Populations that have been genetically isolated for millions of years can still sometimes hybridize and produce fertile offspring. Hybrid populations which have occurred in the past can complicate inference of evolutionary relationships. These events can be modeled using networks, which are generalizations of trees. Much more research has been done on trees than networks, and problems related to networks promise to be a rich area for future research.

Pedro F Embid
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. in Mathematics, U.C. Berkeley, 1984.
- M.A. in Mathematics, U.C. Berkeley, 1981.
- B.S. in Mathematics, Universidad Simón Bolivar, 1977.

Appointments

- Professor, University of New Mexico, 1998-present.
- Associate Professor, University of New Mexico, 1992-1998.
- Assistant Professor, University of New Mexico, 1985-1992.
- Program Director, National Science Foundation, 2016-present.
- Program Director, National Science Foundation, 2012-2014.
- Guest Scientist, LANL, January 2011 to June 2013.
- Guest Scientist, CNLS-LANL, January 2010 to December 2010.
- Guest Scientist, CNLS-LANL, February 2008 to February 2009.
- Visiting Professor, Tufts university, 2002-2003.
- Visiting Professor, Courant Institute, 1995-1996.
- Visiting Professor, Princeton University, 1989-1990, 1993-1996.
- Visiting Professor, Institute for Advanced Studies, 1993-1994.
- Research Assistant, U.C. Berkeley, 1983-1984.
- Teaching Associate, U.C. Berkeley, 1979-1983.
- Instructor, Universidad Simón Bolivar, 1977-1978.
- Teaching Assistant, Universidad Simón Bolivar, 1973-1977.

Distinction and Awards

- Nominated for the 2016-2018 Presidential Teaching Fellow Award.
- Nominated for the 2015-2016 Outstanding Teacher of the Year Award.
- Innovation Award, UNM Science and Technology Corporation, December 2012.
- Recognition as one of the top 10 highest-rated professors at UNM, New Mexico Daily Lobo, September 8, 2011.
- Nominated for the 2008-2010 Presidential Teaching Fellow Award.
- Nominated for the 2006-2008 Presidential Teaching Fellow Award.
- Nominated for the 2007-2008 Outstanding Teacher of the Year Award.
- Outstanding 2010-2011 Undergraduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2008-2009 Graduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2007-2008 Graduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2006-2007 Graduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2005-2006 Undergraduate Mathematics Professor, UNM Department of Mathematics and Statistics.

- Outstanding 2004-2005 Graduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2000-2001 Undergraduate Mathematics Professor, UNM Department of Mathematics and Statistics.
- Outstanding 2001-2001 Outstanding Teacher of the Year Award, University of New Mexico.
- Outstanding 1996-1997 Instruction in Mathematics, Kappa Mu Epsilon Mathematics Honor Society.

Most relevant publications

- (With Dan Topa, Engility Corporation, US Army Corps of Engineers) Orthogonality and Computation, Proceedings of the CSC'15-13th International Conference on Scientific Computing, Las Vegas, Nevada, July 2015.
- Low Rossby Limiting Dynamics for Stably Stratified Flow with Finite Froude Number, with B. Wingate, M. Holmes-Ceron and M. Taylor, Journal of Fluid Dynamics 676, 546-571 (2011).
- Algorithm to Form Composite Lenses from Microlenslet Arrays, patent through the University of New Mexico Science and Technology Corporation, July 2007.
- Averaging over fast gravity waves for geophysical flows with unbalanced initial data, with A. Majda, Theoretical and Computational Fluid Dynamics 11, 155-169 (1998).
- Low Froude Number Limiting Dynamics for Stably Stratified Flow with Small or Fixed Rossby Numbers, with A. Majda, Geophysical Astrophysical Fluid Dynamics 87, 1-50 (1998).
- Introducción a los Fluidos Geofísicos. Asociación Matemática Venezolana. 120 pgs. (1997).
- Averaging Over Fast Gravity Waves For Geophysical Flows With Arbitrary Potential Vorticity, with A. Majda, Communications in Partial Differential Equations 21, 619-658(1996).
- Effective Geometric Front Dynamics for Premixed Turbulent Combustion with Separated Velocity Scales, with A. Majda and P. Souganidis, Combustion, Science and Technology 103, 85-115(1994).
- Simplified Asymptotic Model for Transition to Detonation in Reactive granular Flows, with J. Hunter and A. Majda, SIAM J. Applied Math. 52(5), 1199-1237(1992).
- Deflagration to Detonation Transition (DDT) in Reactive Granular Materials, with J. Nunziato and M. Baer, Progress in Aeronautics and Astronautics (AIAA series) 135, 481-512(1989).

Research grants or Contracts.

- Collaboration on the Formulation and Subsequent Study of Simplified Asymptotic Models Relevant to Geophysical Flows, LANL-DOE contract award, 09/10/2010 09/30/2011.
- Nonlinear Problems in Geophysical and Reactive Flows, NSF award, 05/1997 05/2000.
- Mathematical Analysis of Reactive Multi-Phase Flows, SNL contract, 06/1993-06/1994.
- Mathematical Analysis of Reactive Multi-Phase Flows, NSF award, 05/1991 11/1993.
- Mathematical Analysis of Reactive Multi-Phase Flows, ARO award, 05/1991 05/1992.
- Mathematical Analysis of Reactive Multi-Phase Flows, SNL contract, 05/1991 05/1992.
- Mathematical Sciences Computing Research Environments (with A. Aceves, E. Coutsias, J. Lorenz, S. Steinberg, D. Sulsky), NSF-SCREMS award, 07/1991 07/1992.
- Mathematical Analysis of Reactive Multi-Phase Flows, SNL contract, 02/1989-10/1989.

- Mathematical Analysis of Reactive Multi-Phase Flows, SURP award, 10/1987 10/1988.
- Mathematical Analysis of Reactive Multi-Phase Flows, SURP award, 10/1986 10/1987.

Main synergistic/service activities

- Various collaborations with Los Alamos National Laboratories: COSIM group (2008-2010), CNLS (2008-2010), X-Division (2008-2013).
- Consulting for US Geological Survey, Albuquerque, Fall 2007.
- Consulting for Wave Front Sciences, Albuquerque, Fall 2006, Spring 2007.
- Collaborations with Sandia National Laboratories (1987-1994).
- Reviewer and panelist for the National Science Foundation (2006, 2009, 2010, 2011, 2012, 2016).
- Reviewer for various mathematical and scientific journals: Journal of Atmospheric Sciences. Journal of Mathematical Analysis and Applications. SIAM Journal in Mathematical Analysis. SIAM Journal in Numerical Analysis. Communications in PDE. Combustion Theory and Modelling. Combustion and Flame. Proceedings of the Royal Society of London: Mathematical, Physical and Engineering Sciences. Journal of Differential Equations. Boletín de la Associación Matemática Venezolana.
- Reviewer for various university committees: Graduate Deans Dissertation Fellowship, Spring 2011. UNM limited competition proposal process, Fall 2000. Graduate Scholars Program, AY 97. Graduate Fellowship, AY 97.
- Member of various university committees: UNM committee for the NSF Presidential Awards for Excellence in Science, Mathematics and Engineering mentoring, Spring 2001, Spring 2002, Fall 2003. Graduate Scholars Committee, OGS, Spring 1998, Spring 1999. MIDAS proposal committee, Spring 1998, Fall 1998. A & S Graduate Advisors Committee, 1997, 1998. A & S SOE/Math coordinating Committee.
- Chair of Graduate Committee, AY 1997, AY 1998.
- Member of several departmental committees: Executive Committee, AY 1996. PTI/Lecturer hiring committee, AY 2009, 2012, 2016. Applied Mathematics hiring committee, AY 1996, 1999, 2008, 2015. Undergraduate Commitee, AY 1986, 1988, 1992, 2003. Library Committee, AY 1990, 1992. Oral exam panel in Applied Mathematics, AY 1987. Committee for the formulation and implemention of written MS/PhD qualifying exams, AY 1988.
- Preparation, proctoring and grading of MS/PhD qualifying exams: Fall 1991, 1992, 1997, 1998, 1999, 2000, 2004, 2005, 2006, 2008, 2009, 2012, 2015.
  Spring 1992, 1993, 1997, 1998, 1999, 2001, 2003, 2004, 2005, 2006, 2007, 2009, 2012, 2016.
- Invited presentation at Van Buren Middle School, May 2011.

Summary of research experience

I have worked in the field of Partial Differential Equations using a combination of theoretical analysis, asymptotics, and numerical solutions of the equations under study. I have worked on different areas in fluid mechanics including compressible and incompressible flows, low Mach number combustion, deflagration to detonation transition in multi-phase reactive flows, and geophysical fluid dynamics with emphasis on highly stratified and/or rapidly rotating flows.

Erik Erhardt
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- PhD Statistics, with distinction, University of New Mexico, Albuquerque, NM, Aug 2009.
- MS Applied Statistics, Worcester Polytechnic Institute, Department of Mathematical Sciences, Worcester, MA, Dec 2003.
- BA Mathematics and Computer Science, Franklin Pierce College, Rindge, NH, May 1997.

Appointments

- Associate Professor, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM 87131, Jul 2016– .
- Assistant Professor, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM 87131, Aug 2011– Jun 2016.
- Adjunct Research Scientist, Mind Research Network, Albuquerque, NM 87106, Jun 2015–.
- Director, Biostatistics and NeuroInformatics (BNI) Core, Center for Biomedical Research Excellence (COBRE) in Brain Function and Mental Illness, second phase, Mind Research Network, Albuquerque, NM 87106, Jun 2013– .
- Director, UNM Statistical Consulting Clinic, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM 87131, Aug 2011– Dec 2014.

Distinction and Awards

- 2016–2017 UNM Teaching Fellow, Active-learning redesign of Stat 145.
- 2015 Innovation grant for Stat 427/527 and 428/528 redesign, innovationAcademy, UNM.
- 2016, 15, 14, 13, 12 Nominated for Outstanding New Faculty Teacher of the Year Award, 2011–16, CTE, UNM.
- 2012 Outstanding Undergraduate Instructor (tied as Outstanding Graduate instructor), 2011–12, Department of Mathematics and Statistics, UNM.

Most relevant publications

- **Erhardt, E. B.** and E. Bedrick (2014). "Inference for stable isotope mixing models: a study of the diet of dunlin". Journal of the Royal Statistical Society: Series C 63 (4). pp. 579–593. doi: 10.1111/rssc.12047.
- **Erhardt, E. B.** and E. Bedrick (2013). "A Bayesian framework for stable isotope mixing models". Environmental and Ecological Statistics 20 (3). pp. 377–397. issn: 1352-8505. doi: 10.1007/s10651-012-0224-1.
- Allen, E., E. Damaraju, S. Plis, **E. B. Erhardt**, T. Eichele, and V. Calhoun (2012). "Tracking whole-brain connectivity dynamics in the resting-state". Cerebral Cortex 24 (3). pp. 663–676. doi: 10.1093/cercor/bhs352.
- Allen, E., **E. B. Erhardt**, and V. Calhoun (2012a). "Data visualization in the neurosciences: overcoming the curse of dimensionality". Neuron 74. pp. 603–608. doi: 10.1016/j. neuron.2012.05.001.
- Allen, E., **E. B. Erhardt**, Y. Wei, T. Eichele, and V. Calhoun (2012). "Capturing inter-subject variability with group independent component analysis of fMRI data: a simulation

study". NeuroImage 59 (4). pp. 4141–4159. doi: 10.1016/j.neuroimage.2011.10.010.

- **Erhardt, E. B.**, E. Allen, Y. Wei, T. Eichele, and V. Calhoun (2012). "SimTB, a simulation toolbox for fMRI data under a model of spatiotemporal separability". NeuroImage 59 (4). pp. 4160–4167. doi: 10.1016/j.neuroimage.2011.11.088.
- Allen, E., **E. B. Erhardt**, E. Damaraju, W. Gruner, J. Segall, R. Silva, M. Havlicek, S. Rachakonda, J. Fries, R. Kalyanam, A. Michael, A. Caprihan, J. Turner, T. Eichele, S. Adelsheim, A. Bryan, J. Bustillo, V. Clark, S. F. Ewing, F. Filbey, C. Ford, K. Hutchison, R. Jung, K. Kiehl, P. Kodituwakku, Y. Komesu, A. Mayer, G. Pearlson, J. Phillips, J. Sadek, M. Stevens, U. Teuscher, R. Thoma, and V. Calhoun (2011). "A baseline for the multivariate comparison of resting state networks". Frontiers in Systems Neuroscience 5. pp. 1–23. doi: 10.3389/fnsys.2011.00002.
- **Erhardt, E. B.**, S. Rachakonda, E. Bedrick, E. Allen, T. Adali, and V. Calhoun (2011). "Comparison of multi-subject ICA methods for analysis of fMRI data". Human Brain Mapping 32 (12). pp. 2075–2095. doi: 10.1002/hbm.21170.

Research grants or Contracts.

- $2,260,010, National Institutes of Health (USA), Sep 2016–Aug 2020. PI: Chris Abbott, MD, MS. Co-Is: **E. B. Erhardt** PhD (University of New Mexico, Department of Mathematics and Statistics), et al. Title: ECT current amplitude and medial temporal lobe engagement
- $-, NIH RFA-NS-16-020 on Small Vessel Vascular Contributions in Cognitive Impairment and Dementia (VCID) Biomarkers Development Projects, Sep 2016–Aug 2021. co-PI: Gary Rosenberg, MD, UNM, Department of Neurology; Arvind Caprihan, PhD, MRN, Translational Neuroscience. Co-Is: **E. B. Erhardt**, PhD (UNM), et al.
- $2,596,496, Patient Centered Outcomes Research Institute (PCORI), A Patient- Centered Framework to Test the Comparative Effectiveness of Culturally and Contextually Appropriate Program Options for Latinos with Diabetes from Low-Income Households, Sep 2016–Aug 2018. PI: Janet Page-Reeves, PhD, and Lidia Regino (community member). Co-Is: **E. B. Erhardt** (co-PI, senior statistician), et al. Title: A Patient-Centered Framework to Identify Culturally and Contextually Appropriate Options for Latinos with Diabetes from Low Income Households
- $45,411, Director, Biostatistics and NeuroInformatics (BNI) Core, Center for Biomedical Research Excellence (COBRE) in Brain Function and Mental Illness, second phase, Mind Research Network, Albuquerque, NM 87106, Jun 2013–May 2018. PI: Vince Calhoun, PhD.

Main synergistic/service activities

- Journal referee: Methods in Ecology and Evolution, Marine Ecology Progress Series, NeuroImage, Frontiers in Evolutionary Psychology and Neuroscience, Journal of Environmental Quality, Human Brain Mapping, Human Brain Mapping, Oecologia, MAGMA.
- UNM Math & Stat committees: Executive, statistics, grad, ugrad, hiring, stat consulting clinic, IRB, organizing seminars and student talks, faculty sponsor 2 student orgs
- UNM committees: STEM Gateway redesign council

Postdoctoral and Ph.D. advisees:

- A few MS students.

Summary of research experience

I am driven by the challenge of developing new statistical methods for biology, ecology, brain imaging, and public health. I focus on working in interdisciplinary teams that leverage great potential for developing new statistical tools to address problems of high current research interest. More detail is available in my research statement.

Stable isotope sourcing in foodwebs

Isotopically, "you are what you eat" and where you eat in the trophic foodweb. By constructing a graph of who consumes whom in the environment, then taking tissue samples to measure stable isotopes of carbon, nitrogen, sulfur, and other elements from those sources and consumers, I develop statistical mixing models to estimate proportions of sources contributing to a consumer's diet (average for population proportions or individual-specific proportions). Furthermore, using my models one can learn the position in the foodweb (trophic level) of each consumer, whether those consumers switched their diet and when, and relate what we observe to covariates such as age, sex, time, species, climate, and more. My ongoing research aims to continue model development and refinement from a statistically sound framework, and provide software for the analysis needs of the stable isotope sourcing community. I am writing an NSF grant proposal to help support this work.

fMRI

As Co-director of the Biostatistics and NeuroInformatics (BNI) Core for the second phase of the Center for Biomedical Research Excellence COBRE in Brain Function and Mental Illness at the Mind Research Network, I continue my postdoctoral work in brain imaging by providing statistical support for COBRE projects as well as being the statistician on R01 grant proposals. Other work includes method development and evaluation using group independent component analysis. I have recently completed an invited book chapter on visualization for the 4th edition of the Handbook of Psychophysiology (Cambridge University Press).

Photosynthesis and (photo)respiration in plants

I have developed a statistical framework for measuring uncertainty in stable isotope analyses of photosynthesis and photorespiration in plants, with application to Arabidopsis thaliana, a model organism in plant biology. My R software package [s3] for automating computations from a combined tunable diode laser absorbance spectroscopy - infrared gas analyzer (TDL-IRGA) system in David Hansons Biology Lab here at UNM has been adopted by many group leaders from labs around the world (Nate McDowell, Los Alamos National Lab; Marshall McCue, St. Marys University, Texas; Blair Wolf, UNM; Jerilyn Timlin, Sandia National Lab; Todd Rosensteil, Portland State University; Ralf Kaldenhoff, University of Darmstadt, Germany; and Jaume Flexas, University de les Illes de Balears, Spain). Prof. Hanson and I are writing an NSF grant proposal to help support extensions of this work.

Public health and other areas of interest

As a graduate student I was the primary statistician on the largest case-control study of childhood Hodgkins lymphoma (CHL) and I continue to collaborate with epidemiologists to produce research on CHL and rhabdomyosarcoma. I have recently also contributed to papers on fish vaccination, field experiments for medicinal herbs, dialectical behavior therapy outcomes, and using packrat middens and 14C-dating to understand how droughts caused a shift from ponderosa to piñon pine trees in the Southwest 5000 years ago. However, I am now focussing on the three areas above.

Hongnian Huang
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation (Educational background)

- University of Science and Technology of China, B.S in Mathematics, 2004.
- University of Wisconsin at Madison, Ph.D in Mathematics, 2009.
- CIRGET, University of Quebec at Montreal, Postdoctoral fellow in differential geometry and geometrical analysis, 2009-2011.
- CMLS, Ecole Polytechnique, Hadamard Postdoctoral Fellow in differential geometry and geometrical analysis, 2011-2013.
- CIRGET, University of Quebec at Montreal, Postdoctoral fellow in differential geometry and geometrical analysis, 2013-2014.

Appointments

- Assistant Professor, Department of Mathematics and Statistics, The University of New Mexico, Fall 2014 - Present.
- Research Member, MSRI, Spring 2016.

Most relevant publications

- C. Boyer, H.N. Huang, E. Legendre and C. Tønnesen-Friedman, *The Einstein-Hilbert functional and the Sasaki-Futaki invariant*, to appear in IMRN, arXiv:1506.06084.
- X.X. Chen, H.N. Huang and L. Sheng, *The interior regularity of the Calabi flow on a toric surface*, Calc. Var. Partial Differential Equations 55 (2016), no. 4, 55:106.
- R.J. Feng and H.N. Huang, *The global existence and convergence of the Calabi flow on* $\mathbb{C}^n/(\mathbb{Z}^n + \sqrt{-1}\mathbb{Z}^n)$, J. Funct. Anal. 263 (2012) no. 4 1129-1146.
- H.N. Huang, *Convergence of the Calabi flow on toric varieties and related Kähler manifolds*, J. Geom. Anal. 25 (2015), no. 2, 1080-1097.
- H.N. Huang, *Calabi flow on projective bundles, I*, arXiv:1511.06290.
- C. Boyer, H.N. Huang, E. Legendre and C. Tønnesen-Friedman, *Reducibility in Sasaki Geometry*, arXiv:1606.04859.
- H.N. Huang and K. Zheng, *Stability of the Calabi flow near an extremal metric*, Ann. Sc. Norm. Super. Pisa Cl. Sci. (5) 11 (2012), no. 1, 167-175.
- H.N. Huang, *Toric surfaces, K-stability and Calabi flow*, Math. Z. 276 (2014), no. 3-4, 953-968.
- H.N. Huang, *On the extension of Calabi flow on toric varieties*, Ann. Global Anal. Geom. 40 (2011), no. 1, 1-19.
- H.N. Huang, *On the extension and smoothing of the Calabi flow on complex tori*, arXiv:1609.01834.

Summary of research experience

My research focuses on an important branch of the differential geometry: Kaehler geometry. One of the central problems in Kaehler geometry is to find canonical Kaehler metrics: Kaehler-Einstein metrics, constant scalar curvature Kaehler metrics, etc.

In 1976 S.T. Yau proved the existence of Kaehler-Einstein metrics, provided that the Kaehler manifold has negative or zero first Chern class. In 1982 Yau received the Fields Medal in part for this proof. Much important progress has been made since Yau's work. For example, in 2002 practitioners of Kaehler geometery proposed one of the central conjectures in the field (the Yau-Tian-Donaldson conjecture) which says that the existence of a constant scalar curvature Kaehler metrics is equivalent to the stability of the Kaehler manifold. The Yau-Tian-Donaldson conjecture has been verified in many cases, but still remains largely open.

One of the tools to understand the existence of constant scalar curvature Kaehler metric is the Calabi flow, proposed by the well-known differential geometer E. Calabi in 1980. It is widely believed that if one can prove the long-time existence of the Calabi flow, then one can prove the Yau-Tian-Donaldson conjecture.

I am currently working on proving the long-time existence of the Calabi flow, and on applications to the Kaehler and Sasaki geometry.

Gabriel Huerta
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. 1998, Statistics, Duke University.
- M.S. 1996, Statistics, Duke University.
- M.S. 1994, Statistics, National Autonomous University of Mexico (UNAM).
- B.S. 1991, Actuarial Sciences, National Autonomous University of Mexico.

Appointments

- 2013- Full Professor of Statistics, Department of Mathematics and Statistics, The University of New Mexico (UNM).
- 2007- 2013 Associate Professor, Department of Mathematics and Statistics, The University of New Mexico (UNM).
- 2011-2012 Associate Professor, Department of Statistics, Indiana University (IU) .
- 2002-2007 Assistant Professor, Department of Mathematics and Statistics, The University of New Mexico.
- 1999-2002 Faculty (Investigador Titular 'A'), Department of Probability and Statistics, Research Center in Mathematics (CIMAT), Guanajuato, Mexico.

Distinction and Awards

- 2007-2010 UNM College of Arts and Sciences Regents Lecturer.
- 2001 Aranda-Ordaz award for best Ph.D thesis in any area of Probability and Statistics written by a Latin American in the last three years. Award sponsored by the Bernoulli Society for Probability and Mathematical Statistics through its Latin America Regional Committee.
- 2000-2002 Researcher Level 1 of the National System of Researchers (SNI) of Mexico.
- 1994 Gabino Barrera Medal for outstanding academic studies at the Master level awarded by the National Autonomous University of Mexico (UNAM).

Most relevant publications as in Google Scholar. h-index=13, i-10index=14, 686 citations

- **Huerta, G.**, Sanso, B., and Stroud, J.R. (2004). Space-Time Modeling of Mexico City Ozone Levels. *Applied Statistics*, Vol. 53, 1-18.
- Jackson, C.S., Sen, M.K., **Huerta, G.**, Deng, Y. and Bowman, K.P. (2008). Error Reduction and Convergence in Climate Prediction. *Journal of Climate*, Vol. 21, No. 24, 6698-6709.
- **Huerta, G.** and West, M. (1999). Priors and Component Structures in Autoregressive Time Series Models. *Journal of the Royal Statistical Society, Series B*, Vol. 61, 881-899.
- **Huerta, G.** and Sanso, B. (2007). Time-Varying Models for Extreme Values. *Environmental and Ecological Statistics*, Vol. 14, No. 3, 285-299.
- Aguilar O., **Huerta G.**, Prado R. and West M. (1999). Bayesian Inference of Latent Structure in Time Series (with discussion). *Bayesian Statistics VI;* Eds: J.M. Bernardo, J.O. Berger, A.P. Dawid and A.F.M. Smith. Oxford University Press, 3-26.

- **Huerta, G.** and West, M. (1999). Bayesian Inference on Periodicities and Component Spectral Structure in Time Series. *Journal of Time Series Analysis*, Vol. 20, No. 4, 401-416.
- Villagran, A., **Huerta, G.**, Jackson, C.S. and Sen, M.K. (2008). Computational approaches for Parameter Uncertainty Estimation in Climate Models. *Bayesian Analysis*, Vol. 3, 823-850.
- Prado, R. and **Huerta, G**. (2002). Time-varying autoregressions with model order uncertainty. *Journal of Time Series Analysis*, Vol. 23, No. 5, 599-618
- **Huerta, G.**, Jiang, W. and Tanner, M.A. (2003). Time series modeling via hierarchical mixtures. *Statistica Sinica*, Vol. 13, No. 4, 1097-1118.
- Prado, R.,**Huerta, G.** and West, M. (2000). Time-varying Autoregressions: Theory, Methods and Applications. *Resenhas* IMP-USP, Vol. 4, No. 4, 405-422.

Research grants or Contracts.

- Title: *Collaborative Project: The Problem of Bias in Defining Uncertainty in Computationally Enabled Strategies for Data-Driven Climate Model Development.* Principal Investigator: **Huerta,G.** Prinicipal Investigator (UT-Austin): Jackson, C. Granting Agency: Office of Science (BER), U.S. Department of Energy. Time Period: September 11, 2013-August 31, 2015. Total award: $270,497.
- Title: *Travel Support for the 12th ISBA World Meeting on Bayesian Statistics* Principal Investigator: Sanso, B. (UCSC), Co-Investigators: **Huerta,G.**, Prado, R. (UCSC). Granting Agency: National Science Foundation. Time period: July 2014-December 2014. Total award: $ 25,000
- Title: *Uncertainty Quantification in Climate Models.* Principal Investigator (UNM): **Huerta, G.** Principal Investigators (LANL): Higdon, D., Gattiker, J.
  Granting Agency: Los Alamos National Security, LLC. Time period: January 1, 2010-August 31, 2010. Total award: $21,657.
- Title: *Collaborative Research: Stochastic Representation of Parameter Uncertainty Within Model Predictions of Future Climate.* Principal Investigators: **Huerta, G.** Jackson, C.S. and Sen, M.K. (University of Texas at Austin). Granting Agency: National Science Foundation. Time period: September 2004-September 2008.

Main synergistic/service activities

- National Institute of Statistical Sciences (NISS) Board of Trustees and Affiliates Committee, 2015-2018
- Secretary for the EnviBayes section of the International Society for Bayesian Analysis (ISBA), 2015-2016
- The American Statistical Association (ASA) Caucus of Academic Representatives (rep. of non-statistics/biostatistics department offering Ph.D in Statistics) 2014-2017.
- Associate Editor for *Bayesian Analysis*, 2011-
- Associate Editor for *The American Statistician*, 2011-

Postdoctoral and Ph.D. advisees:

- Postdoctoral mentor for **Menuka Karki**. Departments of Economics and Mathematics and Statistics, University of New Mexico (currently Visiting Assistant Professor at Louisiana Tech).

- Postdoctoral mentor for **Mohammad Hattab**. Department of Mathematics and Statistics, University of New Mexico (currently Postdoc at Virginia Commonwealth University).
- Postdoctoral mentor for **Alvaro Nosedal-Sanchez**. Department of Mathematics and Statistics, University of New Mexico (currently Assistant Professor-teaching stream, at Department of Mathematics, University of Toronto-Mississauaga).

- **Sara Rodriguez Rodriguez** (co-advisor with Hortensia Reyes). Topic: *Modeling and estimating trends for Mexico City ozone extremes.* BUAP, University of Puebla, Mexico. completed August 2016. Faculty/instructor at Universidad de Las Americas-Puebla.
- **Yonghua Wei**. Ph.D. thesis: *Dynamic Generalized Extreme Value via Particle Filters.* UNM, Deparmtent of Mathematics and Statistics, Summer 2015. Statistical and Data analyst for Walmart Headquarters , Arkansas.
- **Maozhen Gong**. Ph.D. thesis: *Order-Constrained Reference Priors with Implications for Bayesian Isotonic Regression, Analysis of Covariance and Spatial Models* UNM, Department of Mathematics and Statistics, Spring 2015. (student started thesis project with Dr. Michael Sonksen).
- **Alejandro Villagran-Hernandez**, Ph.D. thesis: *Monte Carlo Strategies for Calibration in Climate Models.* UNM, Department of Mathematics and Statistics, Spring 2009. Currently Senior Data Analysis at Boeing.
- **Wenxia Ying**, Ph.D. thesis : *Bayesian Modeling of non-stationary extremal events.* UNM, Department of Mathematics and Statistics, Summer 2008. Currently Biostatistics Manager at AMGEN INC. CA

Summary of research experience

My research interests are in Bayesian time series, spatial-temporal modeling, parameter estimation in climate modeling, extreme value analysis and computational methods. My research has stemmed from multiple collaborations and has been funded by the National Science Foundation, the U.S. Department of Energy and Los Alamos National Laboratories. A key aspect of my research is to introduce Bayesian modeling ideas to assist in the solution of complex data analysis and scientific problems.

Alexander O. Korotkevich
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Department of Physical and Quantum Electronics, Moscow Institute of Physics and Technology, B. S. Physics, 1997
- Department of Physical and Quantum Electronics, Moscow Institute of Physics and Technology, M. S. Physics, 1999
- L. D. Landau Institute for Theoretical Physics, Russian Academy of Sciences, Moscow, Russia, Ph. D. in Applied Mathematics and Theoretical Physics, 2003

Appointments

- 8/2013-present Associate Professor of Applied Mathematics, Department of Mathematics and Statistics, The University of New Mexico, USA.
- 8/2009-8/2013 Assistant Professor of Applied Mathematics, Department of Mathematics and Statistics, The University of New Mexico, USA.
- 1/2006-8/2009 Visiting Scholar, Postdoctoral Scholar, Visiting Assistant Professor, Department of Mathematics, The University of Arizona, USA.
- 7/2003-1/2006 Research Scholar, Landau Institute for Theoretical Physics, Moscow, Russia.

Distinction and Awards

Most relevant publications

- *Numerical simulation of surface waves instability on a homogeneous grid*, A. O. Korotkevich, A. I. Dyachenko, and V. E. Zakharov, Physica D: Nonlinear Phenomena **321**, 51-66 (2016);
- *Branch Cuts of Stokes Wave on Deep Water. Part I: Numerical Solution and Padé Approximation*, S. A. Dyachenko, P. M. Lushnikov, and A. O. Korotkevich, Studies in Applied Mathematics, DOI: 10.1111/sapm.12128 (2016);
- *On the comparison of energy sources: Feasibility of radio frequency and ambient light harvesting*, Zh. S. Galochkina, O. Lavrova, and E. C. Coutsias, Renewable Energy **81**, 804–807 (2015);
- *Fast eigensolver for plasmonic metasurfaces*, A. O. Korotkevich, X. Ni, and A. V. Kildishev, Optical Materials Express **4** (2), 288-299 (2014);
- *Proof-of-concept implementation of the massively parallel algorithm for simulation of dispersion-managed WDM optical fiber systems*, A. O. Korotkevich and P. M. Lushnikov, Optics Lett. **36** (10), 1851 (2011);
- *Beyond the random phase approximation: Stimulated Brillouin backscatter for finite laser coherence times*, A. O. Korotkevich, P. M. Lushnikov, and H. A. Rose, Phys. of Plasmas **22**, 012107 (2015);
- *Simultaneous numerical simulation of direct and inverse cascades in wave turbulence*, A. O. Korotkevich, Phys. Rev. Lett. **101**, (7), 074504 (2008);
- *Coexistence of Weak and Strong Wave Turbulence in a Swell Propagation*, V. E. Zakharov, A. O. Korotkevich, A. N. Pushkarev, and D. Resio, Phys. Rev. Lett. **99**, (16), 164501 (2007);

- *Communication through plasma sheaths*, A. O. Korotkevich, A. C. Newell, and V. E. Zakharov, J. Appl. Phys. **102** (8), 083305 (2007);
- *Mesoscopic wave turbulence*, V. E. Zakharov, A. O. Korotkevich, A. N. Pushkarev, and A. I. Dyachenko, JETP Lett. **82**, (8), 544-548 (2005);

Research grants or Contracts.

- Subaward from Los Alamos National Laboratory, Amount:$141,800, Summer 2015 - December 2016, PI: Alexander O. Korotkevich.
- NSF grant "Sustainable Energy Pathways Through Education and Technology (SEPTET)" from, Amount:$1,575,000, 15th of September 2012 – 31st of August 2016, Co-PI, PI: Tito Busani (UNM, ECE).
- NSF grant "Collaborative Research: Deterministic and Statistics Theory of Wind Driven Sea of Finite Depth" from OCE and DMS, Amount:$199,335, 1st of July 2011 – 30th of June 2014, PI: Alexander O. Korotkevich.
- "Effective Algorithm for Simulation of Multilayered Planar Nanoscale Metamaterials" Research Allocation Committee grant # 11-19, February-September 2011, The University of New Mexico, $4,000.
- Subaward from The University of Arizona, Amount:$9,783, Fall Semester 2009, PI: Alexander O. Korotkevich.

Main synergistic/service activities

- During 2010-2016 co-organizer of numerous minisymposia/sessions in the frameworks of AMS, SIAM, and ICNAAM conferences and simposia. (
- Reviewer for the NSF, European Research Council, PRL, PRE, PNAS, AMS, Scientific Reports, Journal of Lightwave Technology, Communications in Computational Physics, Wave Motion, Physics Letters A, European Journal of Applied Mathematics, Optics Communications, Journal of Experimental and Theoretical Physics (JETP), and JETP Letters.
- Head of the Department's Computer Use Committee, Fall 2016 – Spring 2017.
- Head of the Department's Undergraduate Committee, Fall 2014 – Spring 2015.

Postdoctoral and Ph.D. advisees:

- Co-advising of Ph.D. thesis of student Sergei Dyachenko at the Department of Mathematics and Statistics, The University of New Mexico, Albuquerque, USA. Defended Ph. D. thesis in August, 2014. Currently Research fellow at the ICERM, Brown University, USA.
- Advising of Ph.D. student Anastassiya Semenova at the Department of Mathematics and Statistics, The University of New Mexico, Albuquerque, USA.

Summary of research experience

My research interests are mostly on the border between computational applied mathematics, physics, mechanical engineering, optics. To narrow topics where I have substantial expertise I would list the following several branches if science: wave turbulence and ocean wave-forecasting models, theoretical physics, optics of metamaterials, physics of metallic nano-granules, nonlinear optics, solitons and their applications, plasma physics, strong turbulence, computer simulations in general (including large scale parallel computations).

Stephen R. Lau
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Mathematics Ph.D., 2004, University of North Carolina. Adviser: Michael L. Minion.
- Physics Ph.D., 1994, University of North Carolina. Adviser: James W. York, Jr.
- Physics B.S., 1988, Davidson College. Adviser: Wolfgang Christian.

Appointments

- Associate professor of mathematics, Fall 2014 to present, UNM.
- Assistant professor of mathematics, Spring 2009 to Fall 2014, UNM.
- Applied mathematics postdoctoral research associate, Fall 2006 to Spring 2009, Brown University, Providence, RI. Postdoctoral adviser: Jan S. Hesthaven.
- Mathematics postdoctoral fellow, Fall 2005 and Spring 2006, University of New Mexico, Albuquerque, NM. Postdoctoral adviser: Thomas M. Hagstrom.
- Research assistant professor of physics, Fall 2004 and Spring 2005, NASA-funded Center for Gravitational Wave Astronomy, Brownsville, TX. Postdoctoral adviser: Richard H. Price.
- Part-time assistant professor of physics, Summer/Fall 2000, Spring/Fall 2001, and Fall 2003, University of North Carolina, Chapel Hill, NC.
- Physics postdoctoral fellow, Summer/Fall 1997, University of North Carolina, Chapel Hill, NC. Postdoctoral adviser: James W. York, Jr.
- Physics postdoctoral fellow, 1995-1997, Technische Universität Wien, Vienna, Austria. Postdoctoral adviser: Wolfgang Kummer.
- Physics postdoctoral fellow, 1994-1995, Inter-University Centre for Astronomy and Astrophysics, Pune, India. Postdoctoral adviser: Jayant Narlikar.

Most relevant publications

10. S. R. Lau, *Stellar surface as low-rank modification in iterative methods for binary neutron stars*, 29 page preprint, November 2016, submitted to the Journal of Computational Physics.
9. J. A. Ellison, K. A. Heinemann, and S. R. Lau, *Distributional analysis of radiation conditions for the 3+1 wave equation*, submitted to Rocky Mountain Journal of Mathematics, March 2016.
8. S. R. Lau and R. H. Price, *Sparse spectral-tau method for the three-dimensional helically reduced wave equation on two-center domains*, J. Comput. Phys. 231, issue 22, 7695-7714 (2012).
7. S. R. Lau, G. Lovelace, H. P. Pfeiffer, *Implicit-explicit evolution of single black holes*, Phys. Rev. D84, 084023, 16 pages (2011).
6. S. R. Lau, *On Partial Spherical Means Formulas and Radiation Boundary Conditions for the 3+1 Wave Equation*, Quart. Appl. Math. 68, 179-212 (2010).
5. S. E. Field, J. S. Hesthaven, and S. R. Lau, *Discontinuous Galerkin method for computing gravitational waveforms from extreme mass ratio binaries*, Class. Quantum Grav. 26, 165010, 28 pages (2009).
4. S. R. Lau, *Analytic structure of radiation boundary kernels for blackhole perturbations*, J. Math. Phys. 46, 102503, 21 pages (2005).

3. D. Baskaran, S. R. Lau, and A. N. Petrov, *Center of mass integral in canonical general relativity*, Ann. Phys. 307, 90-131 (2003).
2. S. R. Lau, *Lightcone reference for total gravitational energy*, Phys. Rev. D60, 104034, 4 pages (1999).
1. J. D. Brown, S. R. Lau, and J. W. York, Jr., *Energy of isolated systems at retarded times as the null limit of quasilocal energy*, Phys. Rev. D55, 1977-1984 (1997).

Research grants or Contracts.

- *Rapid high-order method for gravitational binaries and evaluation of asymptotic waveforms*, NSF proposal number 1720475 (DMS-Computational Mathematics). Three year grant to to start 1 July 2017. Sole PI Stephen R. Lau. **$212,521** (pending).
- *Collaborative Research: Sparse spectral-tau methods for binary neutron star initial data*, NSF proposal number 1216866 (DMS-Computational Mathematics). Three year grant awarded 11 September 2012. PI Stephen R. Lau, Co-PI Richard H. Price. **$131,490** (UT-Brownsville with separate award of $78,930).
- *Investigations of Beam Dynamics at Current and Future Accelerators*, DOE grant DE-FG02-99ER41104. Three year $263,588 grant awarded March 2011 (with start date 16 May 2011), PI James A. Ellison, Co-PI Stephen R. Lau (this is the grant of J. A. Ellison, but S. R. Lau plays a supporting role as a consultant.) **$263,588.**
- *Multidomain Spectral Methods and Radiation Boundary Conditions with Applications in Numerical Relativity*, NSF proposal number 0855678 (PHY -Gravitational Physics). Three year grant awarded 26 July 2009 (with start date 1 August 2009), on a no-cost extension through 31 July 2013. Sole PI Stephen R. Lau. **$93,080**

Main synergistic/service activities

- Sole developer of Fortran software `SPARTANS` (SPARse TAu Neutron Star code). Currently $> 2.25 \times 10^5$ lines.
- *Gravitational Waves, Blackholes, and Computation*, one-hour presentation given on 05 March 2013 to science undergraduates at Northern New Mexico College, Española, NM.
- Referee for Applied Mathematics and Computation, BIT, Classical and Quantum Gravity, Communications in Computational Physics, Communications in Mathematical Physics, ESAIM: Mathematical Modelling and Numerical Analysis, General Relativity and Gravitation, Journal of Computational and Applied Mathematics, Journal of Computational Physics, Journal of Mathematical Physics, Journal of Scientific Computing, Living Reviews on Relativity, Numerical Algorithms, Numerical Methods for Solving Partial Differential Equations, Physics Letters A, SIAM Journal on Scientific Computing, SIAM Journal on Applied Mathematics, Wave Motion.
- Organizer for workshop *Advances and Challenges in Computational General Relativity*, held May 20-22, 2011 at Brown University.
- Proposal reviewer on two NSF panels and NSERC of Canada.
- Service on numerous Departmental and UNM committees.

Postdoctoral and Ph.D. advisees:

- Adam Frederickson, current.
- Alex G. Benedict, current.
- David A. Bizzozero, UNM Ph.D. 2015 (joint with primary adviser J. A. Ellison).

Summary of research experience.

Computer solution of the Einstein equations or numerical relativity (NR) is a burgeoning field. A goal of NR is simulation of orbiting binaries, such as two blackholes or neutron stars, in order to compute the gravitational waves[1] necessary to analyze output from detectors like the USA-based Laser Interferometric Gravitational Wave Observatory. The challenge of solving the Einstein equations also drives modern research in numerical and applied analysis.

My first research interest was the concept of energy in classical general relativity (GR), in particular Brown and York's quasilocal energy (QLE). My Physics Ph.D. (under J. W. York) examined QLE in terms of Ashtekar variables, Hamiltonian variables which map the phase space of GR into the phase space of Yang-Mills. Subsequent work showed that known concepts of total gravitational energy (the asymptotic ADM, Bondi, and Abbott-Deser concepts) could be unified, and it refined the center-of-mass concept in GR. Much of this work was carried out with collaborators, especially D. Baskaran, J. D. Brown, A. N. Petrov, and J. W. York.

Generalizing the work [SIAM J. Numer. Anal. 37 (2000) 1138] of Alpert, Greengard, and Hagstrom for the ordinary wave equation, my Mathematics Ph.D. (under M. L. Minion, now at the Computational Research Division at Berkeley Lab) developed radiation boundary conditions (RBC) for blackhole perturbations. To my knowledge, these RBC were the first to capture the backscatter of waves propagating in the presence of a long-range potential.

As an applied mathematician, I have collaborated with physicists who perform simulations of binary blackholes. This work began during a 2006-2009 postdoctoral position in the Division of Applied Mathematics at Brown University, with my postdoctoral mentor J. S. Hesthaven (now at EPFL Lausanne). This work involved the application of implicit-explicit methods (about which I had earlier learned much from my advisor M. L. Minion) to GR.

Through contacts with T. Hagstrom, J. S. Hesthaven, E. A. Coutsias, and my UNM colleague D. Appelö, I have become increasingly interested in high-order and spectral methods for wave problems. I also work with the theoretical physicist R. H. Price on sparse spectral methods for modeling binary neutron stars. A collaboration with UNM colleagues (Prof. James A. Ellison, Dr. Klaus A. Heinemann, former graduate student David A. Bizzozero) considers RBC for beam physics models. Overall, my research goal is *efficient computation*.

[1] Similar to water ripples in a pond, these are ripples in spacetime which can travel great distances across space.

LI LI
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- **University of South Carolina (Completed May 2014)**-Columbia,SC
  Ph.D in Statistics
- **Wuhan University (Completed June 2009)**-Wuhan,P.R.China
  B.S. in Statistics

Appointments

- Assistant Professor, Department of Mathematics and Statistics, **University of New Mexico** (August 2014-).
- Associate member, Biostatistics shared resources, Comprehensive cancer center, **University of New Mexico** (August 2016-).
- Graduate assistant, Department of Statistics, **University of South Carolina** (August 2009-May 2014).
- Statistical consultant, Department of Statistics, **University of South Carolina** (August 2012-May 2013).

Distinction and Awards

- Deans' dissertation fellowship, University of South Carolina, 2013.

Most relevant publications

- Li L., Hanson, T., Damien, P., and Popova, E. (2014). A Bayesian nonparametric test for minimal repair. *Technometrics, 56,393–406.*
- Li, L. and Hanson, T. (2014). A Bayesian semiparametric regression model for reliability data using effective age. *Computational Statistics and Data Analysis, 73, 177–188.*
- Li, L., Hanson, T. and Zhang, J. (2015). Spatial extended hazard model with application to Prostate Cancer Survival. *Biometrics,71,313–322.*
- Li, L. and Lee, J. (2016). Latent promotion time cure rate model using dependent tailfree mixtures. *Journal of the Royal Statistical Society: Series A.* (*DOI: 10.1111/rssa.12226*).
- Li, L., Jara, A., Garcia-Zattera, M., and Hanson, T. Marginal Bayesian semiparametric modeling of mis-measured multivariate interval-censored data (*Under revision*).

Research grants or Contracts.

- National Institute of Health. Division: National Institute of Environmental Health Sciences. Title of the proposal: UNM Metal Exposure Toxicity Assessment on Tribal Lands in the Southwest (METALS) Superfund Research Program. Role: **Co-I**. Proposal number: 1P42ES025589. Status: under review (2016).

Main synergistic/service activities

- Refereeing for journals: Bayesian Analysis, The American Statistician, Operations Research Perspectives, Journal of Applied Statistics, Technometrics.

- Jocelyn Noelle Gonzales, working on a master thesis in math education, co-advisor. Major advisor: Michael Nakamaye. Role: Co-advisor.
- Alvaro Emilio Ulloa, May 2016, (thesis title) "Synthetic Structural Magnetic Resonance Image Generator Improves Deep Learning Prediction Of Schizophrenia". Major advisor: Erik, Erhardt. Role: MS thesis committee.
- Mina Lee. May 2016, (thesis title) "Application of model selection techniques and measures of agreement to advertising data". Major advisor: James, Degnan. Role: MS thesis committee.
- Yingzhe Cheng. Fall 2016, (thesis title) "What Affects parents? choices of milk? an application of Bayesian model averaging". Major advisor: Gabriel Huerta. Role: MS thesis committee.

Summary of research experience

In broad terms, my current research interests center around lifetime data modeling using Bayesian nonparametric methods, spatial and longitudinal statistics, and machine learning. My overall vision for current research is through learning and practice so that I may contribute applicable methodologies to the frontier literature of statistics. Below I present more specific details regarding my visions and achievements in those fields.

Lifetime data modeling is a category of research dealing with time-to-event data, encompassing but not limited to, data from population-based cancer observational studies, clinical trials on drugs or treatments, cohort intervention studies, and other health-outcome related observations. Lifetime data typically records the lengths of times among events of interest. Very often subjects are monitored over multiple time points and/or their location information and hence a longitudinal and/or spatial dimension is added to the data correlation structure. A significant amount of scientific questions evolve around understanding the association or causal effects of risk factors on the distributions of time-to-events. The risk factors are numerical quantities that describe treatments or in general intervention codes, demographical information, geographical records, and behavioral information. Besides inferential tasks on the risk factors' effects, statistical studies also typically extend to diagnostics on model assumptions and predictions for unknown responses of interest. My vision for lifetime data modeling is: (1) to make inference on the risk factors' effects for data that has complex correlation structures through building innovative statistical models; (2) to develop and apply Bayesian nonparametric methods and spatial statistics techniques to accommodate complex data structures. My achievements in these categories include: (a) a novel regression model for maintenance histories of repairable systems to assess the effectiveness of different repairing strategies; (b) a Bayesian nonparametric test for an often assumed model assumption in modeling recurrent events; (c) a spatial survival model for a real cancer registration data to provide population-averaged evaluations of risk factors' effects; for example, ethnicity, on the distribution of time-to-death for cancer patients; (d) a latent cure rate model for lifetime data which has a fraction of long-term survivors, to provide flexible interpretations of covariates' effects; for example, radiation on the cure rate; (e) multivariate survival model for interval-censored time-to-event data which are subject to misevaluation, to provide marginal interpretations of covariates' effects; for example brushing habit, on tooth caries development.

For (a), the work on the regression model was published in refereed journal *Computational Statistics and Data Analysis*; for (b), the work on the test was published in refereed journal *Technometrics*, for (c) the work was published in refereed journal *Biometrics*; for (d) the work will appear in refereed journal *Journal of Royal Statistical Society, Series A*; for (e) the work is currently under review. Research projects in progress include a Bayesian multilevel transition event modeling for smoking cessation study and a dynamic survival model for recurrent events. Both projects are intended for publications in refereed journals.

Jens Lorenz
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Habilitation in Mathematics, University of Konstanz, Germany, 1980.
- Ph.D., University of Münster, Germany, 1975.

Appointments

- 2016-present: Chair, Dept. of Mathematics and Statistics, UNM.
- 1994-present: Professor, Dept. of Mathematics and Statistics, UNM.
- 1990-1994: Associate Professor, Dept. of Mathematics and Statistics, UNM.
- 1994-1995: Professor, Lehrstuhl für Numerische Mathematik, RWTH Aachen, Germany.
- 1985-1990: Assistant Professor, Applied Mathematics, Caltech.
- 1983-1985: von Karman Instructor, Applied Mathematics, Caltech.

Distinction and Awards

- prize for Ph.D. thesis, summa cum laude, University of Münster, Germany, 1975.

Most relevant publications (ten)

- Lorenz, J.: *Deterministic and Random Evolution*, Nova Publishers, New York, 2013.
- Guba, O., Lorenz, J., and D. Sulsky: On Well–Posedness of the Viscous–Plastic Sea–Ice Model, *J. of Physical Oceanography*, Vol. 43 (10), pp. 2194–2209 (2013).
- Guba, O., Lorenz, J.: Continuous Spectra and Numerical Eigenvalues. *Math. Comp. Modelling*, **54**, (2011), pp. 2616-2622.
- Beyn, W.–J., Lorenz, J.: Nonlinear stability of rotating patterns. *Dynamics of Partial Differential Equations*, **5**, No. 4, (2008), pp. 349-400.
- Kreiss, G., Kreiss, H.–O., and Lorenz, J.: Stability of viscous shocks on finite intervals. *Archive for Rat. Mechanics and Analysis*, **187**, (2008), pp. 157-183.
- Nadiga, B., Taylor, M., and Lorenz, J.: Ocean modelling for climate studies: Eliminating short time–scales in long–term, high–resolution studies of ocean circulation. *Math. Comp. Modelling*, **44**, (2006), pp. 870-886.
- Beyn, W.–J., Lorenz, J.: Stability of viscous profiles: Proofs via dichotomies. Journal of Dynamics and Differential Equations **18**, No. 1, pp. 141-195, 2006.
- Kreiss, H.–O., Lorenz, J.: A priori estimates in terms of the maximum norm for the solutions of the Navier–Stokes equations. *J. Diff. Equations*, Vol. **203** (2004), pp. 216-231.
- Kreiss, H.-O., Lorenz, J.: Initial-boundary value problems and the Navier-Stokes equations. Classics in Applied Mathematics **47**, SIAM, 2004.

Research grants or Contracts.

- NSF, *Improving Success for Mathematics Students in the Southwest Seeking Advanced Degrees*, Co–PI, 2012–2016.
- NSF, *Improving Success for Mathematics Students in the Southwest Seeking Advanced Degrees*, Co–PI, 2008–2011.

- DOE, *Applied Dynamical Systems: Asymptotic and Numerical Studies*, PI, 1995–2003.
- NSF, *Mathematical Sciences: Computation and Analysis of Invariant Manifolds and Their Bifurcations*, PI, 1996–1999.

Main synergistic/service activities

On the Editorial Board of the Following Journals:

- International Journal of Analysis, 2012 – 2015
- International Journal of Advanced Operations Management (IJAOM), 2008 – present
- International Journal of Business Performance and Supply Chain Modelling, 2008 – present
- Boletim da Sociedade Paranaense de Matemática, 2004 – present
- Mathematical and Computer Modelling, 1992–2013

Postdoctoral and Ph.D. advisees:

- Anne Morlet, Caltech, (PhD 1990)
- Richard Ammons, Caltech, (PhD 1992)
- Capt. Michael Stoecker, UNM, (PhD 1992)
- Peter Kindilien, UNM, (PhD 1995)
- Wangguo Qin, UNM, (PhD 2000)
- Pablo Braz e Silva, UNM, (PhD 2003)
- Manuela L. De Castro, UNM, (PhD 2005)
- Oksana Guba, UNM, (PhD 2008)
- Pavlo Cherepanov, UNM, (PhD 2009)
- Yan (Cindy) Qiu, UNM, (PhD 2010)
- Michael Payne, UNM, (PhD 2013)
- Jason Terry, UNM, (PhD 2013)
- Sahitya Konda, UNM, (PhD 2015)
- Santosh Pathak, current PhD student
- Wilberclay Melo, postdoc, (2015)

Summary of research experience

A part of my research deals with designing and analyzing numerical methods to solve partial differential equations. The paper *Ocean modelling for climate studies: Eliminating short time–scales in long–term, high–resolution studies of ocean circulation*, Math. Comp. Modelling (2006), co–authored by M. Taylor (Sandia) and B. Nadiga (LANL) is an example.

Another part of my research is analysis of differential equations that appear in applications. Together with H.-O. Kreiss I wrote a monograph *Initial-boundary value problems and the Navier-Stokes equations*, Academic Press (1989). The text was republished in the SIAM series *Classics in Applied Mathematics* (2004).

In the field of analysis, I have mostly worked on problems related to fluid dynamics. I found it interesting to study the limit from compressible to incompressible fluid models, which involves the interaction of different time scales. Related work lead to the paper *On Well–Posedness of the Viscous–Plastic Sea–Ice Model*, J. of Physical Oceanography (2013), co–authored by my former PhD student O. Guba (Sandia) and my colleague D. Sulsky (UNM).

Terry A. Loring
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- **Wesleyan University**, Middletown, Connecticut, Mathematics, B.A., 1981.
- **University of California**, Berkeley, Mathematics, Ph.D., 1986.

Appointments

- **Mathematical Sciences Research Institute**, Research Fellow, Berkeley, California, 1986 to 1987.
- **Swansea University**, Research Fellow, U.K. 1987.
- **Dalhousie University**, Killam Postdoctoral Fellow, Halifax, Canada, 1988 to 1990.
- **National Science Foundation**, Postdoctoral Fellow, University of New Mexico, Albuquerque, 1990 to 1993.
- **University of New Mexico**, Assistant/Associate Professor, Albuquerque, 1990 to 1999. Full Professor, since 1999.

Distinction and Awards

- Nominated for UNM Teacher of the Year, 1997.

Most relevant publications

- Marius Dadarlat and Terry A. Loring. The K-theory of abelian subalgebras of AF algebras. *J. Reine Angew. Math.*, 432:39–55, 1992.
- C^*-algebras via ordered, mod-p K-theory. *Math. Ann.*, 305(4):601–616, 1996.
- Marius Dadarlat and Terry A. Loring. A universal multicoefficient theorem for the Kasparov groups. *Duke Math. J.*, 84(2):355–377, 1996.
- Søren Eilers, Terry A. Loring, and Gert K. Pedersen. Stability of anticommutation relations: an application of noncommutative CW complexes. *J. Reine Angew. Math.*, 499:101–143, 1998.
- Søren Eilers, Terry A. Loring, and Gert K. Pedersen. Morphisms of extensions of C^*-algebras: pushing forward the Busby invariant. *Adv. Math.*, 147(1):74–109, 1999.
- Terry A. Loring and Matthew B. Hastings. Disordered topological insulators via C^*-algebras. *Europhys. Lett. EPL*, 92:67004, 2010.
- Terry A. Loring and Tatiana Shulman. Noncommutative semialgebraic sets and associated lifting problems. *Trans. Amer. Math. Soc.*, 364:721–744, 2012.
- Terry A. Loring and Adam P. W. Sørensen. Almost Commuting Orthogonal Matrices. *J. Math. Anal. Appl.* 420(2):1051–1068, 2014.
- Terry A. Loring. K-theory and pseudospectra for topological insulators. *Ann. Physics*, 356:383-416, 2015.
- Ion Cosma Fulga, Dmitry I. Pikulin and Terry A. Loring. Aperiodic Weak Topological Superconductors. *Phys. Rev. Lett.*, 116(25):257002, 2016.

Research grants or Contracts.

- "U.S.-Brazil Cooperative Research: Operator Algebras," co-P.I. with Ruy Exel, **National Science Foundation**, 7/91–2/94, $8,342.
- "Lifting and Perturbation Problems in C^*-Algebras," co-P.I. with Gert K. Pedersen, **NATO-International Scientific Exchange Programs**, 3/92–2/93, $7,000.
- "Operator Algebras," co-P.I. with Frank Gilfeather, **National Science Foundation**, 1/93–6/96, $107,391.
- "Minority Engineering, Mathematics, and Science Program," Co-P.I. with Ricardo Maestas, **Department of the Army**, 1995-6, $780,000.
- "Stable Relations and Their Loci in Operator Variables," **National Science Foundation**, 4/96–5/99, $89,900 and 8/99–6/02, $67,682.
- "The New Mexico Bioscience Center for Informatics," co-P.I. with Terry Yates et al., **DARPA**, 2/02–12/03, $1,430,000.
- "West Coast Operator Algebra Seminar," **National Science Foundation**, 2011-2012, $25,550.
- "Structured Operator Algebras for Physics," collaborative research grant, **Simons Foundation**, 2011-2016, $35,000.
- "Operator algebras and topological insulators," collaborative research grant, **Simons Foundation**, 2016-2021, $35,000.

Main synergistic/service activities

- **Member** of the Centennial Fellowships Selection Committee of the American Mathematical Society, 1995.
- **Chair** of the scientific committee for a 1996 Joint Summer Research Conference, "Classification Problems in C^*-algebras and Dynamical Systems," Mount Holyoke College, South Hadley, Massachusetts.
- **Mentor** in Ronald E. McNair Scholars Program, Fall 2003 − Spring 2004.
- **Member** faculty senate Computer Use Committee, Fall 2003 − Spring 2004.
- **Faculty Senator** from Arts and Science, 2001 − Spring 2005.
- **Member of funding jury** for the French National Research Agency (ANR), 2010–2011 and 2015.
- **Department Chair**, 2011–2016.
- **Editorial board member** of the *Annals of Functional Analysis*, 2011-2014.
- **Organizer** of the West Coast Operator Algebra Seminar, October 1-2, 2011, University of New Mexico.
- **Scientific committee** of the West Coast Operator Algebra Seminar, October 26-27, 2013, University of California at Davis.

Postdoctoral and Ph.D. advisees:

- Martha Monteiro, Ph.D., completed September 2000.
- Fredy Vides, Ph.D., completed May 2016.
- Robert Niemeyer, postdoctoral fellow in the Mentoring through Critical Transition Points (MCTP) program, 2012–2015.

Summary of research experience

I study matrix models of more complex mathematical objects, as well as matrix models of systems in condensed matter physics. It is important to understand the stability of these models. What is surprising is that the rather imposing sounding mathematical subject called K-theory is instrumental in determining the stability.

Matrix models in String theory are often associated with geometric spaces. Recently, some physicists found it advantagous to produce the matrix model first and use a Dirac-type operator to see what manifold emerges. These physicists have rediscovered the Clifford spectrum of operator theory, and found a new use for it. I used almost the same technique to see what topological space emerges from an insulator, and how the complement of that space can be identified by real K-theory (Loring, Ann. Physics, 2015).

I have worked hard to take results in the K-theory of C^*-algebras and produce easy to compute invariants of matrix models. These invariants tend to be easy to understand by researchers who don't know anything about C^*-algebras. Recently, two early-career physicists asked me to try to modify my invariants to work in the case of a weak topological superconductor. We were able to find such an invariant and apply it to a model of a potential system that is based on a quasicrystal (Fulga, Pikulin and Loring, Phys. Rev. Lett., 2016). Because the index formula is very simple, we were able to deduce quantitative results about the stability of the Marjorana modes on two of the four edges.

Much of my work is devoted to bringing forward the theory of K-theory for C^*-algebras. Dadarlat and I showed how mod-p K-theory for C^*-algebras needed to be studied in the context of an ordered group, and only by including that order could the classification of real rank zero C^*-algebras be done correctly (Dadarlat and Loring, Math. Ann. 1996). In the past few years, I have been working with Boersema to find simpler descriptions of all eight K-theory groups for real C^* algebras, and associated natural transformations. It is a work in progress, with Boersema and Schulz-Baldes, to use these natural transformations to show that the more standard indices available for infinite models of topological insulators and superconductors are equal to the more recently defined indices that work on finite models.

Pavel Lushnikov
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- M.S. Physics, Moscow Institute of Physics and Technology, June 1994 (cum laude with Honors)
- Ph.D. Theoretical Physics, Landau Institute for Theoretical Physics of the Russian Academy of Sciences, December 1997

Appointments

2012–Present	Professor, Department of Mathematics and Statistics, University of New Mexico
2006–Present	Associated Member, Landau Institute for Theoretical Physics
2004–Present	Visiting Scholar, Theoretical Division, Los Alamos National Laboratory
2006–2012	Associate Professor (tenured from 2009), Department of Mathematics and Statistics, University of New Mexico
2004–2006	Kenna Assistant Professor, Department of Mathematics, University of Notre Dame
2004–Spring	Visiting Assistant Professor, Department of Mathematics, University of Arizona
1999–2003	Postdoctoral Research Associate, Theoretical Division, Los Alamos National Laboratory
1998–1999	Visiting Researcher, Risø National Laboratory, Denmark
1998–2006	Research Staff, Landau Institute for Theoretical Physics

Distinction and Awards

2008	Doctor of Science Degree in Physical and Mathematical Sciences, highest scientific degree in Russia, awarded for major scientific achievements beyond PhD by the Landau Institute of Theoretical Physics, Moscow, Russia on June 27, 2008. Members of award committee: A.F. Andreev (Vice-president of Russian Academy of Sciences), I.M. Khalatnikov (Member of the Russian Academy of Sciences), I.M. Krichever (Columbia University), E.A. Kuznetsov, (Member of the Russian Academy of Sciences), S.P. Novikov (Distinguished Professor at University of Maryland, Fields medal, Lobachevsky Medal, and Wolf Prize in Mathematics), Ya.G. Sinai (Princeton University, Abel Prize, Boltzmann Medal, Dannie Heineman Prize for Mathematical Physics, Dirac Medal, the Wolf Prize in Mathematics, Nemmers Prize, and the Henri Poincaré Prize, Member of the Russian Academy of Sciences), V.E. Zakharov (Regent Professor of the University of Arizona, Member of the Russian Academy of Sciences, Dirac Medal).
1996-1999	The Landau Scholar, Awarded by KFA, Forschungzentrum, Juelich, Germany.

Most relevant publications

- P.M. Lushnikov. *Structure and location of branch points for Stokes wave on deep water*, Journal of Fluid Mechanics, **800**, 557-594 (2016).
- S.A. Dyachenko, P.M. Lushnikov, and A.O. Korotkevich. *Branch cuts of Stokes wave on deep water. Part I: Numerical solution and Padé approximation*, Studies in Applied Mathematics, DOI: 10.1111/sapm.12128 (2016).
- P.M. Lushnikov and N. Vladimirova. *Nonlinear combining of multiple laser beams in Kerr medium*, Optics Express **23**, 31120-31125 (2015).

- P.M. Lushnikov and N. Vladimirova, *Nonlinear combining of laser beams.* Optics Letters **39**, 3429-3432 (2014).
- S.A. Dyachenko, P.M. Lushnikov, and N. Vladimirova. *Logarithmic scaling of the collapse in the critical Keller-Segel equation*, Nonlinearity, **26**, 3011-3041 (2013).
- P.M. Lushnikov, S.A. Dyachenko and N. Vladimirova. *Beyond leading-order logarithmic scaling in the catastrophic self-focusing of a laser beam in Kerr media*, Physical Review A, **88**, 013845 (2013).
- S.I. Dejak, P.M. Lushnikov, Y.N. Ovchinnikov, and I.M. Sigal. *On Spectra of Linearized Operators for Keller-Segel Models of Chemotaxis*, Physica D **241**, 1245-1254 (2012).
- P.M. Lushnikov. *Collapse and stable self-trapping for Bose-Einstein condensates with* $1/r^b$ *type attractive interatomic interaction potential.* Physical Review A, **82**, 023615 (2010).
- M. Alber, N. Chen, P.M. Lushnikov, and S.A. Newman. *Continuous macroscopic limit of a discrete stochastic model for interaction of living cells.* Physical Review Letters, **99**, 168102 (2007).
- P.M. Lushnikov and H.A. Rose. *Instability versus equilibrium propagation of laser beam in plasma.* Physical Review Letters, **92**, 255003 (2004).

Research grants or Contracts.

2014-2017 NSF DMS-1412140, Spontaneous formation of singularities through critical collapse. $240,000. Single PI.
2010-2014 NSF/DOE Grant 1004118, Collaborative Research: Vlasov Multi-Dimensional Simulation of Langmuir Wave Collapse and Stimulated Raman Scatter in the Fluid-Kinetic Transition Regime. $270,000. PI, lead institution.
2009-2012 NSF/DOE Grant 6834403, Instability and Transport of Laser Beam in Plasma. $67,148. Co-PI, Subcontract from the New Mexico Consortium.
2008-2011 NSF DMS-0807131, Collaborative Research: Strong Turbulence from Singular Collapses in Nonlinear Schrödinger Type of Equations. $108,385. PI, lead institution.
2007-2011 NSF DMS-0719895: Multiscale stochastic model of myxobacteria dynamic. $199,999. Co-PI.

Main synergistic/service activities

2014-2016 Chair of Scheduling Committee
2008-2015 Member of hiring committees
2008-2014 Chair of colloquium committees
2011-2012, 2014-2015 Member of executive committees
2011-2013 Member of university Research Allocation committee,

Postdoctoral and Ph.D. advisees:

- Sergey Dyachenko, 2008-2014, Received PhD from UNM in August 2014. Now ICERM postdoc, Department of mathematics, Brown University
- Denis Silantiev, PhD student Expected date of degree 2017
- Anastassiya Semenova, PhD student Expected date of degree 2019
- Postdoctoral sponsor of Alexey Balakin at UNM (now Senior Researcher at I. of Applied Physics, Russian Academy of Sciences, Russia)
- Postdoctoral sponsor of N. Vladimirova at UNM

Summary of research experience

My research interests include a wide range of topics in applied mathematics, nonlinear waves and theoretical physics. Among them are laser fusion and laser-plasma interaction; dynamics of fluids with free surface and nonlinear interactions of surface waves; theory of the wave collapse, singularity formation and its application to plasma physics, hydrodynamics, biology and nonlinear optics; bacterial aggregation, chemotaxis, cell-cell interactions and collapse of bacterial colonies, stochastic Potts model of a biological cell; pattern formation in photorefractive crystals and other nonlinear optical media; high-bit-rate optical communication; dispersion-managed optical fiber systems; soliton propagation in optical systems; high performance parallel simulations of optical fiber systems; Bose-Einstein condensation of ultracold dipolar gases. The outlined various phenomena have, however, a number of common fundamental aspects. One of them is an explosive instability, which may occur if the system nonlinearity does not saturate an exponential growth of small perturbations corresponding to linear instabilities, but, on the contrary, results in singularity formation in a finite time. Near the singularity point there is usually a qualitative change in the underlying nonlinear phenomena: reduced models loose their applicability and new mechanisms become important such as inelastic many-body collisions which can cause a loss of atoms from the Bose-Einstein condensate; breakdown of slow envelope approximation in nonlinear optical media; wave breaking and foam formation on crest of sea waves; spontaneous breaking of rotational symmetry and formation of a coherent hexagonal pattern in photorefractive crystals; formation of spores and multicellular fruiting body from aggregated bacterial colonies.

Yan Lu
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. Mathematics, May 2007, Arizona State University, Tempe, AZ, Major: Statistics. Thesis Title: Longitudinal Estimation in Dual Frame Surveys. Advisor: Sharon Lohr.
- Sc. M. Mathematics, June 2002, East China Normal University, Shanghai, China, Major: Differential Geometry. Thesis Title: Minimal Sub-manifold in Non Compactly Supported Riemann Surface. Advisor: Chunli Shen.
- B.S. Mathematics, June 1996, Shandong Normal University, Jinan, China, Major: Math Education.

Appointments

- Associate Professor, August 2013 - Present, Department of Mathematics and Statistics, University of New Mexico.
- Assistant Professor, August 2007 - May 2013, Department of Mathematics and Statistics, University of New Mexico.

Distinction and Awards

- "Summer at Census" program award, \$5000, Summer 2013.
- Outstanding Graduate Instructor, Fall 2010-Spring 2011, Department of Mathematics and Statistics, UNM.

Most relevant publications

- Yan Lu, Regression Coefficient Estimation in Dual Frame Surveys, *Communications in Statistics - Simulation and Computation*, Volume 43, No. 7, pages 1675-1684, 2014.
- Yan Lu, Difference Based Variance Estimator for Nonparametric Regression in Complex Survey, *Journal of Statistical Computation and Simulation,* 84, pages 335-343, 2014.
- Yan Lu, Chi-Squared Tests in Dual Frame Surveys, *Survey Methodology*, Vol. 40, No. 2, pages 323-334, 2014.
- Yan Lu and Naisheng Wang, Method of Conditional Moments based on Incomplete Data, *International Journal of Mathematics and Computation*, Volume 20, pages 40-51, 2013.
- Naisheng Wang and Yan Lu, Adapted Autoregressive Model and Volatility Model with Application, *Data Science*, 11, pages 655-671, 2013.
- Yan Lu, Standard Error of the Method of Simulated Moment Estimator for Generalized Linear Mixed Models, *Communications in Statistics - Simulation and Computation,* Volume 42, pages 1-7, 2012.
- Guoyi Zhang and Yan Lu, Bias Corrected Random Forests in Regression, *Journal of Applied Statistics*, Volume 39, pages 151-160, 2012.
- Yan Lu and Guoyi Zhang, The Equivalence Between Likelihood Ratio Test and F Test for The One Way Random Effects Model, *Journal of Statistical Computation and Simulation*, Volume 80, pages 443 - 450, 2010.

- Yan Lu and Sharon Lohr, Gross Flow Estimation in Dual Frame Surveys, *Survey Methodology*, Volume 36, pages 13-22, 2010.
- Guoyi Zhang and Yan Lu, Adjusted Confidence Bands in Nonparametric Regression, *Communications in Statistics - Simulation and Computation,* Volume 37, pages 106 - 113, 2008.

Research grants or Contracts.

- "Estimation of Contract Support Cost Damages for Salazar v. Ramah Navajo Chapter", research grant from M. P. Gross Law Firm, 02/01/2013-01/31/2015, $15,308.

Main synergistic/service activities

- Referee for
  NSF, SES - Methodology, Measurement, and Statistics
  Survey Methodology
  American Statistician
  Annals of Applied Statistics
  Communications in Statistics – Simulation and Computation
  Communications in Statistics-Theory and Methods
  Journal of Applied Statistics
  Journal of Official Statisitcs
  Journal of Statistical Computation and Simulation
  Scientific Reports
  Field Methods
  Journal of Survey Statistics and Methodology
  R-Journal
  Journal of Data Science
- Committee services:
  Webpage Committee, Fall 2016-Present.
  Graduate Committee, Fall 2016-Present.
  Colloquium Committee, Fall 2013-Spring 2016.
  Computer Committee, 2014-Spring 2016.
  Statistics Hiring Committee, 2012, 2013, 2014, 2016
  Executive Committee, Spring 2012-Spring 2013.
  Committee of Qualifying Examination, 2007-present.
  Committee of Comprehensive Examination, 2007-present.
  Undergraduate Committee, 2016.
- Advised many graduate and undergraduate students

Postdoctoral and Ph.D. advisees:

- Lang Zhou, May 2016
  Co-advised with Dr. Guoyi Zhang
  Dissertation Title: A Neyman Smooth Type Goodness of Fit test with Survey data.

Summary of research experience

My primary research interests are in survey sampling. I am also interested in mixed models and nonparametric regression. Much of my work develops new statistical theory and methods in those three areas. My primary field of application is dual frame surveys, in which independent samples are taken from the two overlapping sampling frames to obtain better coverage of the population and to decrease the survey cost. For example, random digit dialing is a popular sampling method. However, the number of Americans who rely solely or mostly on a cell phone has been growing for several years, posing an increasing likelihood that public opinion polls conducted only by landline telephone will be biased. Some agencies now employ a dual frame structure for public polls, in which landline frame and cellphone frame together cover the population of interest. My goal is to develop new statistical methods to solve the problems encountered in dual frame surveys. These developments are new since no such methods available in literature yet. My research in dual frame survey area includes gross flow estimation, Chi-squared tests, regression coefficient estimation, partially linear models and diagnostics. I am currently working with gross flow estimation using stochastic model in dual frame surveys.

Mixed models have also been on the top of my research interests. Most surveys incorporate multi-level clustering and stratification of the population. Mixed models can be used to analyze such data. My investigation into this area considers tests in one-way random effects model, standard error estimation for generalized linear mixed models and mixed random forests for complex surveys. I am also interested in nonparametric regression especially as it relates to complex surveys. Part of my research in nonparametric regression extended the difference based variance estimator from simple random sampling to complex designs, Neyman Smooth Type Goodness of Fit test with Survey data. I also have interest in exploring the properties of the pseudo-residuals as a potential tool for the detection of heteroskedasticity for nonparametric regression in complex surveys.

Mohammad Motamed
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- 2008, PhD in Numerical Analysis, Royal Institute of Technology, Stockholm, Sweden
- 2003, MSc in Scientific Computing, Royal Institute of Technology, Stockholm, Sweden
- 2000, MSc in Structural Engineering, Amirkabir University of Technology, Tehran, Iran
- 1998, BSc in Civil Engineering, Persian Gulf University, Bushehr, Iran

Appointments

- 2013-present, Assistant Professor, Department of Mathematics and Statistics, The University of New Mexico, Albuquerque, USA
- 2010-2013, Visiting researcher, The Institute for Computational Engineering and Sciences, The University of Texas at Austin, USA
- 2009-2013, Postdoctoral fellow, Division of Computer, Electrical and Mathematical Sciences & Engineering, King Abdullah University of Science and Technology, Saudi Arabia
- 2008-2009, Postdoctoral fellow, Mathematics Department, Simon Fraser University, Canada

Most relevant publications

- G. Malenova and M. Motamed and O. Runborg and R. Tempone. A Sparse Stochastic Collocation Technique for High Frequency Wave Propagation with Uncertainty. *SIAM J. Uncertainty Quantification* 4, pp. 1084-1110, 2016.
- I. Babuška and M. Motamed. A Fuzzy-Stochastic Multiscale Model for Fiber Composites: A One-Dimensional Study. *Computer Methods in Applied Mechanics and Engineering* 302, pp. 109-130, 2016.
- M. Motamed and F. Nobile and R. Tempone. Analysis and Computation of the Elastic Wave Equation with Random Data.*Computers and Mathematics with Applications* 70, pp. 2454-2473, 2015.
- Q. Long and M. Motamed and R. Tempone. Fast Bayesian Optimal Experimental Design for Seismic Source Inversion. *Computer Methods in Applied Mechanics and Engineering* 291, pp. 123-145, 2015.
- M. Motamed and O. Runborg. A Wavefront-Based Gaussian Beam Method for Computing High Frequency Waves. *Computers and Mathematics with Applications* 69, pp. 949-963, 2015.
- I. Babuška and M. Motamed and R. Tempone. A stochastic multiscale method for the elastodynamic wave equations arising from fiber composites. *Computer Methods in Applied Mechanics and Engineering* 276, pp. 190-211, 2014.
- M. Motamed and F. Nobile and R. Tempone. A Stochastic Collocation Method for the Second Order Wave Equation with a Discontinuous Random Speed. *Numerische Mathematik* 123, pp. 493-536, 2013.

- M. Motamed and C. B. Macdonald and S. J. Ruuth. On the Linear Stability of the Fifth-Order WENO Discretization. *Journal of Scientific Computing* 47, pp. 127-149, 2011.
- M. Motamed and O. Runborg. Taylor Expansion and Discretization Errors in Gaussian Beam Superposition. *Wave Motion* 47, pp. 421-439, 2010.
- M. Motamed and O. Runborg. A Multiple-Patch Phase Space Method for Computing Trajectories on Manifolds with Applications to Wave Propagation Problems. *Communications in Mathematical Sciences* 5, pp. 617-648, 2007.

Research grants or Contracts.

- *J. T. Oden Faculty Fellowship* for "Uncertainty Quantification" at the Institute for Computational Engineering and Sciences, University of Texas at Austin, 2015, award: $**5,000**.
- *Lars Hiertas Foundation Grant* for Highly Oscillatory Problems at Isaac Newton Institute for Mathematical Sciences, Cambridge University, UK, February 2007, grant: $**6,000**.
- *Albert Einstein Institute Research Grant* for Second Order Hyperbolic Systems in Numerical Relativity, Germany, January 2006, grant: $**3,500**.
- *IPAM scholarship, University of California, Los Angeles* for Bridging Time and Length Scales in Materials Science and Bio-Physics at IPAM, Fall 2005, scholarship: $**4,000**.
- *NordForsk Foundation Grant* for Adaptive Methods for Partial Differential Equations at 4th Winter School in Computational Mathematics, Norway, March 2004, grant: $**2,000**.

Main synergistic/service activities

- Serving as the department website administrator on Computer Use and Website Committee, Fall 2015-present.
- Serving on the department Graduate Committee, Fall 2016-present.
- Developing curriculum for a new graduate course on uncertainty quantification, offered to both UNM students and via Interactive Television technology to researchers at the Sandia National Laboratory, Fall 2014 and Fall 2016.
- Serving as referee for internationally recognized peer review journals, 2008-present:
  - SIAM Journal on Numerical Analysis
  - SIAM Journal on Scientific Computing
  - Communications in Computational Physics
  - Communications in Mathematical Sciences
  - International Journal for Numerical Methods in Engineering
  - Computers and Mathematics with Applications
- Co-roganizing international conferences and workshops:
  - Two mini-symposia on Computational Uncertainty Quantification for Hyperbolic Problems at SIAM Conference in Uncertainty Quantification, April 2016, Lau- sanne, Switzerland.
  - A five-day workshop on Computational Uncertainty Quantification at Banff International Research Station for Mathematical Innovation and Discovery, Canada, to be held in 2017.

Summary of research experience

My general research interest in the field of computational mathematics is the analysis and computation of partial differential equations (PDEs), which are mathematical models that describe physical phenomena arising in many science and engineering fields such as geosciences, climate engineering, materials science, electromagnetics, and biology. My research concerns both deterministic PDEs and non-deterministic PDEs subject to uncertainty. In the latter case, high levels of confidence in predictions require a thorough understanding of the uncertainties in the PDE models. This understanding can be obtained by a process called uncertainty quantification (UQ). UQ is a newly emerged field which is closely intertwined with computational mathematics and aims at developing theory and methods to quantitatively describe the origin, propagation, and interplay of different sources of uncertainty in complex systems. Currently, I have mainly focused my research on the computational uncertainty quantification of PDE models subject to both precise (stochastic models) and imprecise (fuzzy-stochastic models) uncertainties.

Michael Nakamaye
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

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- Gonzaga University, B.S. in mathematics and B.A. in French, 1990.
- Yale University Department of Mathematics, Ph.D. in Mathematics, 1994.

Appointments

- University of New Mexico Mathematics and Statistics Department, Fall 1999 – present
- Harvard University Mathematics Department, Fall 1994 – Spring 1999.

Distinction and Awards

- Teacher of the Year, Harvard University, 1999
- Teacher of the Year, University of New Mexico, 2003
- Presidential Teaching Fellow, University of New Mexico. 2006–2008.

Most relevant publications

- *Multiplicity estimates and the product theorem*, Bull. Soc. Math. France, **123**, 1995, pp. 155–188.
- *Dyson's Lemma and a Theorem of Esnault and Viehweg*, Inventiones mathematicae, **121**, 1995, pp. 355-377.
- *Seshadri constants on abelian varieties*, American Journal of Math, Vol **118**, Number 3, 1996, pp. 621–635. *Intersection theory and diophantine approximation*, Journal of Algebraic Geometry, **8**, 1999, pp. 135–146.
- *Stable base loci of linear series*, Math. Ann., **318**, 2000, pp. 837–847.
- *Base loci of linear series are numerically determined*, Transactions of the AMS, **355** No. 2, 2003, pp. 551–566.
- *Seshadri constants at very general points*, Transactions of the AMS, **357**, 2005, pp. 3285–3297.
- with L. Ein, R. Lazarsfeld, M. Mustata, and M. Popa, *Asymptotic Invariants of Base Loci*,
- *Multiplicity Estimates on Commutative Algebraic Groups*, Crelle, **607**, 2007, pp. 217–235. .
- with L. Ein, R. Lazarsfeld, M. Mustata, and M. Popa, *Restricted volumes and base loci of linear series*, American Journal of Math, **131**, Number 3, 2009, pp. 607–652.

Research grants or Contracts

- *Base Loci of Linear Series and Diophantine Approximation*, Michael Nakamaye, National Science Foundation (Grant 00701990), June 2000–May 2002, $79,500.

Main synergistic/service activities

- Taught courses for undergraduate and beginning graduate students for 3 summers under an NSF funded grant, 2009–2011.

- Cotaught courses for local teachers and undergraduate students for 3 summers with an emphasis on K12 Mathematics, also supported by an NSF grant, 2013–2015.

Postdoctoral and Ph.D. advisees:

- Adam Ringler, Ph.D. received 2008.
- Martha Byrne, Ph.D. received 2014.

Summary of research experience

The common thread unifying my research is the relationship between positivity of line bundles and their base loci. This interest actually originated in a number theoretic context as my early work focused on the zero estimates of transcendence theory introduced by Masser and Wüstholz as well as the diophantine approach to the Mordell conjecture pioneered by Vojta. In both cases, a precise understanding of the base locus of certain line bundles is required. In particular, one starts with an ample line bundle A on a smooth projective variety X and then certain vanishing conditions are imposed on the linear series $|A|$. The goal is then to control the base locus of this system, ideally showing that it is not much bigger than what has been imposed. Dyson's lemma, for example, as developed by Bombieri, Viola, Esnault–Viehweg, and Vojta, gives a sharp bound on the base locus of certain linear series on products of smooth projective curves. My earliest work provided a unified and simplified treatment of these results, based upon intersection theory, vanishing theorems, and Faltings' product theorem.

I have continued to study base loci of linear series in a purely geometric setting. The simplest type of base loci, in some sense, are those obtained by imposing vanishing at a single point $x \in X$. In this context, Seshadri constants measure the moment at which the base locus grows beyond the point x. I have studied these Seshadri constants in many contexts, particularly on surfaces and on abelian varieties and it is striking to find that these locally defined invariants can occasionally yield global information about the variety X. For example, when X is a surface, fibrations of X over a curve can be detected via Seshadri constants. Similarly for an abelian variety, a fibration of relative dimension 1 over another abelian variety can be detected numerically in terms of Seshadri constants. In more recent work, I introduced the notion of a moving Seshadri constant which measures the local positivity of a non–ample line bundle: these numerical invariants govern the base loci of bundles on the interior of the effective cone. I have also recently studied the Seshadri constant of an ample line bundle at a very general point, slightly refining the lower bound obtained by Ein and Lazarsfeld a decade ago. Finally, joint work with Boyer and Galicki applies simple estimates on singularities of divisors together with vanishing theorems to construct Sasakian–Einstein metrics on odd dimensional differentiable manifolds.

My current research interests remain closely tied to understanding base loci of linear series. In particular, I would like to understand the asymptotic behavior of the base locus of a large multiple of a line bundle, with particular emphasis on the embedded components. Standard intersection theoretic arguments encountered in effective versions of the Nullstellensatz give some such bounds and I would like to study these closely. In this context, it would be very interesting to develop a local version of Faltings' product theorem: if the base ideal is highly non–reduced in specific directions then there should be a simple geometric explanation for this phenomenon. Other current projects include further refining estimates for Seshadri constants at general points as well as developing properties of other related numerical invariants attached to line bundles.

Monika Nitsche
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation (Educational background)

- 1987–1992, University of Michigan. August 1992, Ph.D. in Mathematics.
- 1983–1997, Colorado State University. December 1986, B.S. in Applied Mathematics.
- 1973–1983, Humboldt Schule, Caracas, Venezuela. May 1983, Abitur.

Principal Appointments

- 2012–present, University of New Mexico. Full Professor.
- 2005–2012, University of New Mexico. Associate Professor.
- Jan 1999–2005, University of New Mexico. Assistant Professor.
- 1997–Dec 1998, Tufts University. Assistant Professor.
- 1996–1997, Ohio State University. Visiting Assistant Professor.
- 1994–1996, University of Minnesota/Siemens. IMA Industrial Postdoc.
- 1992-1994, University of Colorado at Boulder. Instructor.

Concurrent Temporary of Visiting Appointments

- Aug-Dec 2012, Cambridge University. Visiting Mathematician.
- Aug-Dec 2009, University of Minnesota. Long Term Visitor.
- Feb 2006, University of California at Santa Barbara. Visiting Mathematician.
- Summer 1997, National Center for Atmospheric Research. Visiting Scientist.
- Summer 1993, University of East Anglia. Visiting Mathematician.

Distinction and Awards

- Fall 2015, Nominated to UNM Teacher of the Year Award.
- Summer 1996, Alexander-von-Humboldt Fellowship (declined for personal reasons)

Most relevant publications (up to ten)

- M. Nitsche and R. Krasny. A numerical study of vortex ring formation at the edge of a circular tube, *J. Fluid Mech.* **276**, 139–161 (1994). 138 citations
- M. Nitsche. Scaling properties of vortex ring formation at a circular tube opening, *Phys. Fluids* **8** (7), 1848–1855 (1996). 23 citations
- M. Nitsche. Axisymmetric vortex sheet motion: accurate evaluation of the principal value integral, *SIAM J. Sci. Comp.* **21** (3), 1066–1084 (1999). 17 citations
- M. Nitsche. Singularity formation in a cylindrical and a spherical vortex sheet, *J. Comp. Phys.* **173** (1), 208–230 (2001). 20 citations.
- R. Krasny and M. Nitsche. The onset of chaos in vortex sheet flow, *J. Fluid Mech.* **454**, 47–69 (2002). 43 citations
- M. Nitsche and P. H. Steen. Numerical simulations of inviscid capillary pinchoff, *J. Comp. Phys.* **200**, 299–324 (2004). 27 citations
- D. Holm, M. Nitsche and V. Putkaradze. Comparison of vortex blob and Euler alpha regularization of vortex sheet motion, *J. Fluid Mech.* **454**, 47–69 (2006). 23 citations
- M. Nitsche, H. D. Ceniceros, A. L. Karniala and S. Naderi. High order quadratures for the evaluation of interfacial velocities in axi-symmetric Stokes flows, *J. Comp. Phys.* **229 (18)**, 6318–6342 (2010). 5 citations
- M. Nitsche, P. D. Weidman, R. Grimshaw, M. Ghrist and B. Fornberg. Evolution of solitary waves in a two-pycnocline system, *J. Fluid Mech.* **642**, 235–277 (2010). 6 citations
- L. Xu and M. Nitsche. Scaling behaviour in impulsively started viscous flow past a finite flat plate, *J. Fluid Mech.* **756**, 689-715 (2014), doi:10.1017/jfm.2014.451.
- Y. Huang, M. Nitsche and E. Kanso. Hovering in oscillatory flows, *J. Fluid Mech.* **804**, 531–549 (2016).

Research grants or Contracts.

- **National Science Foundation**, MCTP (Mentoring Through Critical Transition Points), 2012–2015, $1,998,603. PI: Nitsche. Co-PIs: Lorenz, Nakamaye, Pereyra. Senior personnel: Appelo, Skripka, Sulsky, Umland, Vassilev, Vorobieff, Wearing, Zinchenko.

- **National Science Foundation**, MCTP, 2008–2011, $757,346. PI: Pereyra. Co-PIs: Lorenz, Nakamaye, Nitsche
- **National Science Foundation**, Subcontract Award for IMA visit, 2009, $30,000.
- **Various sources as listed**, support for SUnMaRC, 2009,2011: MAA ($2500), UNMs Vice President of Student Affairs ($1500), Dean of Arts & Science ($3400), UNM departments of Biology, Chem & Nuclear Eng, Earth & Planetary Sciences, Math & Stats, Mech Eng, Physics & Astronomy, Political Science, Spanish & Portuguese ($3100).
- **National Science Foundation**, DMS-0308061, 2005 - 2009, $163,329. PI: Nitsche
- **Sandia National Laboratories**, Sandia - University Research Grant (SURP), 2001–2002, $35,000, and 2000-2001, $31,500. PI: Nitsche
- **National Science Foundation**, DMS-9408697, 1994, 1996–2000, $65,000. PI: Nitsche
- **Science and Engineering Research Council** (SERC), 1993, visiting fellowship

Main synergistic/service activities

- Through the NSF-MCTP grant, I have supported many activities geared at attracting and motivating students into Mathematics, and helping those in the field succeed.
  - MCTP provided full support for 2 postdocs with a 1-1 teaching load. Rob Niemeyer was supervised by Terry Loring and is now a faculty member at University of Maine, Orono. Lane McConnell was supervised by me and is now a faculty member at CNM.
  - MCTP provided full support for 1-2 graduate students per year to run a Graduate Student Teacher Training Seminar, under my supervision. I am completing a Coursepack for the seminar aimed at continuing it in the future with more modest resources. The fall seminar, as well as associated spring semester student activities, helped build a stronger graduate student community.
  - MCTP provided full support for a total of 7 summer math camps that we organized from 2008-2015. A total of approximately 25 students from the SW, 10 teachers from NM middle and highschools and 3 UNM graduate students participated each year, with full support (stipend, travel, per diem)
  - MCTP supported a graduate student qualifying exam preparation seminar, run by Jens Lorenz from 2012-2015.
  - MCTP supported undergraduate research projects, contributing greatly to 38 completed undergraduate theses at UNM since 2008.
- Coordinator of Calculus sequence for engineers, Math 162-163-264. I work closely with our departments lecturers to continuously improve the course materials.
- Organizer of SUnMaRC (Southwest Undergraduate Mathematics Research Conference), 2007-present. I organized the conference at UNM twice (∼100 student participants each), and have taken 3-21 UNM students to the conference per year, when it is out of town.
- Undergraduate Chair, 2010-2014.
- Undergraduate Faculty Committee Member 2010-2014 (Committee Chair for one semester)
- Undergraduate student mentoring: I have supervised 5 undergraduate honors thesis and ran 3 semester-long seminars in addition to my regular teaching load for a total of 10 students.
- Organizing Committee Member, SIAM PDE Meeting, 2015.
- APS Nominating Committee Member, 2008-2010.
- Minisymposium Organizer, 1994(Los Alamos Days), 1995(ISCFD), 1998(SIAM), 2004(AMS), 2015(SIAM).

Postdoctoral and Ph.D. advisees:

- Shadi Naderi, PhD 2011.
- Ling Xu, PhD 2012.
- Lane McConnell, MCTP Postdoc 2013-2015
- Robert Niemeyer, MCTP Postdoc 2012-2014

Summary of research experience (no page limit) My research concerns the numerical simulation of fluid flows, with the goal of better understanding the flows and the partial differential equations used to model them using accurate and fast simulations. Some of the topics I have or am studying:

1. *Vortex formation and separation.* Using a simple efficient inviscid model, I have investigated several aspects of vortex ring motion formation at edges, including onset of chaos (with Robert Krasny), scaling behaviour, alternative regularizations (with Darryl Holm), conditions for pinchoff and applications to simulate hovering objects (with Eva Kanso and Yangyang Huang). Ling Xu and I studied viscous vortex formation and separation, and are currently using these results to evaluate the inviscid model. The inviscid vortex model is efficient but less accurate, the viscous computations are orders of magnitude more expensive. With Robert Krasny we are exploring efficient viscous vortex methods for flows past walls to combine efficiency and accuracy. The limiting behaviour of vortex sheet roll-up in the chaotic region also remains an open question that I am interested in addressing with scaling arguments and computations.

2. *Accurate evaluation of axisymmetric interface motion.* I have developed a technique to accurately compute the motion of axisymmetric interfaces and have applied it to study evolution of soapfilms (with Paul Steen), and of highly viscous drops and bubbles (with Hector Ceniceros). I am interested in applications such as the breakup of double emulsions used to deliver medicine. These applications require accurate evaluation of integrals near the interface (not on), which is an interesting current area of research.

3. *Evolution of disturbances on pycnoclines.* In yet another application, I have studied the propagation of disturbances on layers separating fluids of distinct density (with Patrick Weidman). The results give insight into the mathematical properties of the solutions of the modelling equations.

4. *Point vortex motion.* What started as a simple project with an undergraduate student is currently developing into an interesting study of the scattering of 2 point vortices by obstacles.

Matthew Pennybacker
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., August 2013, University of Arizona, Tucson, AZ, Applied Mathematics.
- M.S., May 2011, University of Arizona, Tucson, AZ, Applied Mathematics.
- B.S., May 2007, Rensselaer Polytechnic Institute, Troy, NY, Electrical Engineering.

Appointments

- August 2013 – Present, Assistant Professor, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM.

Distinction and Awards

- None.

Most relevant publications

- M. Pennybacker, P. D. Shipman, and A. C. Newell. *Phyllotaxis: Some Progress, but a Story Far From Over.* Physica D, 2015.
- A.C. Newell and M. Pennybacker. *Fibonacci Patterns: Common or Rare?* Procedia IUTAM, 2013.
- M. Pennybacker and A.C. Newell. *Phyllotaxis, Pushed Pattern-Forming Fronts, and Optimal Packing.* Physical Review Letters, 2013.
- P.D. Shipman, Zhiying Sun, M. Pennybacker, and A.C. Newell. *How Universal Are Fibonacci Patterns?* European Physical Journal D, 2011.
- E.A. Gibson, M. Pennybacker, A.I. Maimistov, I. Gabitov, and N.M. Litchinitser. *Resonant Absorption in Transition Metamaterials: Parametric Study.* Journal of Optics, 2011.

Research grants or Contracts.

- *Energy based Discontinuous Galerkin Methods with Tame CLF Numbers for Simulations of Metamaterials.* NSF DMS, Computational Mathematics, $418,074, Pending.

Main synergistic/service activities

- Member of the Computer Use Committee since August 2016.
- Member of the Colloquium Committee from August 2014 to August 2016.
- Helped prepare and grade ODE/PDE qualifying exam since August 2015.
- Advising six undergraduate applied mathematics majors.
- M.S. Thesis advisor for Renee Stevens-Sheriff and Bryan McCormick.
- Honors Thesis advisor for Montie Avery.

Postdoctoral and Ph.D. advisees:

- None.

Summary of research experience

Pattern formation is one of the most common phenomena observed in nature. The resulting almost-periodic patterns appear as cloud formations, as epidermal ridges on fingerprints, and in many ways on plants: in the arrangements of leaves or branches on the stem, in the venation of leaves, and particularly in flowers with their patterns of shapes and colors. They generally arise as instabilities when a system is driven far from equilibrium by some external stress. At a critical value of that stress, the uniform state can become unstable and certain shapes and configurations are preferentially amplified, thereby breaking some, but not all, of the symmetries of the original system. The preferred configurations compete via nonlinear interactions and a winning planform emerges, at least locally. We restrict ourselves mostly to phyllotactic patterns and to the study of phyllotaxis, a subject dealing with the arrangements of plant organs such as leaves, bracts, branches, petals, florets, and scales. These patterns bear much in common with patterns elsewhere, but there are a few distinguishing characteristics. The principal difference is that the pattern is laid down annulus-by-annulus, and so the bias of the existing pattern in the neighboring annulus plays a critical role in choosing between all possible outcomes for the new pattern.

Plant organs form due to surface deformations in the plant skin, called the tunica, and are created in the vicinity of the growth shoot, called the shoot apical meristem. The fact that plants exhibit regular patterns, such as whorls and spirals, has been known for over four hundred years. It has also been known that plants, such as the sunflower, which exhibit spiral patterns, have an additional striking feature. Counting the spirals, in both the clockwise and counterclockwise directions, often yields members of the regular Fibonacci progression

$$\{1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \ldots\}$$

in which each term is given by the sum of the two preceding terms. We call this regular Fibonacci phyllotaxis, but even families of plants which do not exhibit regular Fibonacci phyllotaxis often have opposing spirals which can be enumerated by the generalized Fibonacci progression

$$\{m, n, m+n, m+2n, 2m+3n, 3m+5n, \ldots\}$$

defined by the same recurrence rule but different initial values m and n.

The great naturalist Charles Bonnet is responsible for perhaps the first serious study of the arrangement of leaves, noting the four kinds of leaf arrangement previously observed: opposite leaves, whorls of three or more leaves, alternate leaves on opposite sides of the stem, and leaves with 'no constant arrangement.' Bonnet commented that he also observed a category of symmetry that escaped the attention of earlier scientists, namely a spiral arrangement. He offered a teleological explanation for the predominance of the spiral, that the final cause was to assure the leaves cover each other as little as possible in order to allow the free circulation of air. A similar argument was made by Hofmeister, when he published the first microscopic study of plant growth . He explained that each new plant organ initially formed in the largest open spot on the meristem. This stance was again taken by Airy, who proposed that the leaves on a plant are positioned so that they are packed as closely as possible , and finally culminated with Van Iterson, who identified all of the best possible packings on the cylinder .

In line with Van Iterson's results, physicists Levitov , Douady, and Couder took a further step in the development of our understanding of phyllotaxis. Instead of using geometrical criteria to explain the positioning of primordia, they used criteria based on the principle of minimal energy. Primordia tend toward positions where the potential energy is at a minimum. Levitov found phyllotactic patterns in the flux lattice of a superconductor. Douady and Couder produced phyllotactic patterns in a laboratory experiment with drops of ferrofluid initiated periodically at the center of a dish, where they were subject to a magnetic field gradient. As magnetic dipoles, they repelled each other. The gradient of the field applied a radial motive force. They found that, as in earlier models, the number of spirals for a given rate of ititiation followed a Fibonacci progression. The analogies with phyllotactic patterns lead directly to the consideration of phyllotaxis from a standpoint where universal symmetries play a more important role than the underlying mechanism.

It is only recently, though, that the mechanisms of plant growth have started to be understood. We have presented remarkable evidence that all of the features of phyllotactic configurations are the result of a pattern-forming front originating principally from biochemically and mechanically induced instabilities . The pattern-forming front is the solution of a pattern forming partial differential equation , informed by the pioneering ideas of Meyerowitz , Traas , Green and others on the particular biochemical and mechanical mechanisms responsible for the instabilities. The patterns we observe exhibit all known self-similar properties associated with spiral phyllotaxis and reveal some new invariants. Many previous results were obtained by projecting the partial differential equation equation onto an appropriate basis whereas our most recent results have been obtained by direct numerical simulation . Analyzing the simulated pattern, we also find that the maxima of the configuration that is laid down by the pushed front coincide almost exactly with the point configurations generated by various discrete algorithms reflecting optimal packing strategies. The ramifications of such a coincidence are potentially very important because they illustrate how an organism can follow an optimal strategy by employing nonequilibrium pattern formation. Finally, we emphasize transitions between patterns, as can be found on the head of a sunflower, over constant patterns, which are the case on many stems. Few previous results give consideration to these transitions even though they are commonly observed.

What is left to understand? As mentioned previously, we have found that phyllotactic patterns can arise as fronts, the moving interfaces between the patterned and unpatterned regions of the meristem. Fronts come in two varieties: linear or "pulled" fronts whose speed and profile derive from the instability of the uniform state ahead of the front and nonlinear or "pushed" fronts whose properties depend principally on conditions behind the front. From our simulations, depending on the selection of parameters, we see examples of both. Remarkably, it is only the parameter values that result in a pushed front that permit the Fibonacci progression. Can we identify the other ingredients necessary for a Fibonacci progression to occur? When the pattern is being laid down, what are the instabilities that the front is susceptible to, which could cause the progression to fail? There has been some analysis of the stability of hexagonal configurations , but in this case, the pattern being laid down is at times far from hexagonal. Ideally, we would like to find an set of parameters for which the the front is not susceptible to instabilities of any kind, so long as the transition is smooth.

Next, many partial differential equations, including our growth model, have a formulation in terms of conserved or dissipated quantities. For example, conservation of mass must be built into any model for fluid flow. Owing to various reasons, both qualitative and quantitative, it can be desirable to preserve this property when designing a numerical simulation. Conservative schemes have been developed specifically for the nonlinear Klein-Gordon equation , the nonlinear Schrödinger equation and the Korteweg-de Vries equation . Dissipative schemes have been developed for the Cahn-Hilliard equation and the Swift-Hohenberg equation . More recently, general algorithms have been developed for the construction of conservative and dissipative methods on entire classes of equations . It is from these that we have drawn inspiration while constructing a numerical method for our model . At the moment, though, our simulation scheme has a number of limitations which we hope to address. It will only operate reliably on simple surfaces such as a disc. Many plants are not disc-shaped, so we must modify it to operate on more general surfaces, but this contributes significant complexity to its implementation. Furthermore, its implementation needs to be made parallel in order to make a comprehensive survey of possible surfaces. It is trivial to distribute an array of surfaces to independent cluster nodes so that they can be computed simultaneously, but there are also low-level improvements that can be made. For example, a large portion of the runtime is spent solving a large, sparse matrix equation. Making a more thorough investigation of solution methods and taking advantage of a multithreaded sparse matrix library could increase the performance by an order of magnitude.

Finally, it is intriguing to ask why an equation such as our growth model has solutions which exhibit so many symmetries and invariants which are observed in phyllotaxis. These are probably not properties which can be derived from the equation itself but rather properties of the projection of the solution onto the underlying pattern, here Fibonacci, which dominates the dynamics. On the other hand, we have been able to show that the full solution of the equation exhibits all of these symmetries and invariants, even quite far from the situation for which the projection is valid. This introduces a novel question in the analysis of partial differential equations. It is known, for example, that many special solutions of a partial differential equation, the ordinary differential equation that describes its traveling wave solutions, can have invariant properties that the original equation does not. How might one go about teasing out the fact that certain dominant special solutions of a given equation have all these hidden symmetries?

The results of this investigation have many applications beyond the plant kingdom. One of the amazing features of the arrangement of seeds on a sunflower head is that it is, in some sense, an optimal packing. This allows the seeds as good as possible access to sunlight and nutrients. Many other problems, though, including developing error correcting codes for reliable data transmission and determining the crystalline structure of materials, can be reduced to problems in packing. Our evidence suggests that we can eventually find optimal packings simply by simulating a particular differential equation. Moreover, the knowledge that we obtain about nonlinear fronts on plants can be used in many related physical systems such as fluid convection and ion bombardment of a solid surface.

María Cristina Pereyra
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- PhD in Mathematics, Yale University 1993. Advisor; Peter W. Jones.
- MS in Mathematics, Yale University, 1989.
- Licenciatura de Matemáticas, Universidad Central de Venezuela, 1987.

Appointments

- Full Professor, UNM (Aug 2008 -present).
- Associate Professor, UNM (Aug 2001 -Jul 2008).
- Assistant Professor, UNM (Aug 1996 - Jul 2001).
- Instructor, Princeton University (Aug 1993 - May 1996).
- Visiting Academic, University of Southern Australia, Adelaide, Australia (Jul 2011).
- Visiting Fellow, Instituto de Matemáticas, Universidad de Sevilla, Spain (May-June 2011).
- Visiting Fellow, Centre de Recerca Matematica, Barcelona, Spain (Aug-Dec 2003).
- Visiting Fellow, Centre de Recerca Matemática, Barcelona, Spain (Summer 1999).
- Visiting Fellow, University of Edinburgh, Scottland (Summer 1997).
- Member of the Institute for Advanced Studies, Princeton, NJ (Jan-Jul 1994).

Distinction and Awards

- Recipient of a University Wide **2012-2013 Outstanding Teacher of the Year Award**.

Most relevant publications

- A. Kairema, Ji Li, M. C. Pereyra, and L. Ward, *Haar bases on quasi-metric measure spaces, and dyadic structure theorems for function spaces on product spaces of homogeneous type.* J. Func. Anal. Volume 271, Issue 7 (2016) pp. 179–1843
- D. Chung, M. C. Pereyra,C. Pérez. *Sharp bounds for general commutators on weighted Lebesgue spaces.* Trans. Amer. Math. Soc. **364** no. 3 (2012), 1163–1177.
- M. C. Pereyra, *Haar multipliers meet Bellman functions.* Revista Matemática Iberoamericana 25 (2009), no. 3, 799-840.
- O. Dragičević, L. Grafakos, M. C. Pereyra, S. Petermichl *Extrapolation and sharp norm estimates for classical operators on weighted Lebesgue spaces*, Publ. Mat. 49 (2005), 73–91.
- S. Efromovich, J. D. Lakey, M. C. Pereyra, N. Tymes. *Data-driven and optimal denoising of a signal and recovery of its derivative using multiwavelets.* IEEE Transactions on Signal Processing, vol 52, no. 3, p. 1-8 (2004).
- J. D. Lakey, M. C. Pereyra, *On the non-existence of certain divergence-free multiwavelets.* In 'Wavelet and Signal Processing', Appl. Numer. Harmon. Anal. Birkhauser Boston, Boston, MA. L. Debnath, Ed. (2003) (invited paper).
- M. C. Pereyra, *Lecture notes on dyadic harmonic analysis.* Contemporary Mathematics 289 AMS, Ch. I, p. 1-61 (2001).
- Nets H. Katz, M. C. Pereyra, *Haar multipliers, paraproducts, and weighted inequalities.* In "Analysis of Divergence", W. Bray, C. Stanojevic eds. Chapter 10, p. 145-170 (1999).
- Nets H. Katz, M. C. Pereyra, *On the two weight problem for the Hilbert transform.* Revista Matemática Iberoamericana 13(01):211-242 (1997).

- M. C. Pereyra, *Sobolev spaces on Lipschitz curves.* Pacific Journal of Mathematics 172(2):553-589 (1996).

Research grants or Contracts.

- Two NSF-MCTP Grants: 1.(PI: Nitsche, CoPIs Lorenz, Nakamaye, Pereyra), **1.2M**, 2012-17. 2.(PI: Pereyra, CoPIs Lorenz, Nakamaye, Nitsche), **757K**, 2008-12. (*Educat. Grant*)
- SURP Grant # AX-6430 (PI: Pereyra, CoPI Lakey (NMSU) **70K**, 1997-99. (*Res. Grant*)
- 4 NSF Grants, PI: Pereyra (4 coPis from UNM/NMSU), **117K** supporting the NM Analysis Seminar (12 confs & "An Afternoon in Honor Cora Sadosky"). (*Conf. Grants*)
- NSF-CBMS Regional Conference in the Mathematical Sciences, PI: Lakey, CoPIs: Giorgi, Pereyra(UNM), Sikora, Smits (all others from NMSU), **31K**. (*Conf. Grant*)

Main synergistic/service activities

- Scientific Committee Member: Satellite Conference to ICM 2018 in Brazil in Harmonic Analysis: (Fall 2015-now)
- Co-organizer of Afternoons in Honor to Cora Sadosky (2014) and to Mischa Cotlar (2007); 5 bloks of AMS Special Sessions (all in Abq); 15 NM Analysis Seminars (1998-09, 2014-16 Abq/Las Cruces); and NSF-CBMS Lecture Series by Terence Tao (2015, Las Cruces).
- NSF Panelist: two panels in Harmonic Analysis and PDEs in 2011 and 2016 (declined to other invitations 2012 and 2013), one MCTP/RTG panel (2008).
- Main Editor "Harmonic Analysis, Partial Differential Equations, Complex Analysis, Banach Spaces, and Operator Theory Celebrating Cora Sadosky's life, Volume I" (and also for Volume II). Pereyra, M.C. et al (Eds.) Association for Women in Mathematics Series, Vol. 4, Springer International Publishing 2016. Second volume will appear in 2017.
- June 2012-May 2017 'Mentoring through Critical Transition Points' (NSF-MCTP, coPI. Activities include: summer program, graduate trainees, undergraduate research projects, postdocs, teaching seminar, qualifying preparation seminar, outreach to K12.
- June 2008-May 2012, 'Mentoring through Critical Transition Points' (NSF-MCTP, PI). Overseeing all activities: summer program, graduate trainees, undergraduate research projects, reporting, recruiting, administrative, etc.
- Taught six mini-courses on *Dyadic Harmonic Analysis*, or on *Wavelets* in the US (2012, IMA, Minneapolis and 2004, IAS, Princeton), Spain (2011, Sevilla), Argentina(2002, Córdoba), Mexico (2000, Cuernavaca and 2006, Oaxaca).
- Taught four intensive minicourses (6 hours a day for 5 days) for the MCTP Summer Program on *Fourier Analysis and Wavelets* (Summer 2008, 2009, 2010, and Summer 2015).
- Co-organizer UNM-PNM Math Contest (1999-03, 2004-06), $\sim$1000 K12 NM students.

Postdoctoral and Ph.D. advisees:

- David Weirich, Expected Spring 2017.
- Jean Moraes, PhD 2011. Adjunct Professor (tenure track). at Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil. (Jan 2013-present)
- Daewon Chung, PhD 2010. Assistant Professor, Department of Mathematics, Keimyung University, Daegu, South Korea (Fall 2014-present).
- Darek Panek, PhD 2008. Lecturer at University of Ohio (Fall 2011-present).
- Oleksandra Beznosova, PhD 2008. Assistant Professor, Department of Mathematics, University of Alabama, Tuscaloosa, AL. (Fall 2014-present)

Summary of research experience

I have published 27 papers in two areas: Harmonic Analysis and Wavelet theory. I have published by myself and with 27 coauthors in the US, Australia, Korea, Brasil, Spain, Finland, France, Slovenia, and Venezuela.

I have published 2 books, I have edited one volume, and I am in the final stages of editing the second volume, collecting papers from distinguished mathematicians in honor of Cora Sadosky:

- *Harmonic Analysis, Partial Differential Equations, Complex Analysis, Banach Spaces, and Operator Theory Celebrating Cora Sadosky's life, Volume II.* Pereyra, M.C., Marcantognini, S., Stokolos, A.M., Urbina, W. (Eds.) In preparation, Association for Women in Mathematics Series, Springer International Publishing.
- *Harmonic Analysis, Partial Differential Equations, Complex Analysis, Banach Spaces, and Operator Theory Celebrating Cora Sadosky's life, Volume I.* Pereyra, M.C., Marcantognini, S., Stokolos, A.M., Urbina, W. (Eds.) Association for Women in Mathematics Series, Vol. 4, Springer International Publishing 2016 (371 p.).
- M. C. Pereyra, L. Ward *Harmonic Analysis: from Fourier to Wavelets.* Student Mathematical Library, 63. American Mathematical Society, Providence, RI; Institute for Advanced Study (IAS), Princeton, NJ, 2012 (410 p.).
- M. Mohlenkamp., M. C. Pereyra, *Wavelets, their friends, and what they can do for you.* EMS Lecture Series in Mathematics, European Mathematical Society 2008 (119 p.).

MathScinet records 17 publications and 85 citations by 74 authors.

Google Scholar reports 27 publications, Citations: 451 (Total), 243 (since 2011); h-index: 12 (Total), 8 (since 2011); 10-index: 12 (Total), 7 (since 2011). With the bulk of the citations occuring in the last 10 years.

I have given talks (conference talks, invited talks, colloquia, seminars) around the world (Argentina, Australia, Canada, Mexico, Scotland, Spain, Venezuela), and around the US at universities such us (U. Alabama, Brown University, New Mexico State University, Princeton University, Rice University, University of California at Los Angeles, University of Missouri at Columbia, Yale University).

I have given minicourses for graduate students, postdocs and junior researchers at institutes and universities in the USA (Institute for Mathematics and its Applications, IMA, Minneapolis, MN; and the Institute for Advanced Study, IAS, Princeton, NJ) and around the world (Instituto de Matemáticas de Sevilla (IMUS), Seville, Spain; Instituto de Matemática, Unidad Cuernavaca, UNAM, México; III Panamerican Advanced Studies Institute in Computational Science and Engineering, Huajuapan de León, Oaxaca, México; I Panamerican Advanced Studies Institute (PASI), Universidad Nacional de Córdoba, Argentina).

I have organized many conferences mostly in New Mexico. I am currently in the scientific committee to organize an International Conference in "Harmonic Analysis", satellite to the International Congress of Mathematics[1] (ICM) to be held in 2018 in Brazil. The committee members are: María Cristina Pereyra (UNM), Carlos Pérez (University of the Basque Country UPV/EHU and IKERBASQUE, Basque Foundation for Science, Spain), Jill Pipher (Director, ICERM and Elisha Benjamin Andrews Professor of Mathematics, Brown University), Christoph Thiele (Hausdorff Chair, Hausdorff Center for mathematics, Universitat Bonn, Germany), Javier Ramos (Brazil), and Jean Moraes (UFRGS, Brazil).

I have trained 4 PhD students (1 women). Three of them are now Assistant Professors of Mathematics in Universities in Brasil, Korea, and the US. I have also trained 4 MS students (3 women), and directed 2 Honors Thesis (1 woman).

[1]This is the most important gathering of mathematicians in the world, it happens every four years, the Field medals are announced there.

Anna Skripka
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- PhD in Mathematics, University of Missouri, USA, 2007.
- Full Higher Education in Mathematics, Kharkiv National University, Ukraine, 2001.
- Full Higher Education in Mathematics & Computer Science Education, Kharkiv National University, Ukraine, 2001.

Appointments

- Associate Professor, University of New Mexico, 08/2016 – present.
- Tenure-track Assistant Professor, University of New Mexico, 08/2012 – 07/2016.
- Tenure-track Assistant Professor, University of Central Florida, 08/2010 – 07/2012.
- Visiting Fellow, University of New South Wales, Australia, 2009 & 2013 & 2015.
- Visiting Assistant Professor, Texas A&M University, 09/2007 – 08/2010.
- Teaching Assistant, University of Missouri, 06/2002 – 05/2007.
- Research Assistant, University of Missouri, 08/2001–05/2002.

Distinction and Awards

- Plenary talk at International Workshop on Operator Theory and Applications, Washington University in St. Louis, July 2016.
- Plenary talk at East Coast Operator Algebras Symposium, University of Iowa, October 2015.
- Plenary talk at Great Plains Operator Theory Symposium, Purdue University, May 2015.
- Plenary talk at 29th Southeastern Analysis Meeting, Virginia Tech, March 2013.
- Plenary talk at East Coast Operator Algebras Symposium, University of Tennessee, October 2012.
- Distinguished Teaching Award, Mathematics Department, University of Missouri, 2006.
- 2 Graduate and Professional Council Travel Awards, University of Missouri, 2006.
- Professional Presentation Travel Fellowship, University of Missouri, 2006.

Most relevant publications

All my 25 publications and preprints are relevant. Below are the most recent ten publications.

- “Functions of unitary operators: derivatives and trace formulas” (w/ D. Potapov, F. Sukochev), Journal of Functional Analysis, 270 (2016), 2048–2072.
- “Hölder’s inequality for roots of symmetric operator spaces” (w/ K. Dykema), Studia Mathematica, 228 (2015), 47–54.
- “Trace formulas for resolvent comparable operators” (w/ D. Potapov, F. Sukochev), Advances in Mathematics, 272 (2015), 630–651.
- “On perturbation determinant for dissipative operators” (w/ K. A. Makarov, M. Zinchenko), Integral Equations and Operator Theory, 81 (2015), no. 3, 301–317.
- “Trace formulas for multivariate operator functions”, Integral Equations and Operator Theory, 81 (2015), no. 4, 559–580.

- “Taylor approximations of operator functions”, Operator Theory: Advances and Applications, Birkhäuser, Basel, 240 (2014), 243–256.
- “Asymptotic expansions for trace functionals”, Journal of Functional Analysis, 266 (2014), no. 5, 2845–2866.
- “Upper triangular Toeplitz matrices and real parts of quasinilpotent operators” (w/ K. Dykema, J. Fang), Indiana University Mathematics Journal, 63 (2014), no. 1, 53–75.
- “Perturbation formulas for traces on normed ideals” (w/ K. Dykema), Communications in Mathematical Physics, 325 (2014), no. 3, 1107–1138.
- “Spectral shift function of higher order for contractions” (w/ D. Potapov, F. Sukochev), Proceedings of the London Mathematical Society, 108 (2014), no. 3, 327–349.

Research grants or Contracts.

- NSF DMS-1554456, CAREER, Analysis Program, sole PI, 2016 – 2021, $449,963.
- NSF DMS-1500704, Analysis Program, sole PI, 2015 – 2018, $151,357.
- NSF DMS-1249186, Analysis Program, sole PI, 2012 – 2015, $109,998.
- NSF DMS-0900870, Analysis Program, sole PI, 2009 – 2012, $92,139.
- AWM-NSF Mentoring Travel Grant, to do research at the University of New South Wales, Sydney, Australia, 2009, $4,000.
- NSF Travel Grant, to speak at the first PRIMA congress, Sydney, Australia, 2009.
- AWM-NSF Workshop grant, to present a poster at the National AMS meeting, 2007.
- NSF DMS–1400429, “New Mexico Analysis Seminar 2014–2016,” to support 4 conferences, Co-PI, 2014 – 2016, $49,388.
- NSF DMS-1148801, MCTP, paid faculty, 2013.
- NSF DRL-0101822, TEP, paid TA, 2005.

Main synergistic/service activities

- (Co)-organizer of 2 conferences and 3 special sessions.
- Analysis seminar organizer, UNM, Fall 2016.
- Colloquium co-organizer, UNM, Fall 2015 – present.
- 36 research conference talks; 30 research seminar talks; 3 educational talks.
- MS thesis examiner for Flinders University, Australia, 2014.
- Mentorship: Sarka E. Blahnik, Undergraduate Honors Thesis, Fall 2016 – Summer 2017.
- Mentorship: Kirstin G. Harriger, Undergraduate Thesis, Spring 2013 – Spring 2014.
- Member of an AWM Mentor Network, Fall 2011 – Spring 2012.
- Member of 2 PhD and 2 MS committees; Honors thesis reader for 3 undergraduates, UNM.
- Academic adviser for undergraduate and graduate mathematics majors, UNM.
- Committees: Honors; Undergraduate; Textbook; 3 qualifying exams in 2 subjects.
- Extensive curriculum development.
- Frequent volunteer service on fixing problems in work conditions.
- Referee for research journals and reviewer for Mathematical Reviews.
- NSF panelist twice.

Postdoctoral and Ph.D. advisees:

- Arup Chattopadhyay, a Fulbright-Nehru scholar, Fall 2016 – Spring 2017.
- Bishnu Sedai, PhD dissertation, since April 2014.
- Abdel Mohamed, PhD project, Fall 2016.

Summary of research experience

The operator theory is a vibrant and diverse field of mathematics closely connected with physics and engineering and also applied in other areas of life. For instance, we deal with operators (also known under the name "matrices" in the finite-dimensional case) when we solve systems of linear equations or solve differential equations. Solving such a system involves finding the spectrum of the respective operator. The spectrum of an operator can have an important physical meaning; for example, the spectrum can correspond to frequencies of a vibrating body and we can also observe a rainbow of colors corresponding to different wavelengths/frequencies of light. Another example is that observable quantities (like position and momentum of a particle) are described by operators in the mathematical formulation of quantum mechanics.

The solution of a system of linear differential equations and the solution of the Schrödinger equation (which is a quantum mechanics analog of Newton's equation of motion) can be expressed via a function of an operator, where the operator describes the system itself. Time evolution as well as perturbation of the parameters of a system change the operator describing the system and, consequently, change the function of the operator that gives the solution of the system. Mathematical understanding of perturbation of operator functions is done by means of noncommutative analysis. Such analysis is called noncommutative because functions are defined on operators that typically do not commute. We recall that operators do not commute if the result of their subsequent application to a physical state depends on the order in which the operators are applied. Noncommutativity of operators also lies in the heart of the Heisenberg uncertainty principle.

My research is primarily in the areas of noncommutative analysis and operator theory. Noncommutativity is an inherent phenomenon in many areas of modern mathematics, with applications in such diverse areas as quantum physics and control theory. I am particularly interested in problems of noncommutative analysis that emerge from mathematical physics and noncommutative geometry.

One of the questions that I have been working on is how perturbation of the parameters of a system affects important physical characteristics of the system. One of real models behind this mathematical problem is how the free energy (that is, the energy that can be converted to work) of an imperfect crystal can be computed based on our knowledge of the free energy of the perfect crystal and of characteristics of the impurities. The imperfections exist due to vibrations of the crystal lattice sites and due to defects such as missing atoms, "wrong" atoms, etc. that are present in the lab grown crystals. These problems require sophisticated mathematical treatment; the larger the defect, the more delicate methods are needed.

I have also been working on studying structure of operators characterized by certain distinctive features and decomposing such operators into prime components or simpler pieces whose structure is better understood. Among such operators are traceless operators and operators commuting with a given family of operators.

Deborah Sulsky
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., Mathematics, June 1982
  Courant Institute of Mathematical Sciences, New York University
  Thesis: "Models of Cell and Tissue Movements"
  Advisors: Stephen Childress and Jerome Percus
- M.S., Mathematics, June 1979
  Courant Institute of Mathematical Sciences, New York University
- B.S., Mathematical Physics, May 1977 (with honors)
  State University of New York, Binghamton, New York

Appointments

- 1998-present: Professor, University of New Mexico
  Department of Mathematics and Statistics and Department of Mechanical Engineering
- 2014-2015: Visiting Professor, University of Washington, Applied Mathematics
- 2000-2001: Visiting Associate in Aeronautics, California Institute of Technology
  Division of Engineering and Applied Science
- Associate Professor, University of New Mexico
  1992-1998: Department of Mathematics and Statistics
  1997-1998: Department of Mechanical Engineering
- 1987-1992: Assistant Professor, University of New Mexico, Mathematics and Statistics
- 1987-1992: Adjunct Assistant Professor, UCLA, Department of Mathematics
- 1982-1984: Instructor, Massachusetts Institute of Technology, Department of Mathematics

Distinction and Awards

- Phi Beta Kappa
- Sigma PI Sigma

Most relevant publications

- An anisotropic elastic-decohesive constitutive relation for sea ice, Tran, HD; Sulsky, DL; Schreyer, HL; Int. J. Num. Anal. Meths. Geomechs. **39**(9): 988-1013 (2015)
- Uncertainty Quantification in Prediction of In-Plane Young's Modulus of Thin Films With Fiber Texture, Madrid, PJ; Sulsky, D; Lebensohn, RA; J MEMS **23**(2):380-390 (2014)
- Toward a new elastic-decohesive model of Arctic sea ice, Sulsky, D; Peterson, K; Physica D-Nonlinear Phenomena **240**(20):1674-1683 (2011)
- Interfacing continuum and molecular dynamics, an application to lipid bilayers, Ayton, G; Bardenhagen, SG; McMurtry, P; Sulsky, D; Voth, GA; JCP **114**(15):6913-6924 (2001)
- Numerical study of stress distribution in sheared granular material in two dimensions, Bardenhagen, SG; Brackbill, JU; Sulsky, D; Phys Rev E **62**(3):3882-3890 Part: B (2000)
- Fluid-membrane interaction based on the material point method, York, AR; Sulsky, D; Schreyer, HL; Int J Num Meths Engnrg **48**(6): 901-924 (2000)

- Application of a particle-in-cell method to solid mechanics, Sulsky, D; Zhou, SJ; Schreyer, HL; Comput Phys Commun **87**(1-2):236-252 (1995)
- A particle-in-cell method for history-dependent materials, Sulsky, D; Chen, Z; Schreyer, HL; Comp Meths Appld Mechs Engrng **118**(1-2) :179-196 (1994)
- Numerical Solution of Structured Population Models I. Age-Structure, Deborah Sulsky J. Math. Biol., **31**, 817-839 (1993).
- A Numerical method for suspension flow, Sulsky, D; Brackbill, JU; J Comp Phys **96**(2) : 339-368 (1991)

Recent Research grants or Contracts. (Continuous external funding since 1989)

- Sea Ice Mechanics and Ice Thickness Distribution: Development, Evaluation & Application of an Elastic Decohesive Sea Ice Model, Principal Investigator: Deborah Sulsky, NOAA, 8/1/15-7/31/18, $570,178.
- A New Approach to Modeling Laminar to Turbulent Transition, Principal Investigator: Deborah Sulsky, DARPA, 1/19/11-6/20/11, $52,566.
- Ice-Ocean Simulations using an Elastic-Decohesive Model, Principal Investigator: Deborah Sulsky, National Science Foundation, 9/1/10-8/31/14, $718,907.
- Effect of Rock Joints on Failure of Tunnels Subjected to Blast Loading, Principal Investigator: Deborah Sulsky, 7/21/10-1/20/12, DTRA, $679,150
- PRISM: Center for the Prediction and Reliability, Integrity and Survivability of Microsystems, Principal Investigator: Jayathi Y. Murthy, 3/1/08-2/28/14, DoE/NNSA ASC-PSAAP, $17M ($972,335 to UNM).
- CMG: Collaborative Research On Multi-Scale Modeling of Arctic Ice, Principal Investigator: D. Sulsky, National Science Foundation, 9/1/06-8/31/09, $437,259.
- Oriented Fracture Patterns and Frazil Pancake Ice Formation: A New Basin Scale Model of Sea Ice Dynamics, Principal Investigators: M. Coon, R. Kwok, H. Schreyer, D. Sulsky, and L. Toudal, 5/1/04-8/31/09, ONR, NASA and MMS $2.5M.

Main synergistic/service activities

- Associate Editor, Expository Research Section of SIAM Review, Jan. 2010-2013. Member, Editorial Board, Cold Regions Science and Technology, Sept. 2011 - present.
- Member, USACM Novel Methods in Comp. Engineering & Sciences TTA, May, 2015-2017. Chair, Specialty Committee on Meshfree Methods, USACM, October, 2009 - July, 2013.
- Scientific Committee: 2016 USACM Conf on Isogeometric Analysis and Meshfree Methods, Oct 10-12, 2016, La Jolla, California; The V International Conf on Particle-Based Methods 26-28 Sep 2017, Hannover, Ger. Minisymp Organizer: 'Recent Advances in Galerkin and Collocation Meshfree Methods', 12th WCCM, Seoul, Korea, 24-29 July 2016. The Material-Point Method, Theory and Applications,' III International Conf on Particle-based Methods. 18-20 Sep, 2013, Stuttgart, Ger. Organizer: AMS Mathematical Research Community, Sea Ice, PDE and Probability, Snowbird, Utah, June 21-26, 2015.

Postdoctoral and Ph.D. advisees:

- Postdoctoral advisees: Andrew Brydon, Edward Love, Giang Nguyen, Oksana Guba, Han Tran, Gunter Leguy
- Ph.D. advisees: Allen R. York II (1997), Shijian Zhou (1998), John E. Snyder, Jr. (1999), Ann Kaul (2000), Kara Peterson (2008), Pedro Madrid (2013), Ming Gong (2015)

Summary of research experience

Deborah Sulsky has research background in scientific computing, numerical analysis, biomathematics, and continuum mechanics. Over the years, Professor Sulsky has developed novel numerical algorithms for studying problems in embryology, population ecology, suspension flow, and solid mechanics. She developed the material-point method (MPM), a numerical technique for continuum mechanics problems. The method is now being used at Los Alamos and Sandia National Laboraorties, and by university researchers in the US, Europe, Asia, Australia, and South Africa. It was used as a key component in The DoE Advanced Simulation and Computing Center at the University of Utah and is now being used in the DoE Predictive Science Academic Alliance Carbon-Capture Multidisciplinary Simulation Center at the University of Utah.

In addition to developing the method and characterizing properties of MPM, Professor Sulsky has extended the method to new applications, including models of granular material, polycrystals, and fracture. She has also applied the method to study manufacturing problems such as metal rolling, cutting, and upsetting, as well as fluid-structure interactions. Thin membranes have also been analyzed to study fabrics such as those in automobile airbags and biological cell membranes. Disney used MPM for animating snow in the movie Frozen.

A recent emphasis of Professor Sulsky's work is modeling Arctic sea ice using MPM and a constitutive relation for sea ice developed jointly with UNM Mechanical Engineering Professor Howard Schreyer (retired). The goal of this research is to improve the representation of sea ice mechanics in Earth System Models (ESMs) and General Circulation Models (GCMs) in order to advance the predictive capabilities of these models. Current-generation models used in the simulation of the Arctic Ocean use sea-ice models that were developed prior to the availability of detailed satellite observations of sea-ice mechanics. A main assumption of the models is that cracks, leads and ridges are randomly distributed over length scales in the range of 100 km. Under this assumption, ice behavior is described as isotropic. This approach was viable when computer resources limited the resolution available for more detailed calculations. However, observations show that the fracture patterns in the Arctic are not random. In a material with oriented fracture patterns, the material is weaker in tensile strength across the fracture, yet it retains its strength along the fracture. When properties of a material depend on its orientation, an anisotropic model is more appropriate. As computational power has improved, it is now feasible and desirable to conduct high-resolution simulations. The isotropy assumption breaks down at these finer scales. In contrast to the isotropic, viscous-plastic rheology of most current sea ice models used in GCMs and ESMs, the new elastic-decohesive rheology explicitly represents the presence and direction of sea ice deformation features such as leads, or cracks in the ice.

Dimiter N. Vassilev
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D., Purdue University, West Lafayette, IN, Mathematics, December 2000
- M.S., Purdue University, West Lafayette, IN, Mathematics, May 1998
- DEA, Université Bordeaux I, Talence-Cedex, France, Mathematics, May 1994
- B.S., University of Sofia, Sofia, Bulgaria, Mathematics, 1993

Appointments

- Associate Professor, University of New Mexico, Department of Mathematics and Statistics, Albuquerque, NM, 2012–present.
- Assistant Professor, University of New Mexico, Department of Mathematics and Statistics, Albuquerque, NM, August 2007–2012.
- Visiting Assistant Professor, University of California - Riverside, Department of Mathematics, Riverside, CA, June 2005–June 2007
- Postdoctoral Fellow, Centre de Recherches Mathématiques-Institut des Sciences Mathématiques (CRM-ISM), Montréal, PQ, January 2003–December 2004
- Visiting Assistant Professor, University of Arkansas, Fayetteville, AR, 2000–2005

Distinction and Awards

- Postdoctoral Fellowship, Centre de Recherches Mathématiques - Institut des Sciences Mathématiques (CRM-ISM), January 2003–December 2004
- Purdue Research Foundation Grants, 1998–1999, 1999–2000

Most relevant publications

- Ivanov, S., Minchev, I., & Vassilev, D., *Quaternionic contact Einstein structures and the quaternionic contact Yamabe problem*, Memoirs of the American Mathematical Society, Volume 231, Number 1086 (2014)
- Ivanov, St., Vassilev, D., *Extremals for the Sobolev Inequality and the Quaternionic Contact Yamabe Problem*, Imperial College Press Lecture Notes, World Scientific Publishing Co. Pte. Ltd., Hackensack, NJ, 2011
- Ivanov, S., & Vassilev, D., *The Lichnerowicz and Obata first eigenvalue theorems and the Obata uniqueness result in the Yamabe problem on CR and quaternionic contact manifolds*, Nonlinear Analysis: Theory, Methods & Applications and its Applications 126 (2015) 262–323
- Fernandez, M., Ivanov, S., Ugarte, L., & Vassilev, D., *The quaternionic Heisenberg group and Heterotic String Solutions with non-constant dilaton in dimensions 7 and 5*, Communications in Mathematical Physics, 339, (2015), 199–219
- Fernandez, M., Ivanov, S., Ugarte, L., & Vassilev, D., *Non-Kahler Heterotic String Solutions with non-zero fluxes and non-constant dilaton.* Journal of High Energy Physics, 06 (2014), 073.
- Ivanov, S., Petkov, A., & Vassilev, D., *The sharp lower bound of the first eigenvalue of the sub-Laplacian on a quaternionic contact manifold in dimension 7.*Nonlinear Analysis:

Theory, Methods & Applications 93 (2013) 51–61.

- Ivanov, St., Minchev, I., & Vassilev, D., *The optimal constant in the L^2 Folland-Stein inequality on the quaternionic Heisenberg group.* Ann. Sc. Norm. Super. Pisa Cl. Sci.(5) Vol. XI (2012), 1–18.
- Ivanov, St. & Vassilev, D., *Conformal quaternionic contact curvature and the local sphere theorem*, Journal de Mathématiques Pures et Appliquées,**93** (2010), 277–307
- Ivanov, St., Minchev, I., & Vassilev, D., *Extremals for the Sobolev inequality on the seven dimensional quaternionic Heisenberg group and the quaternionic contact Yamabe problem*, Journal of the European Mathematical Society (JEMS) 12 (2010), no. 4, 1041–1067
- Garofalo, N., & Vassilev, D., *Symmetry properties of positive entire solutions of Yamabe type equations on groups of Heisenberg type*, Duke Math. J. 106 (2001), no. 3, 411–448

Research grants or Contracts.

- September 2013 - August 2018, PI, *Geometric Analysis related to Math Physics and sub-Riemannian geometry*, Simons Foundation
- January 2012 – December 2014, member of research group, *Special Geometric Structures on Manifolds and applications in Mathematical Physics*, (University of the Basque Country, Spain), funded by "Ministerio de Ciencia e Innovación", MTM2011-28326-C02-02, Spain.
- June 2008 – 2011, outside consultant & member of research group (since June 2011), *Estructuras Geométricas Especiales sobre Variedades y aplicaciones en Física Matemática*, PI Maria Luisa Fernandez Rodriguez (University of the Basque Country, Spain), funded by "VI PLAN NACIONAL de I+D+I", Spain.
- December 2009 – December 2012, *Geometry and analysis of PDEs, Yamabe problems and heterotic strings*, member of four person team, funded by Contract IDEI DID 02-39/21.12.2009, NSF of Bulgaria.

Main synergistic/service activities

- UNM-PNM State Wide High School Math Contest, co-director, 2008 – 2016.
- University Service: Sabbatical Committee, College of Arts and Science UNM, since 2015.
- UNM Department Committees: *Library Committee* (2015-present & 2008–2011); *Pure Math Hiring Committee* (Fall 2013 – Spring 2014); *Scheduling Committee* (Fall 2011 – Spring 2014); Colloquium Committee(Fall 2011 – Spring 2012); *Graduate Committee* (2016–present, 2010 – 2011 & 2008 – 2009); *Analysis graduate qualifying exam co-organizer & grader) (Winter 2009 & Summer 2009*; *Complex Analysis graduate qualifying exam* co-organizer & grader, (Summer 2011, Winter 2011, Winter 2010); *Geometry graduate qualifying exam* co-organizer & grader (Summer 2016, Summer 2014, Summer 2013, Winter 2011 & Summer 2010)
- *Refereed/Reviewed for Mathematical Journals*: Archiv der Mathematik; Communications in Analysis and Geometry; Journal of Geometry and Physics; Complex variables and elliptic Equations; Geometric and Functional Analysis (GAFA); Springer INdAM Series; Journal of Geometric Analysis; Proceedings of the Edinburgh Mathematical Society; Publicationes Mathematicae Debrecen; Acta Mathematicae Applicatae Sinica, English Series; Bulletin of the Korean Mathematical Society. Annali della Scuola Normale Superiore di Pisa - Classe di Scienze; Proceedings of the London Mathematical Society; Analysis and Mathematical Physics; Journal of Differential Equations; Journal of Mathematical Analysis and Applications; International Mathematics Research Notices.

Summary of research experience

The topics of my research concern geometric structures, regularity and geometric properties of solutions of partial differential equations, their singularities or order of vanishing. My work has applications in the areas of (conformal) geometry of Riemannian and sub-Riemannian manifolds, analysis, complex analysis and singularity theory, fluid dynamics and physics. A unifying idea of a large portion of my work is the study of symmetric and steady state configurations relevant for geometric structures of physical importance. Another area of my work involved geometric complex analysis and fluid dynamics. I also have used harmonic and complex analysis in questions related to measuring singularities and order of vanishing of solutions to partial differential equations.

Recent specific topics of interest include:

1. *The quaternionic contact Yamabe problem* has as its main objectives to solve the quaternionic contact Yamabe equation and prove a positive mass theorem.

2. *Embedding problems for qc structures*, concerns the analysis and geometry of qc- Einstein and qc pseudo-Einstein structures. The issues here are the existence, conformal invariants, and characterization through partial differential equations satisfied by eigenfunctions of qc-Einstein and qc-pseudo-Einstein structures.

3. *Comparison theorems in the CR and the quaternionic contact setting.*

4. *Partial Differential Equations in heterotic string solutons*, seeks explicit examples and existence results of quaternionic Kähler metrics, $Spin(7)$, $Spin(4,3) \subset SO(4,4)$ or hyper Kähler metrics, and explicit supersymmetric solutions to the heterotic supergravity with non zero fluxes and non-constant dilaton.

Janet Vassilev
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- A.B. Mathematics; University of Chicago; 1991.
- M.A. Mathematics; University of California, Los Angeles; 1993.
- Ph.D. Mathematics; University of California, Los Angeles; 1997.

Appointments

- Associate Professor; University of New Mexico; 2015 – present.
- Assistant Professor; University of New Mexico; 2012 – 2015.
- Lecturer; University of New Mexico; 2008 – 2012.
- Visiting Assistant Professor; University of California, Riverside; 2005 – 2008.
- Visiting Assistant Professor; University of Arkansas; 2000 – 2005.
- Assistant Professor; Virginia Commonwealth University; 1998 – 2000.
- Visiting Assistant Professor; Purdue University; 1997.

Distinction and Awards

- William P. and Heather W. Weber award for excellence in teaching, July 2011.
- UCLA Dissertation Year Fellowship, Fall 1996–Spring 1997.
- UCLA Office of the President Affirmative Action Fellowship, 1991–1995.

Most relevant publications

- *Star and semistar operations defined on rings with zero divisors*; with Gregory Morre; J. of Algebra; 455 (2016), 209-234.
- *When is a Nakayama Closure Semiprime?*; J. Commutative Algebra 6 (2014), no. 3; 439–454.
- *m -full and basically full ideals in rings of characteristic p*; Rocky Mountain Math Journal 44 (2014), no. 2; 691–704.
- *A look at the prime and semiprime operations of one-dimensional domains*; Houston J. Math. 38 (2012), no. 1; 1–15.
- *A formula for the $*$-core of an ideal*; with Louiza Fouli and Adela Vraciu; Proc. Amer. Math. Soc. 139 (2011), no. 12; 4235–4245.
- *The cl-core of an ideal*; with Louiza Fouli; Math. Proc. Cambridge Philos. Soc. 149 (2010), no. 2; 247-262.
- *When is tight closure determined by the test ideal?*; with Adela Vraciu; J. Commut. Algebra 1 (2009), no. 3; 591-602.
- *Structure on the set of closure operations of a commutative ring*; J. Algebra 321 (2009), no. 10; 2737-2753.
- *Local cohomology modules with infinite dimensional socles*; with Thomas Marley; Proc. Amer. Math. Soc. 132 (2004), no. 12; 3485-3490.
- *Cofiniteness and associated primes of local cohomology modules*; with Thomas Marley; J. Algebra 256 (2002), no. 1; 180-193.

Research grants or Contracts.

- Attracting, Motivating and Preparing Mathematics students in the Southwest by building an energetic community of students and educators Principal Investigators: Monika Nitsche, Jens Lorenz, Michael Nakamaye, Cristina Pereyra Senior Personnel: Daniel Appeloe, Deborah Sulsky, Kristin Umland, Janet Vassilev, Peter Vorobieff, Helen Wearing National Science Foundation May 1, 2012-April 30, 2016, $1,198,603.

Main synergistic/service activities

- UNM-PNM State Math Contest; Co-Director; Fall 2008-present; Advertise Competition; Compose and Grade exams; Post solutions; Organize Winner's Banquet.
- Mentor local high school students on Science Fair Projects: 1) Katherine Cordwell; Manzano High School; 2011-2012; Completing Graphs. 2) Evan Liu; Albuquerque Academy; 2012-2013; A Mathematical Analysis of SET Variants. 3) Ruby Aidun; Albuquerque High School; 2013-2014; Hat Games and the Various Mathematics used in playing optimally. 4) John Keeney; Rio Rancho High School; 2015-2016; Mathematics and Sudoku.
- Departmental Committees: Executive Committee (2016–2017); Undergraduate Committee (2015 – 2017); Hiring Committee (2013–2014); Colloquium Committee (2012–2015).
- Organizer for Math Meetings: Southwest Local Algebra Meeting, March 2017 and Interactions in Commutative Algebra, Special Session at the Spring Western Section Meeting of the AMS, April 2014.
- Referee for various journals including: Amer. Math. Monthly, Comm. Algebra, J. Algebra, J. Comm. Algebra, J. Korean Math. Soc., J. Symb. Computation, Miskolc Math Notes, Novi Sad J. Math.
- Reviewer for Zentralblatt with 35+ reviews.

Postdoctoral and Ph.D. advisees:

- Gregory Morre; Standard Closure Operations on Several Rings of Dimension One; Ph.D. University of New Mexico; 2016.
- Bryan White; Star Operations and Numerical Semigroup Rings; Ph.D. University of New Mexico; 2014.

Summary of research experience

Algebra is the study of the structure given to sets by operations defined on them. If the structure is rigid enough (i.e. the set has an identity and an inverse with respect to the operation(s)) we are able to solve systems of equations. My research lies in the realm of commutative algebra where our algebraic structures are commutative rings and related structures such as modules and ideals which have two operations, addition and multiplication, both satisfying the commutative property: $a * b = b * a$, for all a and b in our set, where $*$ represents either multiplication or addition. The unifying theme to my research centers around closure operations, which are functions on the set of ideals of a ring which are order preserving, extensive and idempotent.

Since the 20th century many commutative algebraists have studied individual closure operations such as the radical, integral closure, tight closure, and others. Some of these closures have led to breakthroughs in classifying singularities and have resulted in shorter proofs to difficult theorems such as the Briancon-Skoda Theorem. One of my goals concerns classifying specific types of closure operations such as semiprime and prime operations as well as Nakayama closures. In my research, I have noted that some sets of closure operations have interesting algebraic structures in their own right. This algebraic structure may help researchers to better understand the relationships between known closure operations on commutative rings such as the tight closure and the basically full closure.

Associated to a closure operation *cl* many other structures can be defined such as *cl*-reductions and the *cl*-core, which is the intersection of all *cl*-reductions. A second goal is to find a formula for or easy ways to compute the *cl*-core of an ideal for closures such as tight closure and basically full closure. Tight closure has become a useful tool in classifying singularities. A third goal is to use tight closure to determine m-full and basically full ideals in non-regular rings and to use tight closure techniques to determine how far away a graph is from being complete.

Helen J. Wearing
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- University of Manchester, U.K.; B.Sc., 1997; Mathematics and French
- Heriot-Watt University, Edinburgh, U.K.; M.Sc.; 1998; Mathematics
- Heriot-Watt University, Edinburgh, U.K.; Ph.D., 2002; Mathematical Biology
- University of Cambridge, U.K.; Postdoctoral; 2002 - 2004; Ecology
- University of Georgia; Postdoctoral; 2004 - 2007; Epidemiology

Appointments

- Assistant Professor, Departments of Biology and Mathematics & Statistics, UNM; 2007-2013
- Associate Professor, Departments of Biology and Mathematics & Statistics, UNM; 2013 - present

Distinction and Awards

- UNM Outstanding Teacher of the Year Award (2013-2014)

Most relevant publications

- **Wearing, H.J.**, Robert, M. A. & Christofferson, R.C. (2016). Dengue and chikungunya: modeling the expansion of mosquito-borne viruses into naïve populations. *Parasitology* 143: 860-773.
- Gunning, C.E., Erhardt, E. & **Wearing, H.J.** (2014). Conserved patterns of incomplete reporting in pre-vaccine era childhood diseases. *Proceedings of the Royal Society of London: B* 281: 0886.
- Manore, C.A., Hickmann, K.S., Xu, S., **Wearing, H.J.** & Hyman, J.M. (2014). Comparing dengue and chikungunya emergence and endemic transmission in A. aegypti and A. albopictus. *Journal of Theoretical Biology* 356: 174-191.
- Gunning, C. E. & **Wearing, H.J.** (2013). Probabilistic measures of persistence and extinction in measles (meta)populations. *Ecology Letters* 16(8): 985-994.
- WHO-VMI Dengue Vaccine Modeling Group, including **Wearing, H.J.** (2012). Assessing the potential of a candidate dengue vaccine with mathematical modeling. *PLoS Neglected Tropical Diseases* 6: e1450.
- **Wearing, H.J.** & Rohani, P. (2009). Estimating the duration of pertussis immunity using epidemiological signatures. *PLoS Pathogens* 5: e1000647.
- **Wearing, H.J.** & Rohani, P. (2006). Ecological and immunological determinants of dengue epidemics. *PNAS* 103: 11802-11807. *Featured faculty of 1000 Medicine.*
- **Wearing, H.J.**, Rohani, P. & Keeling, M.J. (2005). Appropriate models for the management of infectious diseases. *PLoS Medicine* 2: e174.
- **Wearing, H.J.**, Rohani, P., Cameron T.C. & Sait, S.M. (2004). The dynamical consequences of developmental variability and demographic stochasticity for host-parasitoid interactions. *American Naturalist* 164: 543-558.

- **Wearing, H.J.**, Owen, M.R. & Sherratt, J.A. (2000). Mathematical modelling of juxtacrine patterning. *Bulletin of Mathematical Biology*, 62: 293-320.

Research grants or Contracts.

- 05/01/2011-04/30/2017; U01 MIDAS program NIH/NIGMS; Total award: $3.1 million; UNM portion: $408,723 in total costs.
  Role: co-PI (PI: Christopher Mores, LSU)
  Predicting vector-borne virus transmission dynamics and emergence potential.
- 07/01/2016-06/30/2019; NSF/NIH Joint DMS/NIGMS Initiative to Support Research at the Interface of the Biological and Mathematical Sciences funded by NIH; Total award: $981,793; UNM portion: $357,429 in total costs.
  Role: PI (Lead PI: Rebecca C. Christofferson, LSU)
  Collaborative Research: Characterization of temperature-driven heterogeneity in mosquito populations, the mosquito-arbovirus interaction and subsequent effects on transmission.

Main synergistic/service activities

- Undergraduate research mentoring at UNM (13 total, Honors Thesis (Honors) or Independent Study (IS)): Sandra Baldridge (2008-09, IS), Alexander Washburne (2008-10, Math Honors), Bobby Sena (2009-10, Math Honors), Samuel Bonin (2009-12, Math Honors), Zachary Gillooly (2011-12, Biology Honors), Nathan Cournoyer (2011-12, Biology IS), Joseph DeAguero (2012-13, Math IS), Gabriel Arrillaga (2012-13, Math IS), Nikhil Addleman (2014-15, Math IS), Melody Walker (2014-15, Math Honors), Will Knez (2016, Math IS). Post-baccalaureate students: Nicole Telles (2011-12), Noah Silva (2014-15).
- Workshop teaching
  - Ecology and Evolution of Infectious Disease: Developed or co-developed half-day modules on spectral analysis, age-structured models, simulating stochastic and deterministic disease models in the R programming language. Part of NSF-funded 4-day workshop for graduate students and research scientists at Cornell University (2010), UC Santa Barbara (2011) and University of Michigan (2012).
  - Modeling Infectious Diseases: Co-developed lectures, in-class problem sets, Matlab programs for intensive week-long course aimed at undergraduate and graduate students from institutions across the Southwest (2012, 2014). Part of summer math camp (NSF-funded Mentoring through Critical Transition Points program) at UNM.
- Editorial board, Bulletin of Mathematical Biology.

Postdoctoral and Ph.D. advisees:

- Michael Robert, postdoctoral research associate, UNM (October 2013-present).
- Rebecca Christofferson, postdoctoral research associate based at Louisiana State University (2011-2015). Co-mentored with Christopher Mores, LSU. Currently, assistant professor in the Department of Pathobiological Sciences, School of Veterinary Medicine, LSU.
- Larissa Anderson, PhD advisee, Biology, UNM, expected Spring 2018.
- Cesar Alvarado, PhD advisee, Applied Mathematics, UNM, expected Spring 2017.
- Christian Gunning, PhD advisee, Biology with concentration in Integrative Biology, graduated Summer 2014 with distinction. Dissertation title: *Population and metapopulation ecology of childhood diseases in the pre-vaccine era United States.* Currently, postdoctoral research associate at North Carolina State University.

Summary of research experience

1. My early research explored how different modes of cell-to-cell signaling can be mechanisms for pattern formation during early development and wound healing. Prior to my work, it was thought that juxtacrine (or nearest-neighbor) signaling was limited to generating very short-range signals, which could not explain patterns of cell fate over many cell lengths. The reason for this was an implicit assumption that juxtacrine signaling was driven solely by negative feedback, specifically that ligand binding across neighboring cells led to down-regulation of ligand and receptor expression. My modeling work proposed an alternative mechanism involving nonlinear positive feedback - lateral induction - and demonstrated that juxtacrine signaling could generate signals that propagated across many cell lengths. This work provided an alternative explanation, other than simple diffusion, for the long-range determination of cell fate via ligand-receptor interactions such as Delta-Notch. The publications were a collaboration between myself, my PhD supervisor and another colleague, and resulted from my discovery of the long wavelength solutions to the model presented in the first paper below:

   (a) Wearing HJ, MR Owen & JA Sherratt. Mathematical modelling of juxtacrine patterning. Bulletin of Mathematical Biology 2000; 62:293-320.

   (b) Owen MR, JA Sherratt & HJ Wearing. Lateral induction by juxtacrine signalling is a new mechanism for pattern formation. Developmental Biology 2000; 217:54-61.

   (c) Wearing HJ & JA Sherratt. Nonlinear analysis of juxtacrine patterns. SIAM Journal of Applied Mathematics 2001; 62:283-309.

2. Single-host single-parasite systems are the exception rather than the rule, and yet have traditionally been at the core of epidemiological theory. As a postdoctoral researcher, I was involved in a collaborative effort to develop a general theoretical framework for host-multi-pathogen systems, which encompasses the potential interactions that can occur between related and unrelated pathogens. In Wearing & Rohani 2006, I extended the multi-pathogen framework to vector-borne diseases and used it to examine whether hypotheses about dengue infection and transmission were consistent with patterns in strain-specific incidence data. For the first time in the literature, I demonstrated that a period of temporary cross-immunity between serotypes was sufficient to explain disease incidence from Thailand.

   (a) Wearing HJ & P Rohani. Ecological and immunological determinants of dengue epidemics. PNAS 2006; 103:11802-11807.

   (b) Vasco DA, HJ Wearing & P Rohani. Tracking the dynamics of pathogen interactions: modeling ecological and immune-mediated processes in a two-pathogen single-host system. Journal of Theoretical Biology 2007; 245:9-25.

   (c) Rohani P, HJ Wearing, DA Vasco & Y Huang. Understanding host-multi-pathogen systems: the interaction between ecology and immunology. In Ecology of Infectious Diseases (Eds: Osfeld, Keesing & Eviner), Princeton University Press (2008).

3. A significant portion of the worlds population is at risk from pathogens that are vectored by arthropods, such as mosquitoes and ticks. Despite recent advances in vector control and

vaccine development, an understanding of many aspects of vector-borne pathogen transmission remains elusive. Most importantly, the interaction between the pathogen and the arthropod vector is often the least studied part of the transmission cycle. Following on from my earlier contributions to host-parasite modeling, I have been developing and testing mathematical and computational models of arbovirus transmission with a number of different collaborators. These publications quantify aspects of the ecological, immunological and evolutionary factors important for understanding the effectiveness of control measures in endemic regions and the potential for emergence into novel areas.

(a) Nonaka E, GE Ebel & HJ Wearing. Persistence of pathogens with short infectious periods in seasonal tick populations: the relative importance of three transmission routes. PLoS ONE 2010; 5:e11745.

(b) Stoddard ST, HJ Wearing, RC Reiner Jr., AC Morrison, H Astete, S Vilcarromero, C Alvarez, C Ramal-Asayag, M Sihuincha, C Rocha, ES Halsey, TW Scott, TJ Kochel & BM Forshey. Long-term and seasonal dynamics of dengue in Iquitos, Peru. PLoS Neglected Tropical Diseases 2014; 8:e3003.

(c) Christofferson RC, DM Chisenhall, HJ Wearing & CN Mores. Chikungunya viral fitness measures and subsequent transmission potential. PLoS ONE 2014; 9:e110538.

(d) Wearing HJ, Robert MA & Christofferson RC. Dengue and chikungunya: modelling the expansion of mosquito-borne viruses into nave populations. Parasitology 2016; 143:860-873.

4. Theoretical work on infectious disease dynamics has a long history motivated by the temporal and spatial patterns observed in historical records of human infectious diseases. A large amount of this theory has been validated by a small number of datasets. My research group expanded on these datasets by digitizing historical public health records for measles, pertussis and influenza from the United States. These records provide data over a broad spatial scale and over a significant period of time prior to the introduction of mass vaccination. Together with datasets from England & Wales, I have used these data to ask basic questions about disease persistence in metapopulations, as well as testing ideas about the mechanisms of waning immunity and seasonality. I served as the primary or co-investigator in all of these studies.

   (a) Wearing HJ & P Rohani. Estimating the duration of pertussis immunity using epidemiological signatures. PLoS Pathogens 2009; 5:e1000647.

   (b) Gunning CE & HJ Wearing. Probabilistic measures of persistence and extinction in measles (meta)populations. Ecology Letters 2013; 16:985-994.

   (c) Gunning CE, E Erhardt & HJ Wearing. Conserved patterns of incomplete reporting in pre-vaccine era childhood diseases. Proceedings of the Royal Society B 2014; 281:20140886.

   (d) Gunning CE, E Erhardt & HJ Wearing. Data from: Conserved patterns of incomplete reporting in pre-vaccine era childhood diseases. Dryad Digital Repository (2014). http://dx.doi.org/10.5061/dryad.92p46

5. Theoreticians often neglect variability and stochasticity in models, in preference for a more tractable framework. However, there is a growing body of work that has found

unpredictable discrepancies between the results of deterministic models and their stochastic counterparts. Ultimately, if models are to be used to make quantitative predictions to inform public health policy, then we need to have confidence that our simplifying assumptions are appropriate. These publications represent my contributions to assessing the consequences of such assumptions in ecology and epidemiology. In particular, in Wearing *et al.* 2005, I investigated how changing basic but widely-held assumptions about the duration of the infection process can alter model predictions, and thus change estimates of epidemiological parameters. I found that incorporating more realistic distributions for the latent and infectious periods has profound consequences for the temporal dynamics of an epidemic and has direct implications for the control measures implemented during an outbreak.

(a) Wearing HJ, P Rohani, TC Cameron & SM Sait. The dynamical consequences of developmental variability and demographic stochasticity for host-parasitoid interactions. American Naturalist 2004; 164:543-558.

(b) Wearing HJ, P Rohani & MJ Keeling. Appropriate Models for the Management of Infectious Diseases. PLoS Medicine 2005; 2:e174.

(c) Christofferson RC, CN Mores & HJ Wearing. Characterizing the likelihood of dengue emergence and detection in nave populations. Parasites & Vectors 2014; 7:282.

Guoyi Zhang
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- Ph.D. Mathematics, August 2008, Arizona State University, Tempe, AZ, Major: Statistics. Dissertation Title: Smoothing Splines Using Compactly Supported Positive Definite Radial Basis Function.
  Advisor: Dr. Randall Eubank.
- Master of Management, March 1998, Zhejiang University, Hangzhou, China, Major: Techno-economics.
  Thesis Title: Electric Power Exploitation Investment and Conservation Energy Investment with Durable Development in China.
  Advisor: Dr. Ying Shi.
- Bachelor of Engineering, June 1995, Zhejiang University, Hangzhou, China, Major: Industrial Electrification & Automation.

Appointments

- Associate Professor, August 2015 - Present, Department of Mathematics and Statistics, University of New Mexico.
- Assistant Professor, August 2009 - May 2015, Department of Mathematics and Statistics, University of New Mexico.
- Quantitative Data Analyst, June 2000 - April 2002, Bohua Asset Management Co. Ltd, Beijing, China.
- Team Manager, April 1998 - May 2000, Shanghai Xietong Electronics Co. Ltd, Shanghai, China.

Most relevant publications

- Guoyi Zhang, Rong Liu, Bias-corrected Estimators for Scalar Skew Normal, *Communications in Statistics - Simulation and Computation*, Accepted on 21 Oct 2014, probable date of publication: 2016.
- Guoyi Zhang, Gongzhen Mao and Yang Cheng, Adjusted Confidence Band for Complex Survey Data, *Communications in Statistics-Simulation and Computation*, Accepted on 6 Jan, 2014, probable date of publication: 2016.
- Guoyi Zhang, Zhongxue Chen, Inferences on Correlation Coefficients of Bivariate Log-normal Distributions, *Journal of Applied Statistics*, Vol 42, No.3, p 603-613, 2015.
- Guoyi Zhang, Simultaneous Confidence Intervals for Pairwise Multiple Comparisons in a Two-Way Unbalanced Design with Unequal Variances, *Journal of Statistical Computation and Simulation*, Vol 85, No. 13, pages 2727-2735, 2015.
- Guoyi Zhang, Fletcher Christensen and Wei Zheng, Nonparametric Regression Estimators in Complex Surveys, *Journal of Statistical Computation and Simulation*, Volume 85, Issue 5, pages 1026-1034, 2015.
- Guoyi Zhang, A Parametric Bootstrap Approach for One-way ANOVA under Unequal Variances with Unbalanced data, *Communications in Statistics-Simulation and Computation*, Volume 44, Issue 4, pages 827-832, 2015.

- Guoyi Zhang, Simultaneous Confidence Intervals for Several Inverse Gaussian Populations, *Statistics and Probability Letters*, Vol 92, p 125-131, 2014.
- Guoyi Zhang, Improved R and s Control Charts for Monitoring the Process Variance, *Journal of Applied Statistics*, Vol 41, No. 6, p 1260-1273, 2014.
- Guoyi Zhang, Smoothing Splines Using Compactly Supported Positive Definite Radial Basis Functions, *Computational Statistics,* Vol 27, No. 3, p 573-584, 2012.
- Guoyi Zhang, Brandon Beck, Wentao Luo, Fan Wu, Stephen F. Kingsmore, Donghai Dai, Development of a phylogenetic tree model to investigate the role of genetic mutations in endometrial tumors, *Oncology Report,* Vol 25, No. 5, p 1447-1454, 2011.

Main synergistic/service activities

- Peer-reviewed for *Technometrics, Computational Statistics, Journal of Nonparametric Statistics, Statistics and Probability Letters, Journal of Statistical Computation and Simulation, Communications in Statistics-Simulation and Computation, Communications in Statistics: Theory and Methods, Journal of Applied Statistics, British Journal of Mathematics and Computer Science, International Journal of Production Research, Journal of Statistical Theory and Practice, Brazilian Journal of Probability and Statistics, American Journal of Mathematical and Management Sciences, Empirical Economics, Advances in Statistics.*
- Served on editorial boards for *Austin Statistics, Austin Mathematics, Journal of Mathematics and Statistics,* and *Journal of Probability and Statistics.*
- Served on department scheduling committee, 2011-present.
  Served on statistics hiring committee, Fall 2019-Spring 2011, Fall 2011-Spring 2012, Fall 2012-Spring 2013.
  Served on committee of statistics qualifying examination, 2010-present.
  Served on committee of comprehensive examination, 2010-present.
- Served on Dissertation committee of Ph.D students Justin Tevie, (Department of Economics), Yang Li (Department of Electrical and Computer Engineering), Mario Bkassiny (Department of Electrical and Computer Engineering), and Georges EI-howayek (Department of Electrical and Computer Engineering).
  Served on Thesis committee of Master students Andrew Pope (Manufacturing Engineering), Sean Munson (Manufacturing Engineering), Josh Klein (Manufacturing Engineering), and Adrian Baca (Mechanical Engineering).
  Advised many undergraduate students (Timothy Atkinson, Tyler Cameron, Jianfeng Huang, Yourah Hwang, Todd Maese, Paige Mankey, Jeffrey Shepherd, Tyler Wynkoop, Jeffrey Schneider, Michael Romero, Mackey Makvandi, etc.) and graduate students and wrote many recommendation letters for the students.

Postdoctoral and Ph.D. advisees:

- John Pesko, expected 2017
  Co-advised with Dr. Ronald Christensen
  Dissertation title: "Bootstrap and Objective Bayes Testing with An Application to Heteroscedastic ANOVA".
- Lang Zhou, May 2016
  Co-advised with Dr. Yan Lu
  Dissertation Title: A Neyman Smooth Type Goodness of Fit test with Survey data.

Summary of research experience

My primary research interests are in nonparametric function estimation and computational statistics. Much of my work develops new statistical theory, methods and algorithms in these two areas. My broader research interests also include survey sampling, data mining, mixed models, financial engineering and applications in health care.

I first got interested in nonparametric function estimation when I did research on confidence bands in nonparametric regression. Later, my dissertation work dealt with a fast algorithm for a smoothing spline estimation in multivariate regression. Multivariate regression is a useful way to analyze medical and other types of data collected over time, and smoothing splines are the most efficient method from a computational perspective. Recently, I developed an estimator for generalized additive partially linear models, that is an effective semiparametric regression tool for high dimensional data. I also extended nonparametric confidence bands and smoothing splines from independent and identically distributed (iid) case to complex survey data like that obtained from the Current Population Survey (CPS) (CPS provides important information on the labor force status of the U.S. population). In recent years there are two major trends in survey area: the increased use of large scale surveys, especially by health and social science researchers, to explore associations among behavioural, psychosocial, economical and environmental factors, and the increased use of dual frame sampling designs for surveys to reduce cost and/or to improve population coverage (the union of the landline frame and cell phone frame includes all but about 3% of the U.S. population). My current research "Partially Linear Models in Dual Frame Surveys" intends to provide a useful semiparametric estimator for regression problems in dual frame surveys.

I have worked on a variety of problems in computational statistics. One of the areas I am working on is Analysis of Variance (ANOVA). ANOVA is a method for comparing groups of observations that is widely used in many areas, including sociology, education, medical, psychology, economics and so on. The main focus of ANOVA is testing equality of population mean values of the various groups and multiple comparisons (simultaneous pairwise comparisons). A typical example considers an experiment with a treatment group and a control group. It is often of interest to test whether there is a treatment effect or not. I have developed efficient simultaneous confidence intervals for several models under heteroscedasticity (sub-populations have different variabilities). These simultaneous confidence intervals provide valuable insights and possible solutions to previously unsolved problems under heteroscedasticity. On-going research will consider multiple comparison for multi-way unbalanced design with unequal variances, and bootstrap and objective Bayes testing with an application to heteroscedastic ANOVA. I also investigated some general inference problems related to computational statistics. One of them is tests on the median of a survival curve (survival median). Due to skewness of survival data, survival median is thought to be an important measurement of the survival distribution. Comparing the survival medians rather than the curves is often desirable in analyzing data with censored observations. I have proposed an efficient nonparametric test to compare the survival medians for small samples. This is promising since many pharmaceutical experiments are with small sizes due to the expenses. Other inference problems I have worked with focus on under-examined parameters in some important models, such as the correlation coefficient of a bivariate log-normal, and the shape parameter of a skew normal model. I also have successfully improved the classical Shewhart R and s control charts and the random forest regression estimators. In industry, the R and s control charts are widely used for quality control, such as help keeping our daily used cars and refrigerators with high quality. In data mining, random forests are recognized as a powerful statistical classifier and regression tool. Our proposed methodologies outperform the existing ones and are easy to use.

I have a host of ongoing interests ranging from nonparametric function estimation, computational statistics, survey sampling, mixed models to health care research. I have also pursued opportunities to conduct collaborative research on and off campus. During these years' research, many questions and ideas arose and various types of difficulties were encountered and solved. Gradually, I begin to appreciate the beauty of statistics and enjoy my research.

Maxim Zinchenko
Department of Mathematics and Statistics
University of New Mexico

Professional Preparation

- 2006 – 2009, Postdoc in Mathematics, California Institute of Technology, USA.
- 2006 Ph.D. in Mathematics, University of Missouri – Columbia, USA.
- 2002 M.S. in Applied Mathematics, Kharkiv National University, Ukraine.

Appointments

- 01/2016 – 05/2016 Visiting Scholar, Department of Mathematics, University of Missouri – Columbia, USA.
- 08/2014 – Present Associate Professor, Department of Mathematics and Statistics, University of New Mexico, USA.
- 08/2012 – 08/2014 Assistant Professor, Department of Mathematics and Statistics, University of New Mexico, USA.
- 08/2010 – 08/2012 Assistant Professor, Department of Mathematics, University of Central Florida, USA.
- 08/2009 – 08/2010 Assistant Professor, Department of Mathematics, Western Michigan University, USA.
- 08/2006 – 08/2009 Harry Bateman Research Instructor, Department of Mathematics, California Institute of Technology, USA.
- 08/2002 – 08/2006 Teaching/Research Assistant, Department of Mathematics, University of Missouri – Columbia, USA.

Distinction and Awards

- Invited Speaker at the Karcher Colloquium – a Distinguished Lecture Series at the University of Oklahoma, March 2015.
- US Junior Oberwolfach Fellows Award, July 2013, National Science Foundation.
- Mathematics Distinguished Teaching Award, May 2006, University of Missouri.
- Summer Research Assistantship, 2004 and 2005, University of Missouri.
- Research Assistant Fellowship, Academic Year 2002–03, University of Missouri.
- Degree with Honors, June 2002, Kharkiv National University, Ukraine.
- Honors Fellowship, 1998 – 2002, Kharkiv National University, Ukraine.

Most relevant publications

- J. S. Christiansen, B. Simon, and M. Zinchenko, *Asymptotics of Chebyshev polynomials, I. Subsets of* $\mathbb{R}$, arXiv:1505.02604, 29 pp. To appear in Invent. Math.
- F. Gesztesy, S. N. Naboko, R. Weikard, and M. Zinchenko, *Donoghue-type m-functions for Schrödinger operators with operator-valued potentials*, arXiv:1506.06324, 44 pp. To appear in J. d'Analyse Math.
- F. Gesztesy, R. Weikard, and M. Zinchenko, *On spectral theory for Schrödinger operators with operator-valued potentials*, J. Diff. Eqs. **255** (2013), no. 7, 1784–1827.
- J. S. Christiansen, B. Simon, and M. Zinchenko, *Finite gap Jacobi matrices: I. The isospectral torus, II. The Szegő class, III. Beyond the Szegő class*, Constructive Approximation **32** (2010) 1–65, **33** (2011), 365–403, **35** (2012), 259–272.
- F. Gesztesy and M. Zinchenko, *Symmetrized perturbation determinants and applications to boundary data maps and Krein-type resolvent formulas*, Proc. London Math. Soc. **104** (2012), no. 3, 577–612.

- A. Poltoratski, B. Simon, and M. Zinchenko, *The Hilbert transform of a measure*, J. d'Analyse Math. **111** (2010), no. 1, 247–265.
- R. Weikard and M. Zinchenko, *The inverse resonance problem for CMV operators*, Inverse Problems **26** (2010), no. 5, 055012, 10 pp.
- J. Breuer, E. Ryckman, and M. Zinchenko, *Right limits and reflectionless measures for CMV matrices*, Commun. Math. Phys. **292** (2009), no. 1, 1–28.
- F. Gesztesy, M. Mitrea, and M. Zinchenko, *Variations on a theme of Jost and Pais*, J. Funct. Anal. **253** (2007), no. 2, 399–448.
- F. Gesztesy and M. Zinchenko, *A Borg-type theorem associated with orthogonal polynomials on the unit circle*, J. London Math. Soc. **74** (2006), no. 3, 757–777.

Research grants or Contracts.

- 2013 – 2018 Simons Foundation, Collaboration Grants, CGM–281971, sole PI.
- 2014 – 2016 National Science Foundation, Conference Grant DMS–1400429, co-PI.
- 2009 – 2012 National Science Foundation, Analysis Program, DMS–0965411, sole PI.
- 2013 National Science Foundation, MCTP Grant DMS-1148801, Senior Personnel.

Main synergistic/service activities

Conference organization
- 15th New Mexico Analysis Seminar, Albuquerque, NM, February 2016.
- 13th New Mexico Analysis Seminar, Albuquerque, NM, April 2014.
- AMS special session on Spectral Theory, Albuquerque, NM, April 2014.
- AMS special session on Spectral Theory, Tampa, FL, March 2012.

Teaching, training, and curriculum development
- Developed and taught a 30 hours special course for the NSF sponsored MCTP summer undergraduate mathematics program, Summer 2013.
- Developed and taught 4 graduate topics courses, Springs 2007, 2009, 2013, and 2015.
- Organized a weekly analysis seminar, Spring 2015 and Fall 2010 – Spring 2012.
- Local organizer for the Putnam competition at the University of New Mexico, since 2014.
- Question reviewer for the Department of Energy National Science Bowl (NSB) competition for middle and high school students, Fall 2016.

Research mentorship
- Mentored a graduate research project, 2015 – 2016.
- Mentored a masters thesis, 2014 – 2016.
- Mentored an undergraduate individual study, Fall 2014.
- Co-mentored an undergraduate research project, Summer 2008.

Committee work
- Department of mathematics undergraduate honors committee, Fall 2016.
- College of arts and sciences mid-probationary review committee, Spring 2015.
- Department of mathematics Putnam competition committee, since 2014.
- Qualifying examination committee (complex analysis), since 2013.
- Department of mathematics colloquium committee, 2010 – 2012.
- Dissertation committees for 4 graduate students (3 PhD and 1 MS).

Postdoctoral and Ph.D. advisees:

- –

Summary of research experience

My research interests fall within the broad field of mathematical analysis and include the areas of differential and difference equations of relevance to mathematical physics, spectral and inverse spectral theory for operators associated with these equations, and orthogonal polynomials, which are intimately connected with the difference equations. I study mathematical aspects of problems that originate from physics and engineering and are of independent interest to analysts. My recent research has been focused on spectral and perturbation theory for Jacobi, CMV, and Schrödinger operators. I have been also studying some questions in complex analysis related to boundary behavior of Herglotz and Caratheodory functions which have applications in the spectral theory.

In recent years, I had an active research program which resulted in over **30 publications**. I have been also involved in preparation of a research monograph/textbook on spectral theory which is intended to be a survey of recent results as well as an introduction to the subject for graduate students. Recently, my research has been supported by 2 external grants: a highly competitive **3 years NSF grant** in Analysis Program and a **5 years Simons Foundation grant**. In both grants I am the sole principal investigator. My research has also attracted a substantial interest of the mathematical community. Recently, I have given over **20 invited presentations** at national and international conference and over **50 research talks** at seminars and colloquia.

Attachment: Academic Program Plan for Assessment of Student Learning Outcomes

Academic Program
Plan for Assessment of Student Learning Outcomes

Department of Mathematics and Statistics
College of Arts and Sciences
The University of New Mexico

May 9, 2016

Academic Programs of Study[1] covered in this document:

- B.S. Mathematics, Applied Mathematics Concentration
- B.S. Mathematics, Mathematics Education Concentration
- B.S. Mathematics, Mathematics of Computation Concentration
- B.S. Mathematics, Pure Mathematics Concentration
- B.S. Statistics

Contact Persons for the Assessment Plan
Matthew Blair, Chair of the Undergraduate Committee, `blair@math.unm.edu`
Terry Loring, Chair of the Department, `loring@math.unm.edu`

[1]Academic Program of Study is defined as an approved course of study leading to a certificate or degree reflected on a UNM transcript. A graduate-level program of study typically includes a capstone experience (e.g. thesis, dissertation, professional paper or project, comprehensive exam, etc.).

Contents

A B.S. Mathematics, Applied Mathematics Concentration

A.1 Broad Program Goals & Measurable Student Learning Outcomes

A.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Applied Mathematics concentration will have the following competencies:

A. Mathematics knowledge

- Demonstrate understanding of the foundations of calculus and linear algebra.
- Demonstrate the ability to think logically and critically. Specifically the student will be able to differentiate assumptions from conclusions, and be able to construct logical arguments.

B. Problem solving skills

- Demonstrate how to formulate, analyze, and solve problems in applied mathematics both through analytical and computational techniques.
- Demonstrate scientific judgment and the ability to apply mathematics to problems in other fields.

C. Employment and technical skills

- Translate the undergraduate degree into a viable career path or graduate degree.
- Demonstrate oral and written communication skills.

A.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Effectively perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

A.2 Compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

A.3 Construct rigorous proofs.

B.1 Use techniques from calculus to design analytical and numerical methods to solve applied problems, and understand the accuracy and limitations of the methods.

B.2 Understand simple differential equations models and their applicability.

B.3 Use numerical techniques, and judge their accuracy, for solving mathematical problems.

C.1 Attain sufficient background for success in graduate school.

C.2 Communicate well, orally and in writing, in an applied mathematics context.

UNM Goals	Knowledge	Skills	Responsibility
A.1	X	X	
A.2	X	X	
A.3	X	X	
B.1	X	X	
B.2	X	X	
B.3	X	X	
C.1	X	X	
C.2	X	X	

A.2 Assessment of Student Learning Three-Year Plan

All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

A.2.1 Timeline for Assessment

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year/Semester	Assessment Activities
Year 1, Fall	Accumulate data in MATH 321 and 401. This assesses SLOs A.1-3.
Year 1, Spring	Accumulate data in MATH 316 and 375. Administer exit surveys to graduating class. This assesses SLOs A.1, B.1-3 and C. 1-2.
Year 2, Fall	Accumulate data in MATH 316 and 321. This assesses SLOs A.1, B.2 and C. 2.
Year 2, Spring	Accumulate data in MATH 375 and 401. Administer exit surveys to graduating class. This assesses SLOs A.1-3, B.1,3 and C. 1.
Year 3, Fall	Accumulate data in MATH 316 and 401. This assesses SLOs A.1-3, B.2.
Year 3, Spring	Accumulate data in MATH 321 and 375. Administer exit surveys to graduating class. This assesses SLOs A.1, B.1,3 and C. 1-2.

A.2.2 How will learning outcomes be assessed?

1. What:

   (a) *For each SLO, briefly describe the means of assessment, i.e., what samples of evidence of learning will be gathered or measures used to assess students' accomplishment of the learning outcomes in the three- year plan?*

   Learning outcomes A.1-3 and B.1-3 will be assessed directly by instructors of critical courses in the major: MATH 316, 321, 375, and 401. These courses give an introduction to several of the foundational areas in modern applied mathematics: linear algebra, calculus, differential equations, and numerical analysis. Instructors will pose questions on exams that target each of the learning outcomes. They will then record the data and prepare a report at the end of the semester to be submitted to the undergraduate committee. The students in these classes come from a spectrum of majors in mathematics, statistics, and the sciences. The reports will assess the performance of the class as a whole and of the students within each major.

   Learning outcomes C.1-2 will be assessed indirectly in Math 375. This course is required of all applied mathematics majors. This course has complex homework / project assignments that will be used to assess outcomes C. 1-2. The instructor prepared reports in MATH 375 will contain an additional component that gives the percentage of students who are prepared for graduate school and can demonstrate effective written communication.

   Learning outcomes A.1-3, B.1-3, and C.1-2 will be assessed indirectly by surveying students at two stages. One will be an exit survey given to the graduating class. The other will be given at the end the semester in MATH 316, 321, 375 or 401, depending on the semester. For each survey, questions will ask students to self assess their achievement in these SLOs. The survey given to the graduating class will additionally target their experience within the program and future plans after graduation. Data will be collected on the future plans of graduates as part of the annual report.

   (b) *Indicate whether each measure is **direct** or **indirect**. If you are unsure, contact* `assessmentas@unm.edu` *for clarification. You should have **both direct and indirect measures** and at **least half of the assessment methods/measures program wide will be direct** measures of student learning.*

   The instructor reports are direct measures of assessment, except for the portions of the MATH 375 report focusing on preparedness for graduate school. The exit surveys are indirect.

(c) *Briefly describe the **criteria for success** related to each direct or indirect measures of assessment. What is the program's performance target (e.g., is an acceptable or better performance by 60% of students on a given measure acceptable to the program faculty)? If scoring rubrics are used to define qualitative criteria and measure performance, include them as appendices.*

Instructors will determine the level of success on graded problems by following a rubric. Since grading scales vary amongst instructors, success will not be quantified simply by reporting raw scores.

The undergraduate committee will accumulate the data from exit surveys and report on career paths of the graduates. It is expected that students will be able to successfully apply to graduate school or find employment after graduation.

2. Who: *State explicitly whether the program's assessment will include evidence from all students in the program or a sample. Address the validity of any proposed sample of students. Please note that you are recommended to sample all students in your program; however, sampling approx. 20% of the student population is acceptable if the course's total student population (or student enrollment) exceeds 99 in an academic year. A valid explanation should be provided for samples that are less than 20% of the total student population.*

The direct assessment measures will sample the population of applied math majors in any given semester, namely those students in MATH 316, 321, 375, and 401. These courses are required of all applied math majors. Hence the sample in each semester will be representative of the pool of majors in the department. As a byproduct, the performance of other concentrations and majors will also be assessed.

A.2.3 What is the unit's process to analyze/interpret assessment data and use results to improve student learning?

Briefly describe:

1. *who will participate in the assessment process (the gathering of evidence, the analysis/interpretation, recommendations).*
2. *the process for consideration of the implications of assessment for change:*
   a. *to assessment mechanisms themselves,*
   b. *to curriculum design,*
   c. *to pedagogy*
   ...in the interest of improving student learning.
3. *How, when, and to whom will recommendations be communicated?*

Each semester, class reports will be prepared by those teaching MATH 316, 321, 375, and 401. Reports will then be sent to the undergraduate committee who prepare a yearly report which analyzes and interprets this data. At the end of each school year, the undergraduate committee will distribute a survey to the graduating seniors, then summarize the results in the report.

Once a yearly report has been completed, copies will be distributed to the faculty as a whole. A portion of a faculty meeting will then be dedicated to discussing the report, giving faculty an opportunity to recommend avenues for improvement in the assessment mechanisms, curriculum design, and pedagogy.

B B.S. Mathematics, Mathematics Education Concentration

B.1 Broad Program Goals & Measurable Student Learning Outcomes

B.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Mathematics Education concentration will attain:

A. Mathematics knowledge.

- Demonstrate understanding of the foundations of calculus and linear algebra.
- Demonstrate the ability to think logically and critically. Specifically the student will be able to differentiate assumptions from conclusions, and be able to construct logical arguments.

B. An advanced perspective of high school level mathematics.

C. Employment and technical skills.

- Translate the undergraduate degree into a viable career path or graduate degree.
- Demonstrate communication skills (oral and written).

B.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

A.2 Understand the role of definitions, axioms, and theorems in mathematical work. Recognize whether or not an argument is a valid proof. Produce viable proofs on your own with an appreciation of careful use of language.

B.1 Demonstrate an understanding of algebraic structures and, in particular, an algebraic viewpoint of the real number system.

B.2 Demonstrate an understanding of different models of geometry, both Euclidean and non-Euclidean. In particular, understand the real numbers and the cartesian plane geometrically.

B.3 Understand and develop an appreciation for how mathematics and statistics can be applied to real-world phenomena. Demonstrate problem solving skills.

B.4 Demonstrate an understanding of the importance that functions play in connecting topics across the high school curriculum.

C.1 Demonstrate sufficient preparation in higher level mathematics to become successful high school math teachers.

C.2 Demonstrate effective written mathematical communication.

UNM Goals	Knowledge	Skills	Responsibility
A.1	X	X	
A.2	X	X	
B.1	X	X	
B.2	X	X	
B.3	X	X	
B.4	X	X	
C.1	X	X	
C.2	X	X	

B.2 Assessment of Student Learning Three-Year Plan

All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

B.2.1 Timeline for Assessment

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year/Semester	Assessment Activities
Year 1, Fall	Accumulate data in MATH 322 and 401 and STAT 345 through reports and exit surveys. This assesses SLOs A.1-2, B.1, B.3-4.
Years 1, Spring	Accumulate data in MATH 306 and 327 and STAT 345 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.2, B.2-4, C.1-2.
Year 2, Fall	Accumulate data in MATH 322 and STAT 345 through reports and exit surveys. This assesses SLOs A.2, B.1, B.3-4.
Years 2, Spring	Accumulate data in MATH 306 and 401 and STAT 345 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.1-2, B.2-4, C.1-2.
Year 3, Fall	Accumulate data in MATH 327 and 401 and STAT 345 through reports and exit surveys. This assesses SLOs A.1-2, B.3-4.
Years 3, Spring	Accumulate data in MATH 306 and 327 and STAT 345 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.2, B.2-4, C.1-2.

B.2.2 How will learning outcomes be assessed?

1. What:

   (a) *For each SLO, briefly describe the means of assessment, i.e., what samples of evidence of learning will be gathered or measures used to assess students' accomplishment of the learning outcomes in the three- year plan?*

   Learning outcomes A.1-2 and B.1-4 will be assessed directly by instructors of critical courses in the major: MATH 306, 322, 327, 401, and STAT 345. The math courses give a rigorous, proof-based introduction to several of the foundational areas in modern mathematics: algebra, calculus, discrete structures and geometry. The statistics course gives an introduction to probability and statistics inference for science and engineering students. Instructors will pose questions on exams that target each of the learning outcomes. They will then record the data and prepare a report at the end of the semester to be submitted to the undergraduate committee. The students in these classes come from a spectrum of majors in mathematics, statistics, and the sciences. The reports will thus discuss the performance of the class as a whole and of the students within each major.

   Learning outcomes C.1-2 will be assessed indirectly in MATH 306. This course is a rigorous course in axiomatic and transformational geometry and is required of all mathematics education majors. The reports in MATH 306 will contain an additional component that gives the percentage of students who are prepared for teaching at the high school level and can demonstrate effective written communication.

   Learning outcomes A.1-2, B.1-4, and C.1-2 will be assessed indirectly by surveying students at two stages. One will be an exit survey given to the graduating class. The other will be given at the end the semester in MATH 306, 322, 327, 401, or STAT 345, depending on the semester. For each survey, questions will ask students to self assess their achievement in these SLOs. The survey given to the graduating class will additionally target their experience within the program and future plans after graduation. Data will be collected on the future plans of graduates as part of the annual report.

   (b) *Indicate whether each measure is* ***direct*** *or* ***indirect.*** *If you are unsure, contact* `assessmentas@unm.edu` *for clarification. You should have* ***both direct and indirect measures*** *and at* ***least half of the assessment methods/measures program wide will be direct*** *measures of student learning.*

   The instructor reports are direct measures of assessment, except for the portions of the Math 306 report focusing on preparedness for teaching mathematics at the high school level. The exit surveys are indirect.

(c) *Briefly describe the **criteria for success** related to each direct or indirect measures of assessment. What is the program's performance target (e.g., is an ???acceptable or better??? performance by 60% of students on a given measure acceptable to the program faculty)? If scoring rubrics are used to define qualitative criteria and measure performance, include them as appendices.*

Instructors will determine the level of success on graded problems by following a rubric. Since grading scales vary amongst instructors, success will not be quantified simply by reporting raw scores.

The undergraduate committee will accumulate the data from exit surveys and report on career paths of the graduates. It is expected that students will be able to successfully apply to graduate school or find employment after graduation.

2. <u>Who:</u> *State explicitly whether the program's assessment will include evidence from all students in the program or a sample. Address the validity of any proposed sample of students. Please note that you are recommended to sample all students in your program; however, sampling approx. 20% of the student population is acceptable if the course's total student population (or student enrollment) exceeds 99 in an academic year. A valid explanation should be provided for samples that are less than 20% of the total student population.*

The direct assessment measures will sample the population of math education majors in any given semester, namely those students in the classes mentioned in each semester of the three year plan. These courses are required of all math education majors. Hence the sample in each semester expects to be representative of the pool of majors in the department. As a byproduct, the performance of other concentrations and majors will also be assessed.

B.2.3 What is the unit's process to analyze/interpret assessment data and use results to improve student learning?

Briefly describe:

1. *who will participate in the assessment process (the gathering of evidence, the analysis/interpretation, recommendations).*

2. *the process for consideration of the implications of assessment for change:*

   a. *to assessment mechanisms themselves,*

   b. *to curriculum design,*

c. *to pedagogy*
...in the interest of improving student learning.

3. *How, when, and to whom will recommendations be communicated?*

Each semester, course reports will be prepared by those teaching MATH 306, 322, 327, or 401 and STAT 345. Course reports will then be sent to the undergraduate committee who prepare a yearly report which analyzes and interprets this data. At the end of each school year, the undergraduate committee will distribute a survey to the graduating seniors, then summarize the results in the report.

Once a yearly report has been completed, copies will be distributed to the faculty as a whole. A portion of a faculty meeting will then be dedicated to discussing the report, giving faculty an opportunity to recommend avenues for improvement in the assessment mechanisms, curriculum design, and pedagogy.

C B.S. Mathematics, Mathematics of Computation Concentration

C.1 Broad Program Goals & Measurable Student Learning Outcomes

C.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Mathematics of Computation concentration will have the following competencies:

A. Mathematics knowledge

- Demonstrate understanding of the foundations of calculus and linear algebra.
- Demonstrate the ability to think logically and critically. Specifically the student will be able to differentiate assumptions from conclusions, and be able to construct logical arguments.

B. Problem solving skills

- Demonstrate how to formulate, analyze, and solve problems in applied mathematics both through analytical and computational techniques.
- Demonstrate how to efficiently use various computing platforms to implement computational algorithms.
- Demonstrate scientific judgment and the ability to apply mathematics to problems in other fields.

C. Employment and technical skills

- Translate the undergraduate degree into a viable career path or graduate degree.
- Demonstrate oral and written communication skills.

C.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Effectively perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

A.2 Compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

B.1 Use techniques from calculus to design analytical and numerical methods to solve applied problems, and understand the accuracy and limitations of the methods.

B.2 Use numerical techniques, and judge their accuracy, for solving mathematical problems.

B.3 Implement computational algorithms on, and be able to use shared and distributed memory parallel computing platforms.

C.1 Attain sufficient background for success in graduate school.

C.2 Communicate well, orally and in writing, in an computational mathematics context.

UNM Goals	Knowledge	Skills	Responsibility
A.1	X	X	
A.2	X	X	
A.3	X	X	
B.1	X	X	
B.2	X	X	
B.3	X	X	
C.1	X	X	
C.2	X	X	

C.2 Assessment of Student Learning Three-Year Plan

All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

C.2.1 Timeline for Assessment

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year/Semester	Assessment Activities
Year 1, Fall	Accumulate data in MATH 321, 464, and 471. This assesses SLOs A.1-2 and B.3.
Year 1, Spring	Accumulate data in MATH 375. Administer exit surveys to graduating class. This assesses SLOs B.1-2 and C.1-2.
Year 2, Fall	Accumulate data in MATH 321, 464, and 471. This assesses SLOs A.1-2 and B.3.
Year 2, Spring	Accumulate data in MATH 375. Administer exit surveys to graduating class. This assesses SLOs B. 1-2 and C.1.
Year 3, Fall	Accumulate data in MATH 464 and 471. This assesses SLOs A.1-2, B.3.
Year 3, Spring	Accumulate data in MATH 321 and 375. Administer exit surveys to graduating class. This assesses SLOs A.1, B.1-2 and C. 1-2.

C.2.2 How will learning outcomes be assessed?

1. What:

   (a) *For each SLO, briefly describe the means of assessment, i.e., what samples of evidence of learning will be gathered or measures used to assess students' accomplishment of the learning outcomes in the three- year plan?*

   Learning outcomes A.1-2 and B.1-3 will be assessed directly by instructors of critical courses in the major: MATH 321, 375, 464 and 471. These courses give an introduction to several of the foundational areas in modern computational mathematics: algebra, calculus, differential equations, numerical analysis and parallel computing. Instructors will pose questions on exams and homework that target each of the learning outcomes. They will then record the data and prepare a report at the end of the semester to be submitted to the undergraduate committee. The students in these classes come from a spectrum of majors in mathematics, statistics, and the sciences. The reports will assess the performance of the class as a whole and of the students within each major.

   Learning outcomes C.1-2 will be assessed indirectly in Math 375. This course is required of all mathematics of computation majors. This course has complex homework / project assignments that will be used to assess outcomes C. 1-2. The instructor prepared reports in MATH 375 will contain an additional component that gives the percentage of students who are prepared for graduate school and can demonstrate effective written communication.

   Learning outcomes A.1-2, B.1-3, and C.1-2 will be assessed indirectly by surveying students at two stages. One will be an exit survey given to the graduating class. The other will be given at the end the semester in MATH 321, 375, 464 or 471, depending on the semester. For each survey, questions will ask students to self assess their achievement in these SLOs. The survey given to the graduating class will additionally target their experience within the program and future plans after graduation. Data will be collected on the future plans of graduates as part of the annual report.

   (b) *Indicate whether each measure is* ***direct*** *or* ***indirect****. If you are unsure, contact* `assessmentas@unm.edu` *for clarification. You should have* ***both direct and indirect measures*** *and at* ***least half of the assessment methods/measures program wide will be direct*** *measures of student learning.*

   The instructor reports are direct measures of assessment, except for the portions of the MATH 375 report focusing on preparedness for graduate school. The exit surveys are indirect.

(c) *Briefly describe the* ***criteria for success*** *related to each direct or indirect measures of assessment. What is the program's performance target (e.g., is an acceptable or better performance by 60% of students on a given measure acceptable to the program faculty)? If scoring rubrics are used to define qualitative criteria and measure performance, include them as appendices.*

Instructors will determine the level of success on graded problems by following a rubric. Since grading scales vary amongst instructors, success will not be quantified simply by reporting raw scores.

The undergraduate committee will accumulate the data from exit surveys and report on career paths of the graduates. It is expected that students will be able to successfully apply to graduate school or find employment after graduation.

2. <u>Who:</u> *State explicitly whether the program's assessment will include evidence from all students in the program or a sample. Address the validity of any proposed sample of students. Please note that you are recommended to sample all students in your program; however, sampling approx. 20% of the student population is acceptable if the course's total student population (or student enrollment) exceeds 99 in an academic year. A valid explanation should be provided for samples that are less than 20% of the total student population.*

The direct assessment measures will sample the population of mathematics of computation majors in any given semester, namely those students in MATH 321, 375, 464 and 471. These courses are required of all mathematics of computation majors. Hence the sample in each semester will be representative of the pool of majors in the department. As a byproduct, the performance of other concentrations and majors will also be assessed.

C.2.3 What is the unit's process to analyze/interpret assessment data and use results to improve student learning?

Briefly describe:

1. *who will participate in the assessment process (the gathering of evidence, the analysis/interpretation, recommendations).*
2. *the process for consideration of the implications of assessment for change:*
   a. *to assessment mechanisms themselves,*
   b. *to curriculum design,*
   c. *to pedagogy*
   ...in the interest of improving student learning.

3. *How, when, and to whom will recommendations be communicated?*

Each semester, class reports will be prepared by those teaching MATH 321, 375, 464 and 471. Reports will then be sent to the undergraduate committee who prepare a yearly report which analyzes and interprets this data. At the end of each school year, the undergraduate committee will distribute a survey to the graduating seniors, then summarize the results in the report.

Once a yearly report has been completed, copies will be distributed to the faculty as a whole. A portion of a faculty meeting will then be dedicated to discussing the report, giving faculty an opportunity to recommend avenues for improvement in the assessment mechanisms, curriculum design, and pedagogy.

D B.S. Mathematics, Pure Mathematics Concentration

D.1 Broad Program Goals & Measurable Student Learning Outcomes

D.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Pure concentration will have the following competencies:

A. Demonstrate proficiency in calculus and linear algebra, as well as areas of modern, proof-based mathematics.

B. Demonstrate the ability to think logically and critically. Specifically, the student will be able to differentiate assumptions from conclusions, and be able to construct logical arguments.

C. Translate the undergraduate degree into a viable career path or graduate school.

D.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

A.2 Compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

B.1 Write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.

B.2 Work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.

B.3 Construct counterexamples to mathematical statements and understand the importance of hypotheses.

C.1 Demonstrate sufficient preparation for courses in real and complex analysis, algebra, topology, and geometry at the graduate level.

C.2 Demonstrate effective written mathematical communication.

UNM Goals	Knowledge	Skills	Responsibility
A.1	X	X	
A.2	X	X	
B.1	X	X	
B.2	X	X	
B.3	X	X	
C.1	X	X	
C.2	X	X	

D.2 Assessment of Student Learning Three-Year Plan

All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

D.2.1 Timeline for Assessment

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year/Semester	Assessment Activities
Year 1, Fall	Accumulate data in MATH 321, 322, and 401 through reports and exit surveys. This assesses SLOs A.2, B.1-3.
Year 1, Spring	Accumulate data in MATH 327 and 402 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.2, B.1-3 and C. 1-2.
Year 2, Fall	Accumulate data in MATH 321 and 322 through reports and exit surveys. This assesses SLOs A.1, B.1-3.
Year 2, Spring	Accumulate data in MATH 401 and 402 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.2, B.1-3 and C. 1-2.
Year 3, Fall	Accumulate data in MATH 327 and 401 through reports and exit surveys. This assesses SLOs A.2, B.1-3.
Year 3, Spring	Accumulate data in MATH 321, 327 and 402 through reports and exit surveys. Administer exit surveys to graduating class. This assesses SLOs A.1-2, B.1-3 and C. 1-2.

D.2.2 How will learning outcomes be assessed?

1. <u>What:</u>

   (a) *For each SLO, briefly describe the means of assessment, i.e., what samples of evidence of learning will be gathered or measures used to assess students' accomplishment of the learning outcomes in the three- year plan?*

   Learning outcomes A.1-2 and B.1-3 will be assessed directly by instructors of critical courses in the major: MATH 321, 322, 327, 401, and 402. These courses give a rigorous, proof-based introduction to several of the foundational areas in modern mathematics: algebra, calculus, and discrete structures. Instructors will pose questions on exams that target each of the learning outcomes. They will then record the data and prepare a report at the end of the semester to be submitted to the undergraduate committee. The students in these classes come from a spectrum of majors in mathematics, statistics, and the sciences. The reports will thus discuss the performance of the class as a whole and of the students within each major.

Learning outcomes C.1-2 will be assessed indirectly in Math 402. This course is the second semester of the advanced calculus sequence and required of all pure math majors. The reports in Math 402 will contain an additional component that gives the percentage of students who are prepared for graduate school and can demonstrate effective written communication.

Learning outcomes A.1-2, B.1-3, and C.1-2 will be assessed indirectly by surveying students at two stages. One will be an exit survey given to the graduating class. The other will be given at the end the semester in Math 321, 322, 327, 401, or 402, depending on the semester. For each survey, questions will ask students to self assess their achievement in these SLOs. The survey given to the graduating class will additionally target their experience within the program and future plans after graduation. Data will be collected on the future plans of graduates as part of the annual report.

(b) *Indicate whether each measure is **direct** or **indirect**. If you are unsure, contact* `assessmentas@unm.edu` *for clarification. You should have **both direct and indirect measures** and at **least half of the assessment methods/measures program wide will be direct** measures of student learning.*

The instructor reports are direct measures of assessment, except for the portions of the Math 402 report focusing on preparedness for graduate school. The exit surveys are indirect.

(c) *Briefly describe the **criteria for success** related to each direct or indirect measures of assessment. What is the program's performance target (e.g., is an acceptable or better performance by 60% of students on a given measure acceptable to the program faculty)? If scoring rubrics are used to define qualitative criteria and measure performance, include them as appendices.*

Instructors will determine the level of success on graded problems by following a rubric. Since grading scales vary amongst instructors, success will not be quantified simply by reporting raw scores.

The undergraduate committee will accumulate the data from exit surveys and report on career paths of the graduates. It is expected that students will be able to successfully apply to graduate school or find employment after graduation.

2. <u>Who:</u> *State explicitly whether the program's assessment will include evidence from all students in the program or a sample. Address the validity of any proposed sample of*

students. Please note that you are recommended to sample all students in your program; however, sampling approx. 20% of the student population is acceptable if the course's total student population (or student enrollment) exceeds 99 in an academic year. A valid explanation should be provided for samples that are less than 20% of the total student population.

The direct assessment measures will sample the population of pure majors in any given semester, namely those students in MATH 321, 322, 327, 401, and 402. These courses are required of all pure math majors. Hence the sample in each semester will be representative of the pool of majors in the department. As a byproduct, the performance of other concentrations and majors will also be assessed.

D.2.3 What is the unit's process to analyze/interpret assessment data and use results to improve student learning?

Briefly describe:

1. *who will participate in the assessment process (the gathering of evidence, the analysis/interpretation, recommendations).*
2. *the process for consideration of the implications of assessment for change:*
   a. *to assessment mechanisms themselves,*
   b. *to curriculum design,*
   c. *to pedagogy*
   ...in the interest of improving student learning.
3. *How, when, and to whom will recommendations be communicated?*

Each semester, class reports will be prepared by those teaching MATH 321, 322, 327, 401, and 402. Reports will then be sent to the undergraduate committee who prepare a yearly report which analyzes and interprets this data. At the end of each school year, the undergraduate committee will distribute a survey to the graduating seniors, then summarize the results in the report.

Once a yearly report has been completed, copies will be distributed to the faculty as a whole. A portion of a faculty meeting will then be dedicated to discussing the report, giving faculty an opportunity to recommend avenues for improvement in the assessment mechanisms, curriculum design, and pedagogy.

E B.S. Statistics

E.1 Broad Program Goals & Measurable Student Learning Outcomes

E.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Statistics concentration will have the following competencies:

A. Proficiency in probability and statistical theory and methods.

B. Ability to manipulate and visualize data and to compute standard statistical summaries.

C. Skill in applying fundamental mathematical techniques.

E.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Correctly analyze and interpret the results from standard designed experiments, sample surveys, and observational studies, understand the limitations of the procedures and the appropriate scope of conclusions.

B.1 Implement basic computer science skills needed for statistics, including a) data management tools, and b) use of a statistical software package for standard analyses.

B.2 Demonstrate competence in data management, summarizing, and plotting using a high-level statistical programming language (such as R, SAS, or Stata).

C.1 Demonstrate knowledge of basic mathematical skills needed for statistics, including a) probability and statistical theory, b) calculus foundations, c) symbolic and abstract thinking, and d) linear algebra.

C.2 Solve probability problems, with discrete and continuous univariate random variables, and apply the Central Limit Theorem.

UNM Goals	Knowledge	Skills	Responsibility
A.1	X	X	
B.1	X	X	
B.2	X	X	
C.1	X	X	
C.2	X	X	

E.2 Assessment of Student Learning Three-Year Plan

All programs are expected to measure some outcomes and report annually and to measure all program outcomes at least once over a three-year review cycle.

E.2.1 Timeline for Assessment

In the table below, briefly describe the timeframe over which your unit will conduct the assessment of learning outcomes selected for the three-year plan. List when outcomes will be assessed and which semester/year the results will be discussed and used to improve student learning (e.g., discussed with program faculty, interdepartmental faculty, advisory boards, students, etc.)

Year/Semester	Assessment Activities	SLOs
Year 1, Fall	Accumulate data in STAT 345 and STAT 427 through reports and exit surveys.	B.1-2, C.1-2
Year 1, Spring	Accumulate data in STAT 345 and STAT 428 through reports and exit surveys. Administer exit surveys to graduating class.	A.1, B.1-2, C.1-2
Year 2, Fall	Accumulate data in STAT 345 and STAT 440 through reports and exit surveys.	B.1-2, C.1-2
Year 2, Spring	Accumulate data in STAT 345 and STAT 445 through reports and exit surveys. Administer exit surveys to graduating class.	A.1, B.1-2, C.1-2
Year 3, Fall	Accumulate data in STAT 345, STAT 427, and STAT 440 through reports and exit surveys.	B.1-2, C.1-2
Year 3, Spring	Accumulate data in STAT 345, STAT 428, and STAT 445 through reports and exit surveys. Administer exit surveys to graduating class.	A.1, B.1-2, C.1-2

E.2.2 How will learning outcomes be assessed?

1. What:

   (a) *For each SLO, briefly describe the means of assessment, i.e., what samples of evidence of learning will be gathered or measures used to assess students' accomplishment of the learning outcomes in the three- year plan?*

   Learning outcomes A.1 and B.1-2 will be assessed directly by instructors of critical courses in the major: STAT 427, 428, 440, and 445. These courses give both theoretical and applied treatments of ANOVA and Regression. Instructors will pose questions on assignments (in-class, homework, or exams) that target each of the learning outcomes. They will then record the data and prepare a report at the end of the semester to be submitted to the undergraduate committee. The students in these classes come from a spectrum of majors in statistics, the sciences, public policy, and social sciences. The reports will thus discuss the performance of the class as a whole and of the students within each major.

Learning outcomes C.1-2 will be assessed directly in STAT 345. This probability course is required of stat majors, but many students from engineering also take it.

All learning outcomes will be assessed indirectly by surveying students at two stages. One will be an exit survey given to the graduating class. The other will be given at the end the semester in the classes being evaluated, depending on the semester. For each survey, questions will ask students to self assess their achievement in these SLOs. The survey given to the graduating class will additionally target their experience within the program and future plans after graduation. Data will be collected on the future plans of graduates as part of the annual report.

(b) *Indicate whether each measure is* ***direct*** *or* ***indirect****. If you are unsure, contact* `assessmentas@unm.edu` *for clarification. You should have* ***both direct and indirect measures*** *and at* ***least half of the assessment methods/measures program wide will be direct*** *measures of student learning.*

The instructor reports are direct measures of assessment. The exit surveys are indirect.

(c) *Briefly describe the* ***criteria for success*** *related to each direct or indirect measures of assessment. What is the program's performance target (e.g., is an acceptable or better performance by 60% of students on a given measure acceptable to the program faculty)? If scoring rubrics are used to define qualitative criteria and measure performance, include them as appendices.*

Instructors will determine the level of success on graded problems by following a rubric. Since grading scales vary amongst instructors, when there are multiple graders success will not be quantified simply by reporting raw scores.

The undergraduate committee will accumulate the data from exit surveys and report on career paths of the graduates. It is expected that students will be able to successfully apply to graduate school or find employment after graduation.

2. <u>Who:</u> *State explicitly whether the program's assessment will include evidence from all students in the program or a sample. Address the validity of any proposed sample of students. Please note that you are recommended to sample all students in your program; however, sampling approx. 20% of the student population is acceptable if the course's total student population (or student enrollment) exceeds 99 in an academic year. A valid explanation should be provided for samples that are less than 20% of the total student population.*

The direct assessment measures will sample the population of statistics majors in any given semester, namely those students in the courses being assessed in Section E.2.1. These courses are required of all statistics majors. Hence, over time, we expect each student will be evaluated at multiple points in their program.

E.2.3 What is the unit's process to analyze/interpret assessment data and use results to improve student learning?

Briefly describe:

1. *who will participate in the assessment process (the gathering of evidence, the analysis/interpretation, recommendations).*

2. *the process for consideration of the implications of assessment for change:*

   a. *to assessment mechanisms themselves,*

   b. *to curriculum design,*

   c. *to pedagogy*
   ...in the interest of improving student learning.

3. *How, when, and to whom will recommendations be communicated?*

Each semester, class reports will be prepared by those teaching the courses being assessed in Section E.2.1. Reports will then be sent to the undergraduate committee who prepare a yearly report which analyzes and interprets this data. At the end of each school year, the undergraduate committee will distribute a survey to the graduating seniors, then summarize the results in the report.

Once a yearly report has been completed, copies will be distributed to the faculty as a whole. A portion of a faculty meeting will then be dedicated to discussing the report, giving faculty an opportunity to recommend avenues for improvement in the assessment mechanisms, curriculum design, and pedagogy.

F Exit Survey

This is a draft example of an exit survey consisting of three primary questions.
0. Circle your program

- Applied Mathematics
- Computational Mathematics
- Mathematical Education
- Pure Mathematics
- Statistics

1. How well did you achieve each of the following departmental student learning outcomes for your program?

For your program only, evaluate each learning outcome using this rating scale:
5 = extremely well, 4 = very well, 3 = adequately well, 2 = not very well, 1 = not at all

Applied Mathematics

_____ A.1 Be able to effectively perform essential computations in linear algebra, including solving linear systems and computing the eigenvalues of a matrix.

_____ A.2 Be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

_____ A.3 Be able to construct rigorous proofs.

_____ B.1 Be able to use techniques from calculus, such as Taylor's approximation, to approximate derivatives, integrals and to solve scalar equations.

_____ B.2 Be able to understand simple differential equations models and their applicability.

_____ B.3 Be able to use numerical techniques, and judge their accuracy, for solving mathematical problems.

_____ C.1 Attain sufficient background for success in graduate school.

_____ C.2 Communicate well, orally and in writing, in an applied mathematics context.

Mathematics Education

_____ A.1 Students will be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

_____ A.2 Understand the role of definitions and proofs in mathematical work; be able to produce viable proofs on your own with an appreciation of careful use of language; and recognize whether a proof is valid or not.

_____ B.1 Demonstrate an understanding of algebraic structures and, in particular, an algebraic viewpoint of the real number system.

_____ B.2 Demonstrate an understanding of different models of geometry, both Euclidean and non-Euclidean. In particular, understand the real numbers and the Cartesian plane geometrically.

_____ B.3 Understand and develop an appreciation for how mathematics and statistics can be applied to real-world phenomena. Demonstrate problem solving skills.

_____ B.4 Demonstrate an understanding of the importance that functions play in connecting topics across the high school curriculum.

_____ C.1 Students will have sufficient preparation in higher level mathematics to become successful high school math teachers.

_____ C.2 Students will demonstrate effective written mathematical communication

Mathematics of Computation

_____ A.1 Be able to effectively perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

_____ A.2 Be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

_____ B.1 Be able to use techniques from calculus, such as Taylor's approximation, to approximate derivatives, integrals and to solve scalar equations.

_____ B.2 Be able to use numerical techniques, and judge their accuracy, for solving mathematical problems.

_____ B.3 Be able to implement computational algorithms on, and be able to use shared and distributed memory parallel computational platforms.

_____ C.1 Attain sufficient background for success in graduate school.

_____ C.2 Communicate well, orally and in writing, in an applied mathematics context.

Pure Mathematics

______ A.1 Students will be able to effectively perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

______ A.2 Students will be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

______ B.1 Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.

______ B.2 Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.

______ B.3 Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

______ C.1 Students will have sufficient preparation for courses in real and complex analysis, algebra, topology, and geometry at the graduate level.

______ C.2 Students will demonstrate effective written mathematical communication.

Statistics

______ A.1 Be able to correctly apply, analyze, and interpret the results from standard designed experiments, sample surveys, and observational studies, understanding the limitations of the procedures and the appropriate scope of conclusions.

______ B.1 Implement basic computer science skills needed for statistics, including a) data management tools, b) basic programming algorithms and logic, c) use of a statistical software package for standard analyses.

______ B.2 Demonstrate competence in data management, summarizing, and plotting using a high-level statistical programming language (such as R, SAS, or Stata) and reproducible research tools (such as knitr).

______ C.1 Demonstrate their knowledge of basic mathematical skills needed for statistics, including a) probability and statistical theory, b) calculus foundations, c) symbolic and abstract thinking, and d) linear algebra.

______ C.2 Solve probability problems in finite sample spaces, with discrete and continuous univariate random variables, and apply the Central Limit Theorem.

2. What aspects of your education in this program helped you with your learning, and why were they helpful? For example, use of technology, instructor feedback, group work, opportunity to present work in front of others, course sequence, etc.

3. What might the department do differently that would help you learn more effectively, and why would these actions help? Please be as specific as possible; this is your opportunity to improve the program.

4. In hindsight, would you change anything about the order in which you took certain courses? If so, why?

Thank you for your valuable feedback.

Attachement: Course Rubrics

Rubrics For Math 321

1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the pure and applied math majors. The following SLOs are pertinent to the course content in Math 321.

1. Perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.
2. Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.
3. Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.
4. Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Math 321 offers several opportunities for creating exam questions which assess student performance in these areas. Outcome #1 will most likely be assessed in a number of exams questions. Outcome #2 will also be naturally assessed in questions that ask students to prove mathematical statements. Outcome #3 can be assessed by questions which involve an "if and only if" statement or by questions which naturally involve a proof by contrapositive or proof by contradiction. Outcome #4 can be assessed by questions which ask students to disprove a mathematical statement, perhaps after a certain hypothesis is relaxed.

Every instructor for Math 321 is asked to complete a "Semester Report", which provides data on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an electronically administered survey.

2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor's chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a "very good" solution while others may expect 100% credit to be rated at this level, using the "excellent" rating to distinguish exceptional solutions.

2.1 Rubric for SLO #1:

Perform essential computations in linear algebra, including solving linear systems, computing the eigenvalues of a matrix, and determining linear independence.

Excellent	Work shown is exemplary and the student's thought process is lucid. Student demonstrates a clear understanding of the pertinent definitions. Mathematical and English language is highly articulate.
Very Good	Work shown is cogent and the student's thought process is apparent. Student demonstrates an understanding of the pertinent definitions. Mathematical and English language is easily understandable.
Satisfactory	Work shown is comprehensible and the student's thought process is discernable. Student understands the essence of the pertinent definitions. Mathematical and English language is decipherable.
Questionable	Partial progress on the problem is demonstrated. Student's thought process is difficult to follow. It is uncertain if the student has an understanding of the pertinent definitions. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Incomplete solution, with insufficient progress on the problem shown. Student's thought process is mostly undiscernable. Student does not seem to understand the pertinent definitions. Errors are striking. Mathematical and English language is unclear.

2.2 Rubric for SLO #2:

Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.

Excellent	Exemplary proof, with full justification for each step and the logic of argument flows naturally. The chosen strategy for the proof is natural, well motivated, and effective. Proof shows full comprehension of the pertinent mathematical definitions. Mathematical and English language is highly articulate.
Very Good	Cogent proof, with most key steps clearly justified. The chosen strategy for the proof is apparent and effective. Proof shows good comprehension of the pertinent mathematical definitions. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof, with justification for the essential steps. The chosen strategy for the proof is recognizable and mostly effective. Proof shows reasonable comprehension of the pertinent mathematical definitions. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the proof, only some essential steps are justified. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof, essential steps lack justification. The chosen strategy for the proof is unclear and/or ineffective. Comprehension of the pertinent mathematical definitions is uncertain. Errors are striking. Mathematical and English language is unclear.

2.3 Rubric for SLO #3:

Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.

Excellent	Exemplary proof which demonstrates full comprehension of the fundamentals of logic. The chosen strategy for the proof is natural, well motivated, and effective. Student has a clear understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is highly articulate.
Very Good	Cogent proof which demonstrates good comprehension of the fundamentals of logic. The chosen strategy for the proof is apparent and effective. Student has a good understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is easily understandable.
Satisfactory	Understandable proof which demonstrates reasonable comprehension of the fundamentals of logic. The chosen strategy for the proof is recognizable and mostly effective. Student has an understanding of what constitutes the converse or contrapositive statement. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Incomplete proof which demonstrates a partial comprehension of the fundamentals of logic. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Student indicates a partial understanding of what constitutes the converse or contrapositive statement. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which demonstrates little or no comprehension of the fundamentals of logic. The chosen strategy for the proof is unclear and/or ineffective. Student does not demonstrate an understanding of what constitutes the converse or contrapositive statement. Errors are striking. Mathematical and English language is unclear.

2.4 Rubric for SLO #4:

Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Excellent	Exemplary proof which disproves a mathematical statement by constructing a natural counterexample. Proof includes full justification for why the example satisfies the hypothesis but not the conclusion. Student has a complete understanding that the mathematical statement is false. Mathematical and English language is highly articulate.
Very Good	Cogent proof which disproves a mathematical statement by constructing an effective counterexample. Proof includes justification for why the example satisfies the hypothesis but not the conclusion. Student has a good understanding that the mathematical statement is false. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof which disproves a mathematical statement by constructing an effective counterexample. Student gives at least some indication why the example satisfies the hypothesis but not the conclusion. Student has some understanding that the mathematical statement is false. Mathematical and English language is decipherable.
Questionable	Incomplete proof with only partial progress towards a counterexample. Student may show some comprehension of the relevant concepts, but not necessarily that the statement is false. Student understands that the statement is false, but does not justify why the hypotheses are satisfied but not the conclusion. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which casts some doubt as to whether or not the student understands the falsity of the statement. Errors are striking. Mathematical and English language is unclear.

Semester Reports For Math 322

1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the pure and applied math majors. The following SLOs are pertinent to the course content in Math 322.

1. Understand the role of definitions and proofs in mathematical work; be able to produce viable proofs on your own with an appreciation of careful use of language; and recognize whether a proof is valid or not.

2. Demonstrate an understanding of algebraic structures and, in particular, an algebraic viewpoint of the real number system.

3. Demonstrate an understanding of the fundamental importance that functions play in mathematics.

Math 322 offers several opportunities for creating exam questions which assess student performance in these areas. Outcome #1 will be naturally be assessed in most exam questions. Outcome #2 can be assessed by questions pertaining to groups, rings and fields and their substructures. Outcome #3 can be assessed by questions pertaining to binary operations, homomorphisms, one to one correspondences and group actions.

Every instructor for Math 322 is asked to complete a “Semester Report”, which provides data on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an end of semester survey.

2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor’s chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a “very good” solution while others may expect 100% credit to be rated at this level, using the “excellent” rating to distinguish exceptional solutions.

2.1 Rubric for SLO #1:

Understand the role of definitions and proofs in mathematical work; be able to produce viable proofs on your own with an appreciation of careful use of language; and recognize whether a proof is valid or not.

Excellent	Exemplary proof, with full justification for each step and the logic of argument flows naturally. The chosen strategy for the proof is natural, well motivated, and effective. Proof shows full comprehension of the pertinent mathematical definitions. Mathematical and English language is highly articulate.
Very Good	Cogent proof, with most key steps clearly justified. The chosen strategy for the proof is apparent and effective. Proof shows good comprehension of the pertinent mathematical definitions. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof, with justification for the essential steps. The chosen strategy for the proof is recognizable and mostly effective. Proof shows reasonable comprehension of the pertinent mathematical definitions. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the proof, only some essential steps are justified. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof, essential steps lack justification. The chosen strategy for the proof is unclear and/or ineffective. Comprehension of the pertinent mathematical definitions is uncertain. Errors are striking. Mathematical and English language is unclear.

2.2 Rubric for SLO #2:

Demonstrate an understanding of algebraic structures and, in particular, an algebraic viewpoint of the real number system.

Excellent	Exemplary proof pertaining to groups, rings, fields, or some substructures of the aforementioned structures. The chosen strategy for the proof is natural, well motivated, and effective. Student has a clear understanding of what properties need to be shown to exhibit the set along with binary operation(s) is the algebraic structure in question. Mathematical and English language is highly articulate.
Very Good	Cogent proof pertaining to groups, rings, fields, or some substructures of the aforementioned structures. The chosen strategy for the proof is apparent and effective. Student has a good understanding of what properties need to be shown to exhibit the set along with binary operation(s) is the algebraic structure in question. Mathematical and English language is easily understandable.
Satisfactory	Understandable proof pertaining to groups, rings, fields, or some substructures of the aforementioned structures. The chosen strategy for the proof is recognizable and mostly effective. Student has an understanding of what properties need to be shown to exhibit the set along with binary operation(s) is the algebraic structure in question. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Incomplete proof which demonstrates a partial comprehension of groups, rings, fields, or some substructures of the aforementioned structures.. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Student indicates a partial understanding of what properties need to be shown to exhibit the set along with binary operation(s) is the algebraic structure in question. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which demonstrates little or no comprehension of showing a set with one (or two binary operations) is a specific type of group, ring field or some substructure of the aforementioned structures. The chosen strategy for the proof is unclear and/or ineffective. Student does not demonstrate an understanding of what needs to be shown to exhibit the set along with binary operation(s) is the algebraic structure in question. Errors are striking. Mathematical and English language is unclear.

2.3 Rubric for SLO #3:

Demonstrate an understanding of the fundamental importance that functions play in mathematics.

Excellent	Exemplary proof pertaining to binary operations, homomorphisms, one to one correspondences and group actions. Proof clearly and concisely justifies all of the properties of the function in question. Mathematical and English language is highly articulate.
Very Good	Cogent proof pertaining to binary operations, homomorphisms, one to one correspondences and group actions. Proof does a good job of justifying almost all of the properties of the function in question. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof pertaining to binary operations, homomorphisms, one to one correspondences and group actions. Proof does a satisfactory job of justifying most of the properties of the function in question. Mathematical and English language is decipherable.
Questionable	Incomplete proof pertaining to binary operations, homomorphisms, one to one correspondences and group actions. Student may show some comprehension of the relevant function, but has gaps in the justification. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which casts some doubt as to whether or not the student understands binary operations, homomorphisms, one to one correspondences and group actions. Errors are striking. Mathematical and English language is unclear.

Rubrics For Math 327

1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the pure and applied math majors. The following SLOs are pertinent to the course content in Math 327.

1. Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.
2. Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.
3. Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Math 327 offers several opportunities for creating exam questions which assess student performance in these areas. Outcome #1 will be naturally be assessed in many exam questions. Outcome #2 can be assessed by questions which involve an "if and only if" statement or by questions which naturally involve a proof by contrapositive or proof by contradiction. Outcome #3 can be assessed by questions which ask students to disprove a mathematical statement, perhaps after a certain hypothesis is relaxed.

Every instructor for Math 327 is asked to report on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an electronically administered survey.

2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor's chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a "very good" solution while others may expect

100% credit to be rated at this level, using the "excellent" rating to distinguish exceptional solutions.

2.1 Rubric for SLO #1:

Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.

Excellent	Exemplary proof, with full justification for each step and the logic of argument flows naturally. The chosen strategy for the proof is natural, well motivated, and effective. Proof shows full comprehension of the pertinent mathematical definitions. Mathematical and English language is highly articulate.
Very Good	Cogent proof, with most key steps clearly justified. The chosen strategy for the proof is apparent and effective. Proof shows good comprehension of the pertinent mathematical definitions. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof, with justification for the essential steps. The chosen strategy for the proof is recognizable and mostly effective. Proof shows reasonable comprehension of the pertinent mathematical definitions. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the proof, only some essential steps are justified. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof, essential steps lack justification. The chosen strategy for the proof is unclear and/or ineffective. Comprehension of the pertinent mathematical definitions is uncertain. Errors are striking. Mathematical and English language is unclear.

2.2 Rubric for SLO #2:

Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.

Excellent	Exemplary proof which demonstrates full comprehension of the fundamentals of logic. The chosen strategy for the proof is natural, well motivated, and effective. Student has a clear understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is highly articulate.
Very Good	Cogent proof which demonstrates good comprehension of the fundamentals of logic. The chosen strategy for the proof is apparent and effective. Student has a good understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is easily understandable.
Satisfactory	Understandable proof which demonstrates reasonable comprehension of the fundamentals of logic. The chosen strategy for the proof is recognizable and mostly effective. Student has an understanding of what constitutes the converse or contrapositive statement. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Incomplete proof which demonstrates a partial comprehension of the fundamentals of logic. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Student indicates a partial understanding of what constitutes the converse or contrapositive statement. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which demonstrates little or no comprehension of the fundamentals of logic. The chosen strategy for the proof is unclear and/or ineffective. Student does not demonstrate an understanding of what constitutes the converse or contrapositive statement. Errors are striking. Mathematical and English language is unclear.

2.3 Rubric for SLO #3:

Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Excellent	Exemplary proof which disproves a mathematical statement by constructing a natural counterexample. Proof includes full justification for why the example satisfies the hypothesis but not the conclusion. Student has a complete understanding that the mathematical statement is false. Mathematical and English language is highly articulate.
Very Good	Cogent proof which disproves a mathematical statement by constructing an effective counterexample. Proof includes justification for why the example satisfies the hypothesis but not the conclusion. Student has a good understanding that the mathematical statement is false. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof which disproves a mathematical statement by constructing an effective counterexample. Student gives at least some indication why the example satisfies the hypothesis but not the conclusion. Student has some understanding that the mathematical statement is false. Mathematical and English language is decipherable.
Questionable	Incomplete proof with only partial progress towards a counterexample. Student may show some comprehension of the relevant concepts, but not necessarily that the statement is false. Student understands that the statement is false, but does not justify why the hypotheses are satisfied but not the conclusion. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which casts some doubt as to whether or not the student understands the falsity of the statement. Errors are striking. Mathematical and English language is unclear.

Semester Reports For Math 401

1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the pure and applied math majors. The following SLOs are pertinent to the course content in Math 401.

1. Students will be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.
2. Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.
3. Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.
4. Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Math 401 offers several opportunities for creating exam questions which assess student performance in these areas. Outcome #1 can be assessed by asking students to prove the existence of a limit or convergence of a sequence using the formal ϵ-δ or ϵ-N definition. Outcome #2 will be naturally be assessed in most exam questions. Outcome #3 can be assessed by questions which involve an "if and only if" statement or by questions which naturally involve a proof by contrapositive or proof by contradiction. Outcome #4 can be assessed by questions which ask students to disprove a mathematical statement, perhaps after a certain hypothesis is relaxed.

Every instructor for Math 401 is asked to complete a "Semester Report", which provides data on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an electronically administered survey.

2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor's chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a "very good" solution while others may expect 100% credit to be rated at this level, using the "excellent" rating to distinguish exceptional solutions.

2.1 Rubric for SLO #1:

Students will be able to compute limits and derivatives using their definitions, and use the fundamental theorem of calculus to compute definite and indefinite integrals.

Excellent	Exemplary ϵ-δ or ϵ-N proof, with full justification for each step and the logic of argument flows naturally. Choice of the threshold δ or N is well motivated and effective for the given problem. Mathematical and English language is highly articulate.
Very Good	Cogent ϵ-δ or ϵ-N proof, with most key steps clearly justified. Choice of the threshold δ or N is effective for the given problem. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible ϵ-δ or ϵ-N proof, with justification for the essential steps. Choice of the threshold δ or N is effective for the given problem. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the ϵ-δ or ϵ-N proof, only some essential steps are justified. Some visible progress on selecting the choice of the threshold δ or N for the given problem. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written ϵ-δ or ϵ-N proof, essential steps lack justification. Choice of the threshold δ or N is unclear or is ineffective for the given problem. Errors are striking. Mathematical and English language is unclear.

2.2 Rubric for SLO #2:

Students will be able to write rigorous and well written proofs which show comprehension of formal mathematical definitions, recognize hypotheses, and form logical conclusions.

Excellent	Exemplary proof, with full justification for each step and the logic of argument flows naturally. The chosen strategy for the proof is natural, well motivated, and effective. Proof shows full comprehension of the pertinent mathematical definitions. Mathematical and English language is highly articulate.
Very Good	Cogent proof, with most key steps clearly justified. The chosen strategy for the proof is apparent and effective. Proof shows good comprehension of the pertinent mathematical definitions. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof, with justification for the essential steps. The chosen strategy for the proof is recognizable and mostly effective. Proof shows reasonable comprehension of the pertinent mathematical definitions. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the proof, only some essential steps are justified. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof, essential steps lack justification. The chosen strategy for the proof is unclear and/or ineffective. Comprehension of the pertinent mathematical definitions is uncertain. Errors are striking. Mathematical and English language is unclear.

2.3 Rubric for SLO #3:

Students will be able to work with the fundamentals of logic, including mathematical statements and their converses and contrapositives.

Excellent	Exemplary proof which demonstrates full comprehension of the fundamentals of logic. The chosen strategy for the proof is natural, well motivated, and effective. Student has a clear understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is highly articulate.
Very Good	Cogent proof which demonstrates good comprehension of the fundamentals of logic. The chosen strategy for the proof is apparent and effective. Student has a good understanding of what constitutes the converse or contrapositive statement. Mathematical and English language is easily understandable.
Satisfactory	Understandable proof which demonstrates reasonable comprehension of the fundamentals of logic. The chosen strategy for the proof is recognizable and mostly effective. Student has an understanding of what constitutes the converse or contrapositive statement. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Incomplete proof which demonstrates a partial comprehension of the fundamentals of logic. The chosen strategy for the proof has potential. Proof shows an indication of some comprehension of the pertinent mathematical definitions. Student indicates a partial understanding of what constitutes the converse or contrapositive statement. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which demonstrates little or no comprehension of the fundamentals of logic. The chosen strategy for the proof is unclear and/or ineffective. Student does not demonstrate an understanding of what constitutes the converse or contrapositive statement. Errors are striking. Mathematical and English language is unclear.

2.4 Rubric for SLO #4:

Students will be able to construct counterexamples to mathematical statements and understand the importance of hypotheses.

Excellent	Exemplary proof which disproves a mathematical statement by constructing a natural counterexample. Proof includes full justification for why the example satisfies the hypothesis but not the conclusion. Student has a complete understanding that the mathematical statement is false. Mathematical and English language is highly articulate.
Very Good	Cogent proof which disproves a mathematical statement by constructing an effective counterexample. Proof includes justification for why the example satisfies the hypothesis but not the conclusion. Student has a good understanding that the mathematical statement is false. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible proof which disproves a mathematical statement by constructing an effective counterexample. Student gives at least some indication why the example satisfies the hypothesis but not the conclusion. Student has some understanding that the mathematical statement is false. Mathematical and English language is decipherable.
Questionable	Incomplete proof with only partial progress towards a counterexample. Student may show some comprehension of the relevant concepts, but not necessarily that the statement is false. Student understands that the statement is false, but does not justify why the hypotheses are satisfied but not the conclusion. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written proof which casts some doubt as to whether or not the student understands the falsity of the statement. Errors are striking. Mathematical and English language is unclear.

Semester Reports For Math 471

1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the pure and applied math majors. The following SLOs are pertinent to the course content in Math 471.

1. Use techniques from calculus to design analytical and numerical methods to solve applied problems, and understand the accuracy and limitations of the methods.
2. Understand simple differential equations models and their applicability.
3. Use numerical techniques, and judge their accuracy, for solving mathematical problems.
4. Communicate well, orally and in writing, in an applied mathematics context.

Math 471 offers several opportunities for creating homework assignments which assess student performance in these areas.

Outcome #1 and #3 can be assessed by asking students to implement an iterative method and discuss its convergence properties. Outcome #1 and #3 can also be assessed by asking students to derive and implement finite difference approximations to derivatives and discuss their accuracy and stability properties in the context of discretization of differential equations. Outcome #2 will be assessed in a homework assignment on numerical discretization of time dependent ordinary differential equations modeling the interaction of, for example, particles. Outcome #4 can be assessed using

reports that the students hand, in-class presentations, and/or through student instructor interaction during the computer laboratory sessions in the course.

Every instructor for Math 471 is asked to complete a “Semester Report”, which provides data on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an electronically administered survey.

2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor's chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a "very good" solution while others may expect 100% credit to be rated at this level, using the "excellent" rating to distinguish exceptional solutions.

2.1 Rubric for SLO #1:

Use techniques from calculus to design analytical and numerical methods to solve applied problems, and understand the accuracy and limitations of the methods.

Excellent	Exemplary derivation of the numerical method, with full justification for each step and the logic of argument flows naturally. Choice of the approximation is well motivated and effective for the given problem. Mathematical and English language is highly articulate.
Very Good	Cogent derivation of the numerical method, with most key steps clearly justified. Choice of the approximation is effective for the given problem. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible derivation of the numerical method, with justification for the essential steps. Choice of the approximation is effective for the given problem. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Partial progress on the derivation of the numerical method, only some essential steps are justified. Some visible progress on selecting the approximation for the given problem. Mathematical and English language is incomplete.
Unacceptable	Poorly written the derivation of the numerical method, essential steps lack justification. Choice of the the approximation is unclear or is ineffective for the given problem. Errors are striking. Mathematical and English language is unclear.

2.2 Rubric for SLO #2:

Understand simple differential equations models and their applicability.

Excellent	Exemplary discussion which demonstrates full comprehension of the model. Student has a clear understanding of what the differential equations models. Mathematical and English language is highly articulate.
Very Good	Cogent discussion which demonstrates good comprehension of the model. Student has good understanding of what the differential equations models. Mathematical and English language is easily understandable.
Satisfactory	Understandable discussion which demonstrates reasonable comprehension of the model. The chosen strategy for approximation is recognizable and mostly effective. Student has an understanding of what the differential equations models. Errors are relatively minor. Mathematical and English language is decipherable.
Questionable	Incomplete discussion which demonstrates a partial comprehension of the model. The chosen strategy for the approximation has potential. Student indicates a partial understanding of what the differential equations models. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poorly written discussion which demonstrates little or no comprehension of the model. The chosen strategy for the approximation is unclear and/or ineffective. Student does not demonstrate an understanding of what the differential equations models. Errors are striking. Mathematical and English language is unclear.

2.3 Rubric for SLO #3:

Use numerical techniques, and judge their accuracy, for solving mathematical problems.

Excellent	Exemplary use and implementation of the numerical method. Student has a complete understanding of the accuracy of the method. Mathematical and English language is highly articulate.
Very Good	Cogent use and implementation of the numerical method. Student has a good understanding of the accuracy of the method. Mathematical and English language is easily understandable.
Satisfactory	Comprehensible use and implementation of the numerical method. Student gives at least some indication of the accuracy of the method. Mathematical and English language is decipherable.
Questionable	Incomplete use and implementation of the numerical method. Student may show some comprehension of the accuracy of the method. Errors are significant. Mathematical and English language is incomplete.
Unacceptable	Poor use and implementation of the numerical method. Unclear whether or not the student understands the method. Errors are striking. Mathematical and English language is unclear.

2.4 Rubric for SLO #4:

Communicate well, orally and in writing, in an applied mathematics context.

Excellent	Exemplary reports where the mathematical and English language is highly articulate.
Very Good	Cogent reports where the mathematical and English language is easily understandable.
Satisfactory	Comprehensible reports where the mathematical and English language is decipherable.
Questionable	Incomplete reports where the mathematical and English language is incomplete.
Unacceptable	Poor reports where the mathematical and English language is unclear.

Assessment Rubrics
for Statistics Student Learning Outcomes

Department of Mathematics and Statistics
College of Arts and Sciences

The University of New Mexico

Erik Erhardt

February 23, 2017

Contents

Contact Persons for the Assessment Plan

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How to use this document

In discussion with the faculty, the 2015-16 Undergraduate Committee created the student learning outcomes for all department majors.

The SLOs listed in Section E.1 (from the "Academic Program Plan for Assessment of Student Learning Outcomes") will be assessed in the courses listed in Table 1 using the rubrics provided in Section E.2.

E B.S. Statistics

E.1 Broad Program Goals & Measurable Student Learning Outcomes

E.1.1 Broad Program Learning Goals for this Degree/Certificate Program

Upon graduation the students of the Statistics concentration will have the following competencies:

A. Proficiency in probability and statistical theory and methods.

B. Ability to manipulate and visualize data and to compute standard statistical summaries.

C. Skill in applying fundamental mathematical techniques.

E.1.2 List of Student Learning Outcomes (SLOs) for this Degree/Certificate Program

A.1 Correctly analyze and interpret the results from standard designed experiments, sample surveys, and observational studies, understand the limitations of the procedures and the appropriate scope of conclusions.

B.1 Implement basic computer science skills needed for statistics, including a) data management tools, and b) use of a statistical software package for standard analyses.

B.2 Demonstrate competence in data management, summarizing, and plotting using a high-level statistical programming language (such as R, SAS, or Stata).

C.1 Demonstrate knowledge of basic mathematical skills needed for statistics, including a) probability and statistical theory, b) calculus foundations, c) symbolic and abstract thinking, and d) linear algebra.

C.2 Solve probability problems, with discrete and continuous univariate random variables, and apply the Central Limit Theorem.

E.2 Rubrics

Every instructor will be asked to complete a "Semester Report", which provides data on the performance of these students in achieving these outcomes. In addition, we need the *major and concentration of each student* which can be obtained by a small class survey as part of an assignment or separately. Near the end of the semester, instructors will ask students to self-assess their performance on these SLOs through an online survey. Finally, the instructor "Semester Report" data will be merged with the student self-assessment and summaries the SLO assessments will be generated.

Table 1 indicates which SLOs are assessed by which Stat courses. Table 2 provides an example for mapping a quiz/assignment score to a rubric rating.

There are several strategies that an instructor can use to assess whether each student has mastered each SLO.

1. Create a set of exam question throughout the semester that directly address an SLO, record evaluations of those questions.

   This will require some advanced planning, and tracking of these individual scores throughout the semester. It may require scanning a page of student solutions to review and aggregate later.

2. Design quizzes and small assignments that each assess an SLO, use the scores as evaluation. This is easier to track directly from the gradebook.

Table 1: SLOs assessed by Courses

	Stat Courses				
SLO	345	427	428	440	445
A.1		X	X	X	X
B.1		X	X	X	X
B.2		X	X	X	X
C.1	X				
C.2	X				

Table 2: Rubric Likert scale example

Likert	Score
5 Excellent	96 – 100%
4 Very good	90 – 95%
3 Satisfactory	80 – 89%
2 Questionable	60 – 80%
1 Unacceptable	0 – 59%

E.2.1 Rubric for Stat 345

E.2.1.1 Stat SLO C.1 Demonstrate knowledge of basic mathematical skills needed for statistics, including a) probability and statistical theory, b) calculus foundations, c) symbolic and abstract thinking, and d) linear algebra.

Rating	**Description**
Excellent	• Exemplary solution which demonstrates full comprehension of the skill. • The strategy follows directly from theoretical results. • No errors. • Student has clearly interpreted solution in highly articulate Statistical and English language.
Very Good	• Cogent solution which demonstrates good comprehension of the skill. • The strategy was apparent and effective. • Errors are insignificant. • Student has interpreted solution in understandable Statistical and English language.
Satisfactory	• Understandable solution which demonstrates reasonable comprehension of the skill. • The strategy was recognizable and mostly effective. • Errors are minor. • Student has interpreted solution in decipherable Statistical and English language.
Questionable	• Incomplete solution which demonstrates partial comprehension of the skill. • The strategy was potential effective. • Errors are significant. • Student has interpreted solution incompletely or misused in Statistical and English language.
Unacceptable	• Poor solution which demonstrates little to no comprehension of the skill. • The strategy was unclear or ineffective. • Errors are striking. • Student has misinterpreted solution completely or used unclear Statistical and English language.

E.2.1.2 Stat SLO C.2 Solve probability problems, with discrete and continuous univariate random variables, and apply the Central Limit Theorem.

Rating	**Description**
Excellent	• Exemplary solution which demonstrates full comprehension of the skill. • The strategy follows directly from theoretical results. • No errors. • Student has clearly interpreted solution in highly articulate Statistical and English language.
Very Good	• Cogent solution which demonstrates good comprehension of the skill. • The strategy was apparent and effective. • Errors are insignificant. • Student has interpreted solution in understandable Statistical and English language.
Satisfactory	• Understandable solution which demonstrates reasonable comprehension of the skill. • The strategy was recognizable and mostly effective. • Errors are minor. • Student has interpreted solution in decipherable Statistical and English language.
Questionable	• Incomplete solution which demonstrates partial comprehension of the skill. • The strategy was potential effective. • Errors are significant. • Student has interpreted solution incompletely or misused in Statistical and English language.
Unacceptable	• Poor solution which demonstrates little to no comprehension of the skill. • The strategy was unclear or ineffective. • Errors are striking. • Student has misinterpreted solution completely or used unclear Statistical and English language.

E.2.2 Rubric for Stat 427, 428, 440, 445

E.2.2.1 Stat SLO A.1 Correctly analyze and interpret the results from standard designed experiments, sample surveys, and observational studies, understand the limitations of the procedures and the appropriate scope of conclusions.

Rating	**Description**
Excellent	• Exemplary solution which demonstrates full comprehension of the skill. • The strategy follows directly from theoretical results. • No errors. • Student has clearly interpreted solution in highly articulate Statistical and English language.
Very Good	• Cogent solution which demonstrates good comprehension of the skill. • The strategy was apparent and effective. • Errors are insignificant. • Student has interpreted solution in understandable Statistical and English language.
Satisfactory	• Understandable solution which demonstrates reasonable comprehension of the skill. • The strategy was recognizable and mostly effective. • Errors are minor. • Student has interpreted solution in decipherable Statistical and English language.
Questionable	• Incomplete solution which demonstrates partial comprehension of the skill. • The strategy was potential effective. • Errors are significant. • Student has interpreted solution incompletely or misused in Statistical and English language.
Unacceptable	• Poor solution which demonstrates little to no comprehension of the skill. • The strategy was unclear or ineffective. • Errors are striking. • Student has misinterpreted solution completely or used unclear Statistical and English language.

E.2.2.2 Stat SLO B.1 Implement basic computer science skills needed for statistics, including a) data management tools, and b) use of a statistical software package for standard analyses.

Rating	**Description**
Excellent	• Exemplary solution which demonstrates full comprehension of the skill. • The strategy follows directly from theoretical results. • No errors. • Student has clearly interpreted solution in highly articulate Statistical and English language.
Very Good	• Cogent solution which demonstrates good comprehension of the skill. • The strategy was apparent and effective. • Errors are insignificant. • Student has interpreted solution in understandable Statistical and English language.
Satisfactory	• Understandable solution which demonstrates reasonable comprehension of the skill. • The strategy was recognizable and mostly effective. • Errors are minor. • Student has interpreted solution in decipherable Statistical and English language.
Questionable	• Incomplete solution which demonstrates partial comprehension of the skill. • The strategy was potential effective. • Errors are significant. • Student has interpreted solution incompletely or misused in Statistical and English language.
Unacceptable	• Poor solution which demonstrates little to no comprehension of the skill. • The strategy was unclear or ineffective. • Errors are striking. • Student has misinterpreted solution completely or used unclear Statistical and English language.

E.2.2.3 Stat SLO B.2 Demonstrate competence in data management, summarizing, and plotting using a high-level statistical programming language (such as R, SAS, or Stata).

Rating	**Description**
Excellent	• Exemplary solution which demonstrates full comprehension of the skill. • The strategy follows directly from theoretical results. • No errors. • Student has clearly interpreted solution in highly articulate Statistical and English language.
Very Good	• Cogent solution which demonstrates good comprehension of the skill. • The strategy was apparent and effective. • Errors are insignificant. • Student has interpreted solution in understandable Statistical and English language.
Satisfactory	• Understandable solution which demonstrates reasonable comprehension of the skill. • The strategy was recognizable and mostly effective. • Errors are minor. • Student has interpreted solution in decipherable Statistical and English language.
Questionable	• Incomplete solution which demonstrates partial comprehension of the skill. • The strategy was potential effective. • Errors are significant. • Student has interpreted solution incompletely or misused in Statistical and English language.
Unacceptable	• Poor solution which demonstrates little to no comprehension of the skill. • The strategy was unclear or ineffective. • Errors are striking. • Student has misinterpreted solution completely or used unclear Statistical and English language.