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REU Site: Supercomputing Undergraduate Program in Maine (SuperMe)

Yifeng Zhu
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Bruce Segee
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Final Report for Period: 02/2012 - 09/2012   **Submitted on:** 01/10/2013

Principal Investigator: Zhu, Yifeng .   **Award ID:** 0754951

Organization: University of Maine

Submitted By:

Zhu, Yifeng - Principal Investigator

Title:

REU Site: Supercomputing Undergraduate Program in Maine (SuperMe)

<div align="center">

Project Participants

</div>

Senior Personnel

    Name: Zhu, Yifeng

    Worked for more than 160 Hours: Yes

    Contribution to Project:

Dr. Zhu is the PI of this project. He is responsbile for recruiting and mentoring REU students. He supervised three REU summer participants and one REU participant during the regular semester.

Each summer Dr. Zhu give a one-week intensive training on parallel programming.

Dr. Zhu advised (1) Lance Doiron in 2012 on project titled ARM-based embedded system computation, (2) Jason Monk in 2011 on project titled Using GPU to Accelerate Parallel Applications, (3) Kevin Hanselman in 2011 on project titled Using GPUs in conjunction with the Matlab environment, (4) Raymond Flagg in 2011 on project titled USB protocol as a mechanism to gather data using a low-cost microcontroller, (5) Matthew Dunn in 2010 on project titled Parallel I/O Testing for Hadoop, (6) Brandon Abbott in 2010 on project titled Performance study of multi-GPU acceleration of LU factorization algorithm, (7) Robert King in 2009 on project titled GPU-Acceleration in Matlab, (8) Timothy Russell in 2008 on project titled Energy-Optimal Cache Replacement Algorithm

    Name: Segee, Bruce

    Worked for more than 160 Hours: Yes

    Contribution to Project:

Dr. Segee is the co-PI of this project. He is responsbile for recruiting and mentoring REU students. He supervised three REU summer participants and three REU participants during the regular semester.

Dr. Segeehas supervised the following REU participants.
(1) Jason Monk in 2012 on project titled Implementing math algorithms to run on Graphics Processing Units,
(2) Kevin Hanselman in 2012 on project titled Development of low cost data gathering devices for K-12 laptop computers,
(3) Raymond Flagg in 2011 on project titled Improve the usability of the Environmental Change Model (ECM),
(4) Catherine Sullivan in 2010 on project titled User Input for the Display Wall,
(5) Aaron Robinson in 2009 on project titled Performance Optimization on Display Wall,
(6) Jason Monk in 2009 on project titled Display Wall Optimization through CUDA Programming,
(7) Jessica David in 2008 on project titled High-resolution Data Visualization,

    Name: Liu, Xiongyi

    Worked for more than 160 Hours: Yes

    Contribution to Project:

Dr. Liu has served as the Program Evaluator. She performed surveys to REU participants, analyzed survey data and wrote evaluation reports.

    Name: Chai, Fei

    Worked for more than 160 Hours: No

    Contribution to Project:

REU faculty supervisor. Dr. Chai has supervised the following projects.
(1) Kevin Demers in 2010 on the project titled Parallel Peruvian Anchovy Bioenergtics Model,
(2) Stephen Beery in 2009 on the project titled CUDA Performance Optimization Fish Modeling,
(3) Jennifer Brown in 2008 on the project titled Modeling of Harmful Algal Bloom Dynamics in the Gulf of Maine.

Name: Dickens, Philip

Worked for more than 160 Hours: No

Contribution to Project:

REU faculty supervisor. Dr. Dickens has supervised the following REU participants. (1) Kara West in 2008 on the project titled Real-Time Visualization of Ice Sheet Data in the Classroom,
(2) Gerry Shannon in 2010 on the project titled Scientific Grid Portal, and (3) Sara Doan in 2009 on the project titled Parallelization of Climate Change Models.

Name: Eason, Richard

Worked for more than 160 Hours: No

Contribution to Project:

REU faculty supervisor. Dr. Eason has supervised Craig Harrison in 2008 on the project titled Design of an Upgraded System for Controlling the Trimming of the Sole of a Shoe.

Name: Koons, Peter

Worked for more than 160 Hours: No

Contribution to Project:

REU faculty supervisor. Dr. Koons has has supervised the following REU participants.
(1) Matthew Edwards in 2010 on the project titled Linear Climate Model,
(2) Elliott Moy in 2009 on the project titled Modeling Mass Balance effects on Glaciers,
(3) Andrew Pellett in 2008 on the project titled Climate Data Visualization,
(4) Donald Lewis in 2008 on the project titled ST. Elias Erosion/tectonics Project.

Name: McKay, Susan

Worked for more than 160 Hours: No

Contribution to Project:

REU faculty supervisor. Dr. Mckay has supervised the following REU participants.
(1) Zarchary Smith in 2010 on the project titled The Ising Model of Spin Glass,
(2) Breana Coyle in 2010 on the project titled Disease Spread Modeling,
(3) Matt Jones in 2009 on the project titled Modeling Disease Spread in a Dynamic Small World Network,
(4) Wen Luo in 2008 on the project titled Monte Carlo Simulation on Spin Glass.

Name: Xue, Huijie

Worked for more than 160 Hours: No

Contribution to Project:

REU faculty supervisor. Dr. Xue has supervised the following REU participants.
(1) Nash Kellaway in 2009 on the project titled Visualization of Lobster Larvae Migration in the Gulf of Maine,
(2) Stacey Gomm in 2009 on the project titled Visualization of Whale Migration,
(3) Omar Padron in 2008 on the project titled Visualization of Oceanic Simulation Data in Google Earth.

Name: Giudice, Nicholas

Worked for more than 160 Hours: No

Contribution to Project:

REU Faculty advisor. Dr. Giudice has supervised Timothy McGrath in 2010 on the project titled Viewshed Creation In Virtual Reality Applications.

Name: Rasaiah, Jay

Worked for more than 160 Hours: No

Contribution to Project:

REU Faculty advisor. Dr. Rasaiah has supervised the following students.
(1) Dylan Suvlu in 2009 on the project titled Molecular Dynamics of Polypeptides in a Confined Environment, and
(2) Daniel Dorman in 2008 on the project titled Modeling Water to Calculate its Chemical Potential in the Bulk Phase.

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Cousins, Steve

Worked for more than 160 Hours: No

Contribution to Project:

Steve Cousin has provided technical support about how to use the University's supercomputers.

Other Participant

Name: Gomm, Janice

Worked for more than 160 Hours: No

Contribution to Project:

Administration Assistant. Janice Gomm helped managed the application, coordination of housing, payment, and summer activies.

Name: Niles, Susan

Worked for more than 160 Hours: No

Contribution to Project:

Administrative Assistant. Susan Niles help coordinate the application process.

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Jon Geiger (jon.geiger@jax.org)
Director of REU Summer Program
The Jackson Laboratory
Bar Harbor Maine

Our REU fellows has visited the Jackson Laboratory and interacted with their NSF-REU participants. The Jackson Laboratory is a world-leading organization focusing on mammalian genetics research to advance human health. They are also hosting an NSF-REU site titled 'Functional Genomics Research Projects for Undergraduates'. The program is led by Dr. Jon Geiger.

Activities and Findings

Research and Education Activities:

List of major activity
(1) One-week training of supercomputer programming

(2) Weekly seminars (including Ethic components)
(3) Weekly research meeting
(4) Program symposium

Details are given in the attached annual report.

Findings:

The program is in no-cost extension in Year 2012. In fact, we realized that the project did not pay the summary salary of the co-PI Dr. Segee in Year by mistake (Note: Dr. Segee received less than two-month summary salary in Year 1, including this award.). As a result, we had much less fund than we originally expected.

Jason Monk, Computer Engineering, University of Maine, Advisor: Dr. Segee
Jason Monk has worked in implementing algorithms to run on Graphics Processing Units (GPUs) within computers. This work began during a conventional 10 week REU program and continued during the academic year. He has published an abstract at the 2009 AGU meeting and most recently at Supercomputing 2012. He continued on to grad school after his undergrad career as well as operating a small software company.

Forrest Flag, Computer Engineering, University of Maine, Advisor: Dr. Segee
Forrest Flag worked with researchers in Geodynamics to greatly improve the usability of their Environmental Change Model (ECM). This software uses historic weather data combined with perturbation models to predict the likely outcomes of small changes in the Earth climate system. Additionally he worked with GPUs and numerous other projects on a part time basis.

Kevin Hanselman, Computer Engineering, University of Maine, Advisor: Dr. Segee
Kevin Hanselman worked on the development of low cost data gathering devices for K-12 laptop computers. The device is based on a printed circuit board that can be plugged directly into a USB port on a computer. The device presents itself as a USB keyboard, and the data gathering appears as a person typing on this keyboard. The entire board can be assembled for under $5 and has been used at a local high school.

Derrick Cox, Mathematics & Statistics, University of Maine Advisor: Dr. Andre Khalil.
Derrick prepared and managed two databases of images and will perform some computational 2D and 3D analyses on the said images. The first database consists in 3D chromosome territory images from mouse and human cells. The pre-analysis consists in sorting the image files, delimiting regions of interest, and running sorting macros with the 3D image analysis software Fiji. The analysis consists in performing a segmentation of the chromosome territories from nuclear background via different automated methods and to measure several different quantitative parameters, such as volume, surface area, chromosome proximity, radial positioning, etc. The second database consists in 2D mammography images of human breast tissue, including benign and malignant tumors. Derrick will sort and manage a new set of images that correspond to regions of interest that neighbor the actual tumors. Derrick will then launch an analysis of these regions in an effort to determine, quantitatively, the differences between the tumors and the non-tumor tissue surrounding them.

Lance Doiron, Computer Engineering, University of Maine, Advisor: Dr. Zhu
Lance prepared the embedded system program research and teaching modules that leverage recent ARM processors. As ARM processor becoming increasingly popular in mobile platforms, servers, and desktops, understanding the basics of ARM computer assembly-level programming lays a foundation for performance optimization for a variety of applications. He developed several modules that program ARM, its coprocessor and the peripheral. These modules are being used in our research of embedded systems and the undergraduate education.

Training and Development:

(1) How to perform literature survey?
(2) How to write technical papers and give technical presentation?
(3) How to apply patents?
(4) How to formulate research questions?

Detailed can be found in the attached report. The program evaluations on these training and development can be also be found in the attached program evaluation report.

Outreach Activities:

This year our REU fellows had valuable opportunities to interact with middle-school students and teachers, and also the undergraduate participants of a different NSF-REU site.
(1) Interacting with NSF-ITEST Participating K-12 Teachings
(2) Help Organizing MLTI K-12 Student Conference

(3) Interacting with students in another NSF-REU Site in Maine

Please refer to the attached report for details.

Journal Publications

Matthew Jones, "An investigation of the impacts of vaccination and adaptive rewiring on disease spreading in an SIR model", 11th Annual Greater Boston Area Statistical Mechanics Meeting, p. , vol. , (2009). Published,

Wen Luo (*), Michael Mihalco, Thomas E. Stone, Susan R McKay, "Overlap as a Measure of Spin-Glass Memory and a Probe of Free Energy Landscape", American Physical Society March Meeting, p. , vol. , (2009). Published,

Aaron Robinson, "Visualization Walls Using Commodity Clusters", ACM Student Fall Conference, p. , vol. , (2009). Published,

J Monk, Y Zhu, P O Koons, B E Segee, "Utilizing General Purpose Graphics Processing Units to Improve Performance of Computer Modeling and Visualization", 2009 Fall Meeting of American Geophysical Union (AGU), p. , vol. , (2009). Published,

Books or Other One-time Publications

Web/Internet Site

URL(s):
http://arch.eece.maine.edu/superme
Description:
The program website

Other Specific Products

Contributions

Contributions within Discipline:
The SuperMe REU site is a multi-disciplinary program led by nine faculty mentors from six different departments, with a coherent intellectual focus on scientific computing. Each year, our program provides both computer systems projects and computer application projects.

During no-cost extension (2011-2012), the project has supported five students on a smaller scale working on various projects.

In 2010, the computer systems projects include (1) Parallel I/O Testing for Hadoop, (2) Performance study of multi-GPU acceleration of LU factorization algorithm, (3) Viewshed Creation In Virtual Reality Applications, (4) User Input for the Display Wall, and (5) Scientific Grid Portal. The Computer Application projects include (1) Linear Climate Model, (2) Modeling a Cell Nucleus, (3) The Ising Model of Spin Glass, (3) Disease Spread Modeling (4) Parallel Peruvian Anchovy Bioenergtics Model.

In 2009, the computer systems projects include (1) CUDA performance optimization fish modeling, (2) performance optimization on display wall, (3) display wall optimization through CUDA programming, (4) GPU-acceleration in Matlab. the computer application projects include (1) visualization of lobster larvae migration, (2) visualization of whale migration, (3) molecular dynamics of polypeptides in a confined environment, (4) modeling disease spread in a dynamic small world network, (5) modeling mass balance effects on glaciers, and (6) parallelization of climate change models.

In 2008, the computer systems projects include (1) energy-efficient buffer caching for high-end data servers, (2) high-resolution data display wall, (3) real-time visualization of ice sheet data, (4) upgrading of an intelligent control systems, and (5) parallel computing for earth modeling. The computer application projects include (1) modeling water to calculate its chemical potential in the bulk phase, (2) visualization of oceanic simulation data in Google earth, (3) Monte Carlo simulation on spin glass, (4) harmful algal bloom dynamics in the Gulf of Maine, and (5)

geological data visualization.

The research finding and contributions are summarized in their project abstracts, given later in this report.

In addition, we have the following publications.
1. Matthew Jones, University of Maine, An investigation of the impacts of vaccination and adaptive rewiring on disease spreading in an SIR model, 11th Annual Greater Boston Area Statistical Mechanics Meeting Saturday, Boston, MA, October 10, 2009
2. Aaron Robinson, Visualization Walls Using Commodity Clusters, ACM 2009 Fall Conference, Gatlinburg, TN, November 12-13, 2009
3. Wen Luo, Michael Mihalco, Thomas E. Stone, Susan R McKay. Overlap as a Measure of Spin-Glass Memory and a Probe of Free Energy Landscape. 2009 American Physical Society March Meeting, Pittsburgh, Pennsylvania
4. Mattew Jones (*), Thomas Stone, Dr. Susan McKay, Effects of Super-Spreaders in Epidemic Models on Dynamic Small-World Networks, Dynamic Days 2010, International Conference on Chaos and Nonlinear Dynamics, January 4-7, 2010, Evanston, IL (poster)

Contributions to Other Disciplines:

Due to the inter-disciplinary nature of our REU program, many REU fellows have worked very closely with faculty and researchers in many disciplines. Developing a supercomputer application or a data visualization tool requires both computer science and also the knowledge of the target science problem in marine sciences, physics, earth sciences, and chemistry.

Contributions to Human Resource Development:

A total of 35 undergraduates which included eight woman students participated in the program. Nine faculty mentors, one post-doc, and nine graduate students are closely involved in this program. Under the direct supervision of faculty mentors, each REU fellow worked on a research topic for a period of ten weeks. The project director Dr. Yifeng Zhu conducted one-week workshop to give them hand-on experiences on developing supercomputing applications. The program directors Dr. Yifeng Zhu and Dr. Bruce Segee held informal discussions with each REU fellow and his/her research mentor periodically throughput the duration of the program. Each REU fellow maintained a wiki website to report their program and disseminate their research finding. A weekly entire group meeting was organized. At the end of the summer program, a formal symposium was organized in which each REU fellow gave a formal powerpoint presentation of their summer research. The department chairs, all REU mentors and their graduate students, research associates, and post-doctors participated the conferences. The symposium was organized in the same format as an international conference with different sections and section chairs. In addition, each REU fellow submitted a formal report to their faculty mentor for future conference or journal publication.

All REU fellows are being followed up after the summer program ended. All participants are continued to work with their mentors, particularly on their technical papers, in order to formally publish their research finding. In this Fall semester, many on-campus RUE fellows are hired by their faculty mentors as paid undergraduate research assistants on a part-time basis.

The REU program has created a valuable boost on the student's motivation on pursuing graduate studies after receiving their bachelor degrees. During the summer program, these REU fellows were treated as peers, instead of students. They discussed research issues with their faculty mentors and worked together with the graduate students on a daily basis. Many of REU fellows actually gave research seminars to their faculty mentors and graduate students during the summer program. The ten-week experiences really made them enjoy the graduate life, be confident of their research capability, and most importantly be fascinated about their research work. The existing survey shows that 90% of our participants plan to enter a graduate program in STEM-related disciplines after graduation. At least eight of them are in program of or have earned graduate degrees.

The REU program also directly helps our faculty mentors' research. Many of our faculty mentors are not computer scientists. The program modules that REU students developed during the summer program directly move further their research progress. For example, the Earth simulation module developed by the group of Dr. Peter Koons took over weeks to simulate a large module. By using the parallel software framework developed by our REU student, the running time is now reduced to one day. This REU student continues to work for Dr. Peter Koons this semester.

Please refer to the attached program evaluation report for details.

Contributions to Resources for Research and Education:

This project exploits Web 2.0 to disseminate the research results. Each REU fellow maintains a wiki web page that summarizes related research work and presents their weekly research reports. The wiki pages can be accessed from the project website (http://arch.eece.maine.edu/superme).

Contributions Beyond Science and Engineering:

Our REU fellows had valuable opportunities to interact with middle-school teachers and students. They had fruitful discussion on curriculum modules with 11 middle-school teachers who participated in an NSF-ITEST program leaded by the PI and co-PI of this REU site. These

modules are being integrated into several middle schools. Our REU fellows also successfully organized a one-day conference that teach middle-school students about new laptop computer software, new applications and new ways to make the best use of laptops for research, classroom activities and 21st Century educational exploration. In 2008, a total of 645 Maine's middle school students participated in that conference at the University of Maine to push the boundaries of their laptop computer skills.

Please refer to the program report for details.

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

Any Book

Any Product

Any Conference

SuperMe

NSF REU Annual Report 2012 (Year 4)

REU Site: NSF/DoD Research Experience for Undergraduates (REU) Supercomputing Undergraduate Program in Maine (SuperMe)

NSF Grant #0754951

Department of Electrical and Computer Engineering
University of Maine
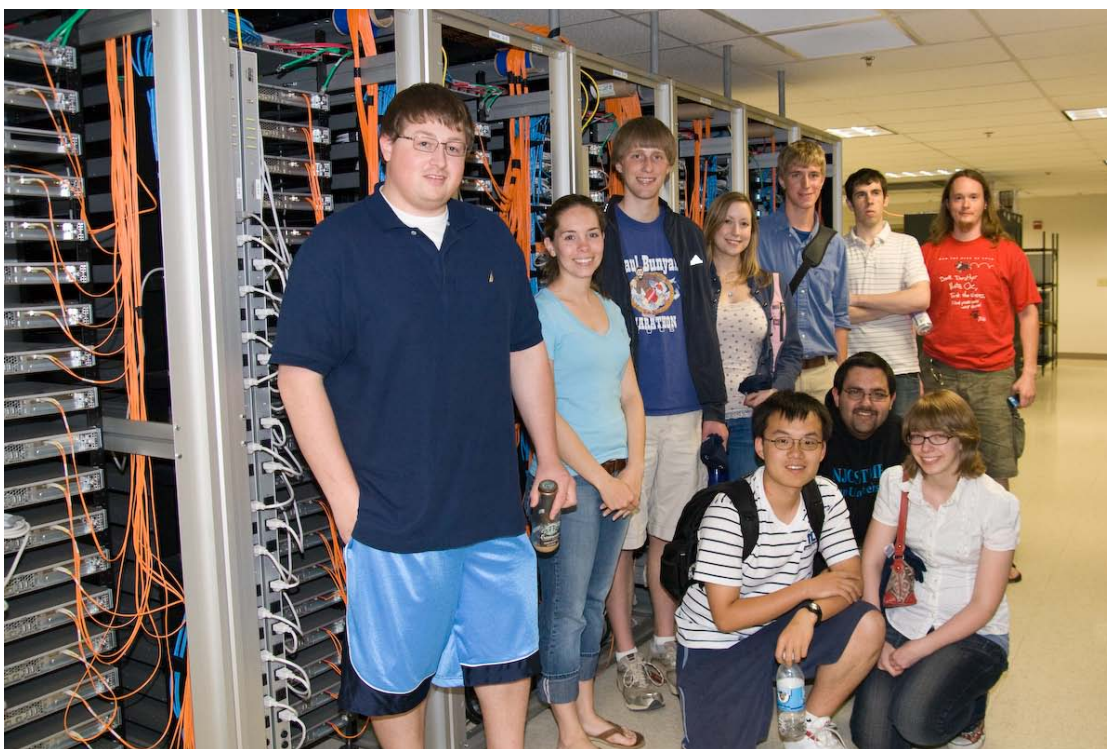**Orono, ME 04473**

Dr. Yifeng Zhu and Dr. Bruce Segee

October 1, 2012

Contents

I. NSF-REU Participants in Spring 2012 and Fall 2012

The program is in no-cost extension in Year 2012. In fact, we realized that the project did not pay the summer salary of the co-PI Dr. Segee in Year by mistake (Note: Dr. Segee received less than two-month summer salary in Year 1, including this award.). As a result, we had much less fund than we originally expected.

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Derrick Cox, Mathematics & Statistics, University of Maine Advisor: Dr. Andre Khalil.
Derrick prepared and managed two databases of images and will perform some computational 2D and 3D analyses on the said images. The first database consists in 3D chromosome territory images from mouse and human cells. The pre-analysis consists in sorting the image files, delimiting regions of interest, and running sorting macros with the 3D image analysis software Fiji. The analysis consists in performing a segmentation of the chromosome territories from nuclear background via different automated methods and to measure several different quantitative parameters, such as volume, surface area, chromosome proximity, radial positioning, etc. The second database consists in 2D mammography images of human breast tissue, including benign and malignant tumors. Derrick will sort and manage a new set of images that correspond to regions of interest that neighbor the actual tumors. Derrick will then launch an analysis of these regions in an effort to determine, quantitatively, the differences between the tumors and the non-tumor tissue surrounding them.

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Lance prepared the embedded system program research and teaching modules that leverage recent ARM processors. As ARM processor becoming increasingly popular in mobile platforms, servers, and desktops, understanding the basics of ARM computer assembly-level programming lays a foundation for performance optimization for a variety of applications. He developed several modules that program ARM, its coprocessor and the peripheral. These modules are being used in our research of embedded systems and the undergraduate education.

II. NSF-REU Participants in 2011

The program is in no-cost extension in Year 2011. The following four undergraduates were supported in 2011.

Jason Monk, Computer Engineering, University of Maine, Advisor: Dr. Segee and Dr. Zhu

Jason Monk performed research in the use of GPUs for parallel processing. His work included developing algorithms for GPUs and included Particle Swarm Algorithms and Genetic algorithms. One paper was presented at the American Geophysical Union meeting in December 2009. Two additional papers have been submitted and are under review. Jason completed his undergraduate degree and began Graduate work utilizing GPUs for NSF project EAR-1027809.

Kevin Hanselman, Computer Engineering, University of Maine, Advisor: Dr. Segee and Dr. Zhu

Kevin Hanselman performed research in the use of GPUs in conjunction with the Matlab environment. In particular he studied how GPU code can be called from Matlab to parallelize some operations.

Raymond Flagg, Computer Engineering, University of Maine, Advisor: Dr. Segee and Dr. Zhu

Raymond Flagg researched the USB protocol as a mechanism to gather data using a low-cost microcontroller that is both powered by and communicates through the USB bus. The ultimate goal was a "no software" device compatible with Maine K-12 laptop computers. After further development these devices have successfully been beta tested in a grade 9 Physical Science classroom.

Derrick Cox, Math and Statistics, University of Maine, Advisor: Dr. Andre Khalil

Derrick Cox has prepared and managed two databases of images and performed some computational 2D and 3D analyses on the said images. The first database consists in 3D chromosome territory images from mouse and human cells. The pre-analysis consists in sorting the image files, delimiting regions of interest, and running sorting macros with the 3D image analysis software Fiji. The analysis consists in performing a segmentation of the chromosome territories from nuclear background via different automated methods and to measure several different quantitative parameters, such as volume, surface area, chromosome proximity, radial positioning, etc. The second database consists in 2D mammography images of human breast tissue, including benign and malignant tumors. Derrick has sorted and managed a new set of images that correspond to regions of interest that neighbor the actual tumors. Derrick then launched an analysis of these regions in an effort to determine, quantitatively, the differences between the tumors and the non-tumor tissue surrounding them.

III. NSF-REU Participants, Summer 2010

Left to Right (Standing): Matthew Edwards, Craig Verrill, Zachary Smith, Matthew Dunn, Timothy McGrath, Catherine Sullivan (Female)

Left to Right (Kneeling): Brandon Abbott, Breana Coyle (Female), Gerry Shannon, Kevin Demers

REU Fellows	Gender	Major	Graduation	Home Institution	Home's Highest Degree
Breana Coyle	Female	Computer Science	2011	Saint Anselm College	Bachelor.
Catherine Sullivan	Female	Computer Science	2013	Rochester Institute of Technology	Ph.D.
Gerry Shannon	Male	Computer Science	2012	University of Southern Maine	Bachelor
Zarchary Smith	Male	Applied Physics	2013	Rensselaer Polytechnic Institute	Ph.D.
Brandon Abbott	Male	Computer Science	2012	University of Denver	Ph.D.
Matthew Edwards	Male	Electrical and Computer Engineering	2011	University of Maine	Ph.D.
Craig Verrill	Male	Computer Engineering	2012	University of Maine	Ph.D.
Matthew Dunn	Male	Computer Engineering	2011	University of Maine	Ph.D.
Timothy McGrath	Male	Mechanical Engineering	2011	University of Maine	Ph.D.
Kevin Demers	Male	Computer Engineering	2011	University of Maine	Ph.D.

REU Participants	Faculty Supervisor	Graduate/Post Doc Partner	Project Title
Matthew Edwards	Dr. Peter Koons	Dr. Sean Birkel	Linear Climate Model
Craig Verrill	Dr. Andre Khalil		Modeling a Cell Nucleus
Zarchary Smith	Dr. Susan McKay	Tom Stone	The Ising Model of Spin Glass
Matthew Dunn	Dr. Yifeng Zhu	Jianhui Yue	Parallel I/O Testing for Hadoop
Timothy McGrath	Dr. Nicholas Giudice		Viewshed Creation In Virtual Reality Applications
Catherine Sullivan	Dr. Bruce Segee		User Input for the Display Wall
Brandon Abbott	Dr. Yifeng Zhu		Performance study of multi-GPU acceleration of LU factorization algorithm
Breana Coyle	Dr. Susan McKay	Tom Stone	Disease Spread Modeling
Gerry Shannon	Dr. Phillip Dickens		Scientific Grid Portal
Kevin Demers	Dr. Fei Chai	Stephen Cousins	Parallel Peruvian Anchovy Bioenergtics Model

IV. NSF-REU Participants, Summer 2009

Figure 1. Group Photo of NSF-REU SuperMe 2009 Fellows
Left to Right (Standing): Dylan Suvlu, Robert King, Matt Jones, Elliott Moy, and Jason Monk

Left to Right (Kneeling): Nash Kellaway (F), Stacey Gomm (F), Aaron Robinson, Sara Doan (F), and Stephen Beery

Table 1. List of Ten REU Participants in 2009

REU Fellows	Gender	Major	Graduation	Home Institution	Home's Highest Degree
Stephen Beery	Male	Computer Science	2010	Benedictine College	Bachelor
Sara Doan	Female	Computer Science	2011	Allegheny College	Bachelor
Nash Kellaway	Female	Computer Science	2010	Wellesley College	Bachelor
Aaron Robinson	Male	Computer Science and Mathematics	2010	High Point University	Bachelor
Elliott Moy	Male	Computer Science	2010	University of Massachusetts, Lowell	Ph.D.
Stacey Gomm	Female	Civil Engineering	2011	University of Maine	Ph.D.
Robert King	Male	Computer Engineering	2010	University of Maine	Ph.D.
Jason Monk	Male	Computer Engineering	2011	University of Maine	Ph.D.
Matt Jones	Male	Computer Engineering	2010	University of Maine	Ph.D.
Dylan Suvlu	Male	Chemistry	2010	University of Maine	Ph.D.

Table 1. REU Research Projects and Supervisors

REU Participants	Faculty Supervisor	Graduate/Post Doc Partner	Project Title
Stephen Beery	Dr. Fei Chai	Stephen Cousins	CUDA Performance Optimization Fish Modeling
Sara Doan	Dr. Phillip Dickens		Parallelization of Climate Change Models
Nash Kellaway	Dr. Huijie Xue	Stephen Cousins	Visualization of Lobster Larvae Migration in the Gulf of Maine
Aaron Robinson	Dr. Bruce Segee	Jason Withee	Performance Optimization on Display Wall
Elliott Moy	Dr. Peter Koons	Sean Birkel	Modeling Mass Balance effects on Glaciers
Stacey Gomm	Dr. Huijie Xue	Stephen Cousins	Visualization of Whale Migration
Robert King	Dr. Yifeng Zhu		GPU-Acceleration in Matlab
Jason Monk	Dr. Bruce Segee	Nate Bou	Display Wall Optimization through CUDA Programming
Matt Jones	Dr. Susan McKay	Tom Stone	Modeling Disease Spread in a Dynamic Small World Network
Dylan Suvlu	Dr. Jay Rasaiah		Molecular Dynamics of Polypeptides in a Confined Environment

v. NSF-REU Participants, Summer 2008

Figure 2. Group Photo of NSF-REU SuperMe 2008 Fellows

Left to Right (Standing): Andrew Pellett, Kara West (F), Craig Harrison, Jennifer Brown (F), Daniel Dorman, Donald Lewis, Timothy Russell,

Left to Right (Kneeling): Wen Luo, Omar Padron, Jennifer Brown (F)

Table 2. List of Ten REU Participants in 2008

REU Fellows	Gender	Major	Graduation	Home Institution	Home's Highest Degree
Timothy Russell	Male	Math & Computer Sci.	2009	Eastern Illinois University	Bachelor
Daniel Dorman	Male	Biomedical Engineering	2010	LeTourneau University	Bachelor
Omar Padron	Male	Computational Math	2010	Kean University	Bachelor
Jessica David	Female	Computer Engineering	2010	University of Evansville	MS
Wen Luo	Male	Computer Science	2011	University of Nebraska	Ph.D.
Andrew Pellett	Male	Computer Engineering	2010	University of Maine	Ph.D.
Kara West	Female	Computer Science	2010	University of Maine	Ph.D.
Jennifer Brown	Female	Biological Engineering	2010	University of Maine	Ph.D.
Donald Lewis	Male	Computer Engineering	2009	University of Maine	Ph.D.
Craig Harrison	Male	Computer Engineering	2010	University of Maine	Ph.D.

Table 2. REU Research Projects and Supervisors

REU Participants	Faculty Supervisor	Graduate/Post Doc Partner	Project Title
Jennifer Brown	Dr. Fei Chai		Modeling of Harmful Algal Bloom Dynamics in the Gulf of Maine
Jessica David	Dr. Bruce Segee	Jason Withee, Nathan Bourgoin	High-resolution Data Visualization
Daniel Dorman	Dr. Jay Rasaiah	Dr. Guogang Feng	Modeling Water to Calculate its Chemical Potential in the Bulk Phase
Craig Harrison	Dr. Richard Eason		Design of an Upgraded System for Controlling the Trimming of the Sole of a Shoe
Omar Padron	Dr. Huijie Xue		Visualization of Oceanic Simulation Data in Google Earth
Andrew Pellett	Dr. Peter Koons	Sean Birkel	Climate Data Visualization
Donald Lewis	Dr. Peter Koons	Benjamin P. Hooks	ST. Elias Erosion/tectonics Project
Wen Luo	Dr. Susan McKay	Thomas Stone, Michael Mihalco	Monte Carlo Simulation on Spin Glass
Timothy Russell	Dr. Yifeng Zhu	Jianhui Yue	Energy-Optimal Cache Replacement Algorithm
Kara West	Dr. Philip Dickens	James Campbell, Tristan Deane	Real-Time Visualization of Ice Sheet Data in the Classroom

VI.   Contribution of REU Faculty Advisors

Faculty Advisor	REU Participants	Year	Project Title
Dr. Andre Khalil	Derrick Cox	2011	Computational 2D and 3D analyses on the bio images
	Craig Verrill	2010	Modeling a Cell Nucleus
Dr. Bruce Segee	Jason Monk	2012	Implementing math algorithms to run on Graphics Processing Units
	Kevin Hanselman	2012	Development of low cost data gathering devices for K-12 laptop computers
	Raymond Flagg	2011	Improve the usability of the Environmental Change Model (ECM)
	Catherine Sullivan	2010	User Input for the Display Wall
	Aaron Robinson	2009	Performance Optimization on Display Wall
	Jason Monk	2009	Display Wall Optimization through CUDA Programming
	Jessica David	2008	High-resolution Data Visualization
Dr. Fei Chai	Kevin Demers	2010	Parallel Peruvian Anchovy Bioenergtics Model
	Stephen Beery	2009	CUDA Performance Optimization Fish Modeling
	Jennifer Brown	2008	Modeling of Harmful Algal Bloom Dynamics in the Gulf of Maine
Dr. Huijie Xue	Nash Kellaway	2009	Visualization of Lobster Larvae Migration in the Gulf of Maine

	Stacey Gomm	2009	Visualization of Whale Migration
	Omar Padron	2008	Visualization of Oceanic Simulation Data in Google Earth
Dr. Jay Rasaiah	Dylan Suvlu	2009	Molecular Dynamics of Polypeptides in a Confined Environment
	Daniel Dorman	2008	Modeling Water to Calculate its Chemical Potential in the Bulk Phase
Dr. Nicholas Giudice	Timothy McGrath	2010	Viewshed Creation In Virtual Reality Applications
Dr. Peter Koons	Matthew Edwards	2010	Linear Climate Model
	Elliott Moy	2009	Modeling Mass Balance effects on Glaciers
	Andrew Pellett	2008	Climate Data Visualization
	Donald Lewis	2008	ST. Elias Erosion/tectonics Project
Dr. Philip Dickens	Kara West	2008	Real-Time Visualization of Ice Sheet Data in the Classroom
	Gerry Shannon	2010	Scientific Grid Portal
	Sara Doan	2009	Parallelization of Climate Change Models
Dr. Richard Eason	Craig Harrison	2008	Design of an Upgraded System for Controlling the Trimming of the Sole of a Shoe
Dr. Susan McKay	Zarchary Smith	2010	The Ising Model of Spin Glass
	Breana Coyle	2010	Disease Spread Modeling
	Matt Jones	2009	Modeling Disease Spread in a Dynamic Small World Network
	Wen Luo	2008	Monte Carlo Simulation on Spin Glass
Dr. Yifeng Zhu	Lance Doiron	2012	ARM-based embedded system computation
	Jason Monk	2011	Using GPU to Accelerate Parallel Applications
	Kevin Hanselman	2011	use of GPUs in conjunction with the Matlab environment
	Raymond Flagg	2011	USB protocol as a mechanism to gather data using a low-cost microcontroller
	Matthew Dunn	2010	Parallel I/O Testing for Hadoop
	Brandon Abbott	2010	Performance study of multi-GPU acceleration of LU factorization algorithm
	Robert King	2009	GPU-Acceleration in Matlab
	Timothy Russell	2008	Energy-Optimal Cache Replacement Algorithm

VII.   Program Management

A.   Summary

SuperMe provides scientific exploration ranging from engineering to sciences with a coherent intellectual focus on scientific computing. Our long term goals are: (1) to stimulate participants'

interests in science and technology by exposing them to exciting cutting-edge research at an early age; (2) to improve participants' sense of achievement and persistence in learning; (3) to foster aspiration among the participants for graduate education in scientific computing; and (4) to encourage participants to explore and seek science and engineering careers

Our REU site provides ten-week summer research experiences for ten undergraduates each year. With integrated expertise of ten faculty researchers from both computer systems and domain applications, SuperMe allows each undergraduate to conduct meaningful research, such as developing supercomputing techniques and tools, and solving cutting-edge research problems through parallel computing and scientific visualization.

The program for was announced in late January with application deadline of March 14. Offers were made in early April and welcome letters were sent as soon as the offer was accepted. The ten-week program started on May 27 (Orientation) and ended on August 1 (REU Symposium) in 2008. Our 2009 program started on June 1 (Monday) and ended on August 6 (Friday).

B.   Financial Support

Each REU participant received a stipend of $400/week, subsistence costs (housing and meals), and up to $500 round trip travel expenses to the University of Maine. The program will also provide travel expenses for selected REU participants to present their research results at national conferences and symposia.

C.   Advertisement and Selection

We have developed a web-based application and recommendation system. When an application is completed on-line, an email is then automatically sent to each preferred referee to ask for the recommendation. The recommendation can be completed through our on-line recommendation system. Applicants are required to mail their official academic transcript after submitting the on-line application. I have found that our on-line system significantly speedups the application process and gives us precious time for competing with other REU sites.

This year, our recruitment focuses on (1) female applicants and (2) applicants from colleges with limited supercomputing resources. We have emailed our program poster to 44 women's colleges and 200 chairpersons in the eastern states. I have also put our program advertisement on several mailing lists, such as ACM Special Interest Group on Computer Science Education (SIGCSE).

In 2008, we received a total of 35 applications, including 24 external and 11 internal. In 2009, we received a total of 64 applications, including 54 external and 10 internal. In 2010, we received a total of 60 applications, including 52 external and 8 internal. The reason why the number of internal applications is low is that many internal applications, especially freshmen, sophomores and the ones with low GPAs, are discouraged to apply for our program. There are four female external applications and four female internal applications. We have also received four applicants who are Hispanic or Latino, two who are black or African American, and two who are Asian. Detailed demographics are presented in detail later in this report.

The selection committee was composed of Yifeng Zhu (PI) and Bruce Segee (Co-PI). Various criteria were used to select REU fellows. They should have achieved at least a B average in mathematics and computer-related courses. Primary consideration was given to the grades obtained by the student in these courses. The background of the applicants was also incorporated so as to give special consideration to women, minorities and handicapped students or students whose home institutes have limited supercomputing research resource. In cases of equal academic performance in courses, recommendations from the referees or from faculty who were acquainted with students were evaluated. After selecting the REU fellows, we also performed the initial matches between the prospective fellows and our faculty supervisors.

D.   Registration and Housing

In 2010, out-of-state REU fellows are housed in the Delta Tau Delta, with one person in each room. Our REU fellows are required to bring their own beddings (pillow, sheets, bedspreads and quilts). Each room comes with a twin bed, a desk, and wireless internet. The fraternity (co-ed) will also have kitchen facilities and a fully functional free laundry. The cost for a single-bed room is approximately $950, which includes utilities, Internet, etc. No alcohol is allowed in public areas (living room, kitchen, dining room, etc.), even for people over 21.

In 2009, out-of-state REU fellows are housed in Sigma Phi Epsilon Fraternity on campus. Each room comes with twin bed, dresser, desk, and has Internet and phone accessibility. The fraternity (co-ed) has kitchen facilities, a fully functional laundry, a gym, a library and a game room. REU fellows are required to bring their own bed linens and towels. The cost for staying in Sigma Phi for the 10-week period is $937.50. Each of them receives the housing and food with a total of amount of $1,700 in two separate checks with equal amount, one issued in the middle of our summer program and one issued at the end. Sigma Phi Epsilon is dry. No alcohol is allowed in public areas (living room, kitchen, dining room, etc.), even for people over 21.

The program registration is performed during our Kick-Off meeting. The following is the agenda. During our Kick-off meeting, all REU faculty supervisors met our REU participants and presented their research projects briefly.

Kick-Off Meeting Agenda

NSF-REU SuperMe
9AM-4:30PM Tuesday, June 1, 2010
Arthur St. John Hill Auditorium, Barrows Hall
University of Maine

MORNING SESSION

8:30-9:30   Coffee and Breakfast
9:30-10:00   Program Description & Operation
                 Yifeng Zhu & Bruce Segee, PIs, NSF-REU-SuperMe
10:00-10:30   NSF-REU Self-Introductions

10:30-11:30	Program Evaluation, Administration & Related Programs
	Mohamad Musavi – Science and Engineering Education
	Janice Gomm – Payroll
11:30-1:00	Lunch
AFTERNOON SESSION	
1:15-1:30	Group Photo
1:30-2:50	NSF-REU Advisor Research (Brief PowerPoint Presentations)
	Dr. Fei Chai, Professor of School of Marine Sciences
	Dr. Phil Dickens, Professor of Computer Sciences
	Dr. Richard Eason, Professor of Electrical and Computer Engineering
	Dr. Peter Koons, Professor of Earth Dynamics & Climate Change Inst.
	Dr. Susan McKay, Professor of Physics
	Dr. Jayendran C. Rasaiah, Professor of Chemistry
	Dr. Bruce Segee, Professor of Electrical and Computer Engineering
	Dr. Huijie Xue, Professor of School of Marine Sciences
	Dr. Yifeng Zhu, Professor of Electrical and Computer Engineering
3:00-4:00	Supercomputing Tour
4:00-4:30	REU Pre-Program Survey
	Program Evaluator

E. Training of Parallel Programming

As outlined in the original support letter, the University of Maine supercomputing center has provided an access account for every REU participants. Each REU fellow has equal access to the supercomputing and data storage resource as the graduates and faculty on campus. The university has covered the costs for the compute time and also the supercomputing technical supports.

The program director Dr. Yifeng Zhu has given a one-week programming workshop to all REU fellows at the beginning of the summer program. Lectures on MPI and two programming projects are conducted to give them hand-on experiences on programming a supercomputer. At the end of the workshops, our REU fellows are able to using MPI to develop parallel applications.

F. Ethic Components

We organized a weekly lunch seminar to incorporate some ethic components into our summer program. Each seminar is organized by a REU faculty supervisor and all REU fellows are required to attend. Some seminar provides valuable ethics education, such as *Science and Society* and *Creativity in Sciences*, while other seminars focus on why and how start graduate studies.

Table 3. Wednesday Lunch Seminar Series Offered in 2008, 2009, and 2010

#	Speaker	Seminar Title
1	Dr. Yifeng Zhu	Literature Search Tutorial
2	Dr. Bruce Segee	Making Good Arguments
3	Dr. Phil Dickens	Communicating Evidence Visually
4	Dr. Guogang Feng	From Questions to Problems
5	Dr. Fei Chai	Scientific Communication
6	Dr. Rich Eason	How to Apply Patents
7	Dr. Yifeng Zhu	Graduate Studies
8	Dr. Fei Chai	Science and Society
9	Tom Stone	Graduate Studies from a Graduate Student Perspective
10	Dr. Peter Koons	Creativity in Sciences

The following is REU fellows' evaluation on each seminar. No fellows have missed any seminar. They particularly enjoy the seminars such as "Gradate studies from a graduate student perspective", "scientific communication", and "creativity in sciences". In the next year, we will change the topics of seminars that they don't enjoy, according to the survey results.

Table 4. Students' Evaluation of Lunch Seminar Series Offered in 2008

	Not informative	Somewhat informative	Informative	Very informative	Did NOT attend	Response Count
Literature Search Tutorial	1	5	**2**	**2**	0	10
Making Good Arguments	1	3	**5**	**1**	0	10
Communicating Evidence Visually	3	5	**2**	0	0	10
From Questions to Problems	6	4	0	0	0	10
Scientific Communication	0	0	**2**	**8**	0	10
How to Apply Patents	0	1	**5**	**4**	0	10
Graduate Studies	0	2	**4**	**4**	0	10
Science and Society	1	4	**1**	**4**	0	10
Graduate Studies from a Graduate Student Perspective	0	0	**4**	**6**	0	10
Creativity in Sciences	0	1	**0**	**9**	0	10

Table 5. Students' Evaluation of Lunch Seminar Series Offered in 2009

	Not informative	Somewhat informative	Informative	Very informative	Did NOT attend	Response Count
Literature Search Tutorial	0	2	**6**	2	0	10
Cyber-Infrastructure in Maine	0	0	3	**7**	0	10
Communicating Evidence Visually	1	2	**5**	2	1	10
How to Make Good Presentation	0	1	3	**6**	0	10
How to Apply Patents	0	0	**5**	**4**	0	10
Graduate Studies	0	0	2	**8**	0	10
Graduate Studies from a Graduate Student Perspective	0	0	1	**9**	0	10

Creativity in Sciences	0	`	**4**	**5**	0	10

Table 6. Students' Evaluation of Lunch Seminar Series Offered in 2010

	Not informative	Somewhat informative	Informative	Very informative	Did NOT attend	Response Count
How to do a Literature Search (Dr. Yifeng Zhu)	1	0	**3**	4	0	8
How to apply patents (Dr. Rick Easons)	0	0	3	**5**	0	8
Graduate study and application (Dr. Yifeng Zhu)	0	2	**2**	6	0	8
Graduate studies from a graduate's perspective (Thomas Stone/Dr. Susan McKay)	0	1	0	**8**	0	8
Cyberinfrastructure development in Maine (Dr. Bruce Segee)	0	0	**2**	6	0	8
Creativity in sciences (Dr. Peter Koons)	0	3	2	**3**	0	8
How to Make Good Presentation (Dr. Fei Chai)	0	2	1	**5**	0	8
Fractal Geometry (Andre Khalil)	0	1	**4**	3	0	8

The evaluation results show that our seminars were significantly improved in our second year and students were much more satisfied when we compare with our first year.

G.   Social Activities

Figure 3. REU fellows dinning, camping, and hiking

Social activities were coordinated to make our REU experiences enjoyable. In each year, one REU fellow was elected as the social chair. Our lesson we learned is that selecting the right person is very important. The social activities in the second year are much better organized comparing the first year. Some of the sponsored events included:

1. Hiking in the Acadia National Park
2. Dining out during the weekends
3. Camping in Bar Harbor
4. Penobscot River day trip

There are also some unsponsored events, including movie night, computer game night and ping-pong match. Based on the feedback from our fellows, we plan to provide more sponsored events in next year.

H.   Weekly Meeting

Our REU fellows met their research supervisors at least once each week. A weekly meeting consisting of the entire REU group was held. Each fellow was required a weekly report and placed on the project wiki web site. The group then discussed the weekly reports, identified potential issues, and made future research plans. Sometimes special technical seminars, which were of interest to the whole group, were organized immediately after the weekly meeting. For example, Omar Padron gave a tutorial how to make animations in Google Earth.

One important lesson that we learned is that our weekly meeting took too long and they were very tired at the end. In the next year, we plan to change our meeting format. In addition, a fellow will make a report once every other week, instead of every week.

I.   Outreach

This year our REU fellows had valuable opportunities to interact with middle-school students and teachers, and also the undergraduate participants of a different NSF-REU site.

1.   Interacting with NSF-ITEST Participating K-12 Teachings

Figure 4. REU fellows interacts with middle-school teachers

Prof. Yifeng Zhu and Bruce Segee, PIs of this REU site, are organizing a NSF-funded education program named as IDEAS that brings exciting experiences of supercomputing and scientific data visualization to middle school teachers (NSF ITEST, Grant No DRL- 0737583). The Maine Department of Education has equipped each 7th and 8th grade student and teacher with wireless laptop computers. The IDEAS project exploits this laptop program and generates educational computer modules applicable to middle school classrooms. From member schools of the Penobscot River Education Partnerships, twelve teachers are participating this program this year. IDEAS is a three-year program and it will involve 60 middle-school teachers and 180 middle-school students.

The REU participants have interacted directly with these middle teachers through two one-day workshops. They have mainly discussed two components: (1) *Mathematical Modeling*. Teachers use NetLogo to design computer-based class modules. NetLogo is a graphical and programmable modeling environment for simulating natural phenomena. (2) *Data Mining and Analysis*. Teachers use computer visualization tools analyze the climate data provided at National Climate Data Center, such as the temperature trends of Maine. Our REU fellows evaluated their own K-12 education experiences and provided constructive suggestions to our teachers by using computer and math skills learned in the college. The feedback from both teachers and students are very positive.

2. Help Organizing MLTI K-12 Student Conference

Our REU undergraduates help organizing the 5th annual MLTI K-12 Student Technology conference on Friday, May 30, 2008. More than 600 of Maine's middle school students were at the University of Maine for a day of pushing the boundaries of their laptop computer skills.

As part of the 5th annual MLTI Student Technology Conference, students from more than 45 schools learned about new laptop computer software, new applications and new ways to make the best use of laptops for research, classroom activities and 21st Century educational exploration. Students broke up for nearly 40 sessions on new software, educational games and dozens of the latest new media applications. The conference sessions taught students skills ranging from starting their own student tech teams at their schools to file sharing, blogs and podcasts, making iMovies about their communities and learning about math and science in innovative, imaginative ways.

Our REU undergraduates successfully helped the Department of Electrical and Computer Engineering organize such a large event. The major activities of our REU fellows included helping session organizers, trouble-shooting for network accesses, doing projects together with middle-school students, and providing campus guide. Through participating and organizing this technology conference, our REU students not only learned how computer laptops are used in K-12 classes in creative ways, but also to have a valuable opportunity to stimulate Maine middle school students to start thinking about college sooner.

Figure 5. REU fellows help organized a technology conference for middle school students

3. Interacting with students in another NSF-REU Site in Maine

Our REU fellows has visited the Jackson Laboratory and interacted with their NSF-REU participants. The Jackson Laboratory is a world-leading organization focusing on mammalian genetics research to advance human health. They are also hosting an NSF-REU site titled "Functional Genomics Research Projects for Undergraduates". The program is led by Dr. Jon Geiger. The following activities are organized during our visit.

1. Dr. Jon Geiger introduced the role of mice in genetics research, the Jackson Lab, and their summer research program.
2. Our fellows and their students introduced their summer research projects. Three of their REU participants gave formal presentation of their research findings.
3. REU fellows have lunch together to have informal interactions.
4. Janice Woychik gave a tour of their research facilities to our REU fellows.

The feedbacks from REU students are very positive. They are excited to have an opportunity to learn the genetics research, and also the research experiences at a different REU site.

Figure 6. REU fellows visit the Jackson Laboratory and interact with their REU participants.

J.   Contributions of Our REU Site

1.   Contributions within disciplines

The SuperMe REU site is a multi-disciplinary program led by nine faculty mentors from six different departments, with a coherent intellectual focus on scientific computing. Each year, our program provides both computer systems projects and computer application projects.

During no-cost extension (2011-2012), the project has supported five students on a smaller scale working on various projects.

In 2010, the computer systems projects include (1) Parallel I/O Testing for Hadoop, (2) Performance study of multi-GPU acceleration of LU factorization algorithm, (3) Viewshed Creation In Virtual Reality Applications, (4) User Input for the Display Wall,

and (5) Scientific Grid Portal. The Computer Application projects include (1) Linear Climate Model, (2) Modeling a Cell Nucleus, (3) The Ising Model of Spin Glass, (3) Disease Spread Modeling (4) Parallel Peruvian Anchovy Bioenergtics Model.

In 2009, the computer systems projects include (1) CUDA performance optimization fish modeling, (2) performance optimization on display wall, (3) display wall optimization through CUDA programming, (4) GPU-acceleration in Matlab. The computer application projects include (1) visualization of lobster larvae migration, (2) visualization of whale migration, (3) molecular dynamics of polypeptides in a confined environment, (4) modeling disease spread in a dynamic small world network, (5) modeling mass balance effects on glaciers, and (6) parallelization of climate change models.

In 2008, the computer systems projects include (1) energy-efficient buffer caching for high-end data servers, (2) high-resolution data display wall, (3) real-time visualization of ice sheet data, (4) upgrading of an intelligent control systems, and (5) parallel computing for earth modeling. The computer application projects include (1) modeling water to calculate its chemical potential in the bulk phase, (2) visualization of oceanic simulation data in Google earth, (3) Monte Carlo simulation on spin glass, (4) harmful algal bloom dynamics in the Gulf of Maine, and (5) geological data visualization.

The research finding and contributions are summarized in their project abstracts, given later in this report.

In addition, we have the following publications.

- Matthew Jones (*), University of Maine, ***An investigation of the impacts of vaccination and adaptive rewiring on disease spreading in an SIR model***, 11th Annual Greater Boston Area Statistical Mechanics Meeting, Boston, MA, October 10, 2009

- Aaron Robinson (*), ***Visualization Walls Using Commodity Clusters***, ACM 2009 Fall Conference, Gatlinburg, TN, November 12-13, 2009

- Wen Luo (*), Michael Mihalco, Thomas E. Stone, Susan R McKay. ***Overlap as a Measure of Spin-Glass Memory and a Probe of Free Energy Landscape***. 2009 American Physical Society March Meeting, Pittsburgh, Pennsylvania

- Mattew Jones (*), Thomas Stone, Dr. Susan McKay, ***Effects of Super-Spreaders in Epidemic Models on Dynamic Small-World Networks***, Dynamic Days 2010, International Conference on Chaos and Nonlinear Dynamics, January 4–7, 2010, Evanston, IL (poster)

2. **Contributions to Other Disciplines**

Due to the inter-disciplinary nature of our REU program, many REU fellows have worked very closely with faculty and researchers in many disciplines. Developing a

supercomputer application or a data visualization tool requires both computer science and also the knowledge of the target science problem in marine sciences, physics, earth sciences, and chemistry.

3. **Contributions to Human Resource Development**

Our REU program has successfully attracted female applicants, minority students, and applicants from relatively small colleges with limited supercomputing resources. We consistently contact 44 women's colleges and 200 chairpersons in the eastern states through posters and emails. In the past three years, we have received over 200 applications while we can only accept 30 students (10 each year, including 5 UMaine and 5 non-UMaine). Our REU participants include eight female students, and six minorities (only one female minority). Among 15 external participants from outside of UMaine, eight participants were from small colleges that only offer bachelor degrees and two were from colleges whose highest degree offered is master. As a result, 66% of our external participants were from small colleges with very limited research resources and opportunities.

Nine faculty mentors, one post-doc, and nine graduate students are closely involved in this program. Under the direct supervision of faculty mentors, each REU fellow worked on a research topic for a period of ten weeks. The project director Dr. Yifeng Zhu conducted one-week workshop to give them hand-on experiences on developing supercomputing applications. The program directors Dr. Yifeng Zhu and Dr. Bruce Segee held informal discussions with each REU fellow and his/her research mentor periodically throughput the duration of the program. Each REU fellow maintained a wiki website to report their program and disseminate their research finding. A weekly entire group meeting was organized. At the end of the summer program, a formal symposium was organized in which each REU fellow gave a formal powerpoint presentation of their summer research. The department chairs, all REU mentors and their graduate students, research associates, and post-doctors participated the conferences. The symposium was organized in the same format as an international conference with different sections and section chairs. In addition, each REU fellow submitted a formal report to their faculty mentor for future conference or journal publication.

All REU fellows are being followed up after the summer program ended. All participants are continued to work with their mentors, particularly on their technical papers, in order to formally publish their research finding. In this Fall semester, many on-campus RUE fellows are hired by their faculty mentors as paid undergraduate research assistants on a part-time basis.

The REU program has created a valuable boost on the student's motivation on pursuing graduate studies after receiving their bachelor degrees. During the summer program, these REU fellows were treated as peers, instead of students. They discussed research issues with their faculty mentors and worked together with the graduate students on a daily basis. Many of REU fellows actually gave research seminars to their faculty mentors and graduate students during the summer program. The ten-week experiences really made them enjoy the graduate life, be confident of their research capability, and most importantly be fascinated about their research work. The existing survey shows that 90% of our participants plan to enter a graduate program in STEM-related disciplines after graduation.

The REU program also directly helps our faculty mentors' research. Many of our faculty mentors are not computer scientists. The program modules that REU students developed during the summer program directly move further their research progress. For example, the Earth simulation module developed by the group of Dr. Peter Koons took over weeks to simulate a large module. By using the parallel software framework developed by our REU student, the running time is now reduced to one day. This REU student continues to work for Dr. Peter Koons this semester.

Our program has made positive changes to students' self-efficacy and attitudes toward scientific based on pre- and post- survey, as shown below. By the end of the program, their self-efficacy showed improvement for most of the eight skills required for successfully conducting scientific research. Their average self-efficacy across various skills increased from 83.06 to 86.67, on a 100-point scale. In terms of attitude toward scientific research, most students strongly agreed that scientific research is interesting, enjoyable, useful, and valuable to the society. After the SuperMe program, students continued to hold such positive attitude.

Skill comparison between pre-survey and post-survey

Identify a problem to be investigated.

1. Using deduction, generate a prediction from the hypothesis or model.
2. Design experimental procedures to test the prediction.
3. Conduct a scientific experiment, observation or simulation to test the hypothesis or model
4. Collect meaningful data, organize, and analyze data accurately and precisely
5. Apply numerical and statistical methods to numerical data to reach and support conclusions
6. Explain any unexpected results
7. Using available technology, report, display, and defend the results of an investigation to audiences that might include professionals and technical experts

Pre-Post Self-efficacy for Scientific Research
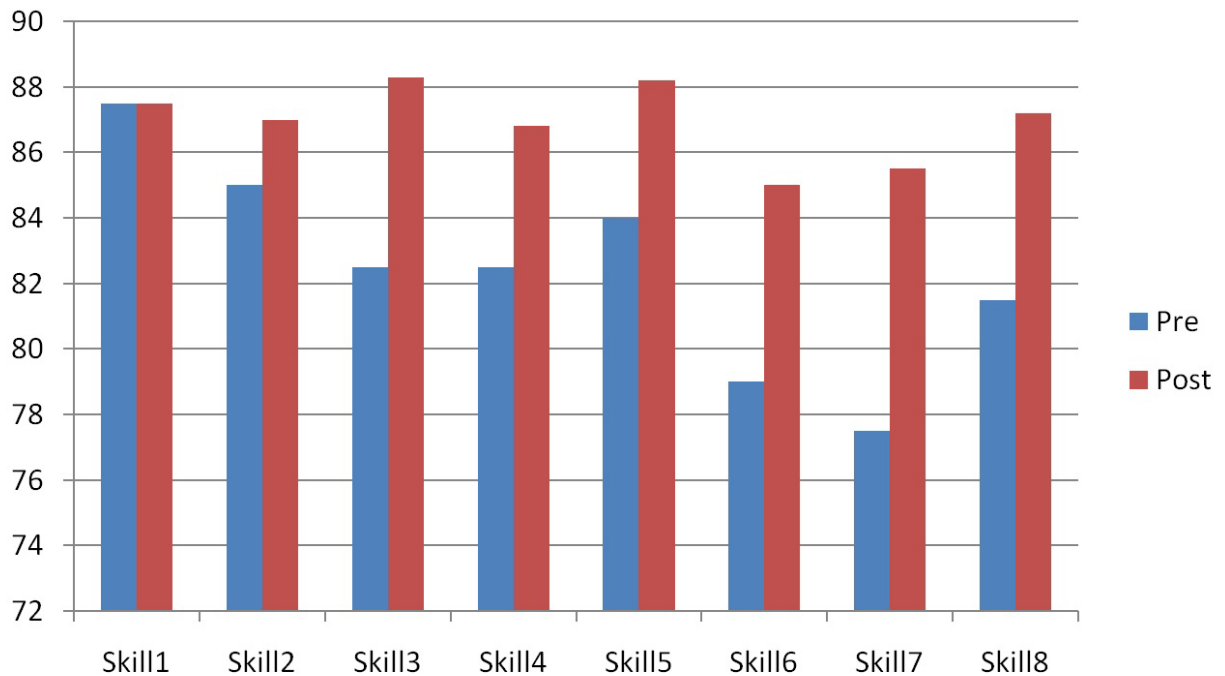
4. Contributions to Resources for Research and Education

This project exploits Web 2.0 to disseminate the research results. Each REU fellow maintains a wiki web page that summarizes related research work and presents their weekly research reports. The wiki pages can be accessed from the project website (http://arch.eece.maine.edu/superme).

5. Contribution Beyond Science and Engineering

Our REU fellows had valuable opportunities to interact with middle-school teachers and students. They had fruitful discussion on curriculum modules with 11 middle-school teachers who participated in an NSF-ITEST program leaded by the PI and co-PI of this REU site. These modules are being integrated into several middle schools. Our REU fellows also successfully organized a one-day conference that teach middle-school students about new laptop computer software, new applications and new ways to make the best use of laptops for research, classroom activities and 21st Century educational exploration. A total of 645 Maine's middle school students participated in that conference at the University of Maine to push the boundaries of their laptop computer skills.

VIII. Demographics

A. Application demographics

NSF-REU SuperMe Summer 2008, 2009 and 2010 Applications
(Application Received/REU Offers Made/REU Accepted)

Alabama
Auburn University …………….…….…… (1/0/0)

Arkansas
Hendrix College …………..………..…..… (1/0/0)

Canada
McGill University …………….……..…… (1/1/0)

California
California State University …….……… (1/0/0)
Mills College………………..……….…..… (1/0/0)
San Francisco State University…….…. (1/0/0)
Stanford University ………………..…….(1/0/0)
San Jose State University………..….….(1/0/0)

Colorado
University of Denver………………..……(2/1/1)

Connecticut
Wesleyan University …………….……… (1/0/0)
Quinnipiac University……………..…….. (1/0/0)
Wesleyan University ………………..…… (1/0/0)

Florida
Florida A & M University ……………… (1/1/0)
Stetson University …………….……….… (1/0/0)

Georgia
Southwestern University ……..……… (1/0/0)
Valdosta State University……….……… (1/0/0)
Covenant College …………….………..… (1/0/0)
University Of West Georgia….……….. (1/0/0)

Illinois
Eastern Illinois University ………..…… (1/1/1)
Augustana College………………..…….... (1/0/0)

Indiana
Earlham College ……………..…….…..… (1/0/0)
University of Evansville ………….…..… (1/1/1)

Rose-Hulman Institute of
Technology……….……………….…………… (3/1/0)
DePauw University…………….…………... (1/0/0)

Iowa
Northwestern College………..…….….… (1/0/0)
William Penn University……….…..…..… (1/0/0)
Grinnell College………….………..…….… (1/0/0)

Kansas
Benedictine College…………..…….…..… (1/1/1)

Kentucky
Transylvania University…………..…….. (1/0/0)

Louisiana
Louisiana State University………..…….. (1/0/0)
University of Louisiana at Lafayette... (1/0/0)

Maine
University of Maine …………..……… (29/15/15)
University of Southern Maine ……….. (6/2/1)

Maryland
University of Maryland Baltimore
County…………………………………….…… (2/1/0)
Johns Hopkins University …………….. (1/0/0)

Massachusetts
Harvard University …………….……….… (1/0/0)
Wellesley College ……………….……..… (1/1/1)
University of Massachusetts Lowell (1/1/1)
Amherst College………………..……….… (1/0/0)
Brandeis University………………..…….. (1/0/0)
Saint Anselm College……………..…….. (1/1/1)
Boston College……………….……….…… (1/0/0)
Worcester State College……………..…. (3/0/0)
University of Massachusetts Lowell..(1/0/0)

Montana
Montana State University …………….. (1/1/0)

Michigan

Michigan State University……………….. (1/0/0)

Minnesota
Macalester College ……………………… (1/0/0)
Augsburg College …………………………. (1/0/0)
University of St. Thomas………………. (1/0/0)
Carleton College…………………………. (1/0/0)

Mississippi
Mississippi Valley State University … (2/1/0)
Truman State University…………………. (1/1/0)

Nebraska
University of Nebraska-Lincoln …….. (1/1/1)

New Hampshire
Plymouth State University……………... (1/1/0)

New Jersey
Kean University …………………………. (3/1/1)
The College of New Jersey……………. (3/1/0)

New Mexico
University of New Mexico…………… (1/0/0)

New York
Saint Lawrence University ……………. (1/0/0)
Clarkson University ……………………. (1/0/0)
University at Buffalo……………………. (1/0/0)
City University of New York - Brooklyn
College…………………………………………. (1/0/0)
Stony Brook University……………………. (2/0/0)
Utica College……………………………………. (1/0/0)
Vassar College ………………………………. (1/0/0)
Rochester Institute of Technology….. (2/2/1)
Fordham University………………………. (1/1/0)
Macaulay Honors College at City College of New
YorK ……………………………………. (1/0/0)

North Carolina
Elizabeth City State University ……… (1/1/0)
North Carolina State University……. (2/1/0)
High Point University……………………. (1/0/0)
Gardner-Webb University…………… (1/0/0)

Oregon
Reed College…………………………………….. (1/0/0)

Ohio
Xavier University……………………………….(1/1/0)

University of Cincinnati………………………(1/1/0)
The College Of St.Elizabeth………………(1/1/0)
Allegheny College ……………………………. (1/1/1)
Hiram College………………………………….. (1/0/0)

Pennsylvania
Dickinson College ……………………………. (1/0/0)
Allegheny College……………………………. (1/0/0)
Temple University ……………………………. (1/0/0)
Bryn Mawr College ……………………… (1/0/0)
Washington & Jefferson College….. (1/0/0)
Shippensburg University……………… (1/0/0)
Ursinus College……………………………. (1/0/0)
Temple University………………………… (1/0/0)
Haverford College………………………… (1/0/0)
Penn State University…………………… (2/0/0)
Villanova University……………………… (2/0/0)
Carnegie Mellon University…………… (1/0/0)

Puerto Rico
University of Puerto Rico-Mayaguez..(2/1/0)

South Carolina
Coastal Carolina University …………… (1/0/0)
Wofford College……………………………. (1/1/0)

Texas
LeTourneau University …………………. (1/1/1)
Texas Tech University ……………………. (1/0/0)

Tennessee
Belmont University…………………………(2/1/0)
Tennessee Technological
University………………………………………(2/1/0)

Virgin Islands
University of the Virgin Islands …….. (1/0/0)

Washington, DC
George Washington University…………(1/1/0)

Washington
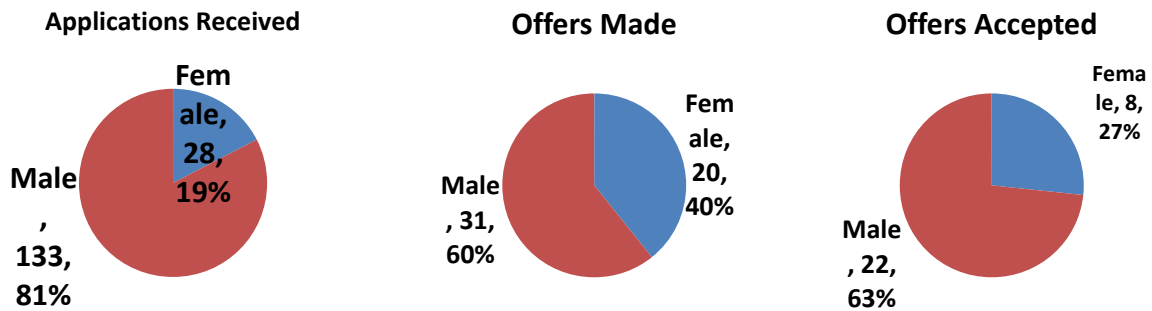Washington State University…………..(1/0/0)

Wisconsin
Ripon College………………………………(1/0/0)
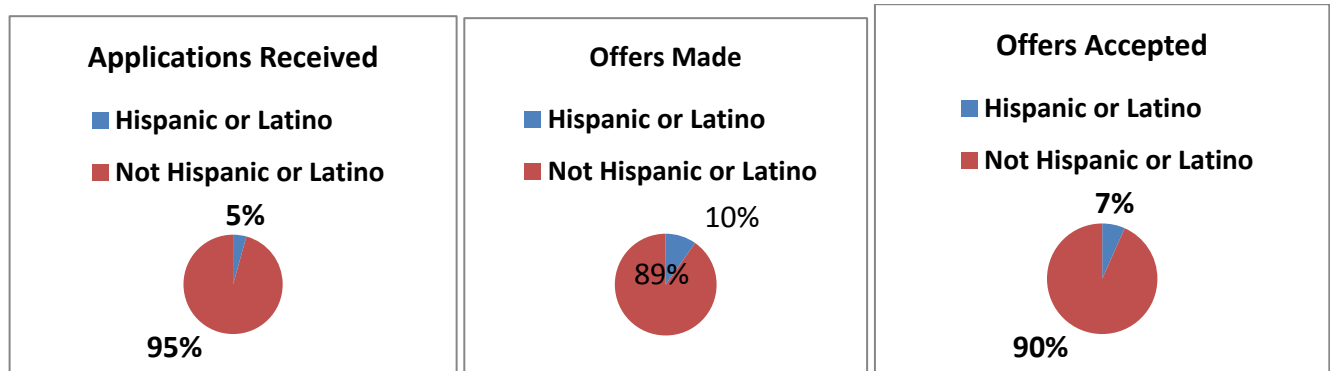Beloit College…………………………………(1/0/0)

Summary: 159 Applications received,

41 Offers made, and

30 Offers accepted

B.   Participant demographics

1.   Gender Distribution of 2008, 2009, and 2010

Applications Received

Female, 28, 19%

Male, 133, 81%

Offers Made

Female, 20, 40%

Male, 31, 60%

Offers Accepted

Female, 8, 27%

Male, 22, 63%

2.   Race Distribution of 2008, 2009, and 2010

Applications Received

- Hispanic or Latino
- Not Hispanic or Latino

5%

95%

Offers Made

- Hispanic or Latino
- Not Hispanic or Latino

10%

89%

Offers Accepted

- Hispanic or Latino
- Not Hispanic or Latino

7%

90%

3.   Ethnicity Distribution of 2008, 2009, and 2010

Applications Received

1% 7%
7% 1%
0%
84%

Black or African American

Asian

Offers Made

2% 10%
9%
2%
0%
77%

1
2
3
4
5

Offers Accepted

3% 0% 7% 3% 0%
87%

1
2
3
4
5
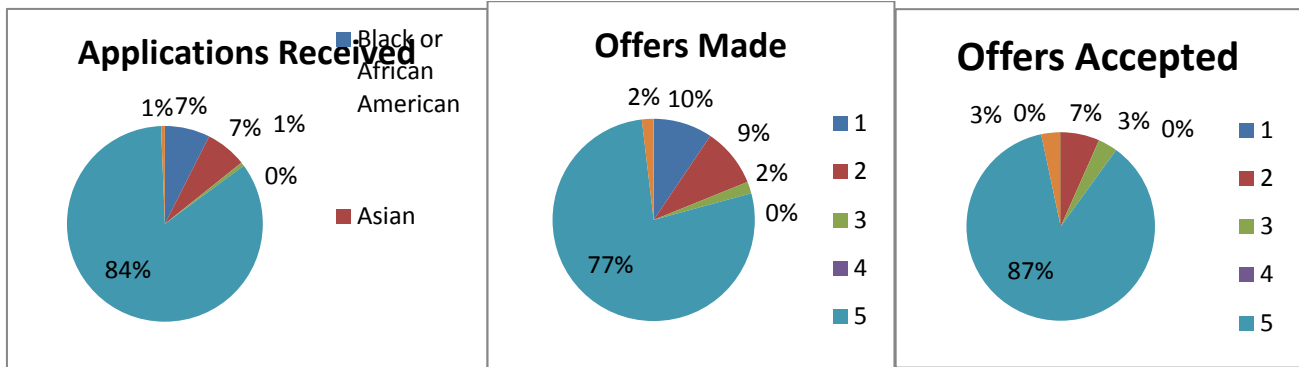
Research Experience for Undergraduates

SuperMe: Supercomputing in Maine

Arthur St. John Hill Auditorium

165 ESRB-Barrows Hall, University of Maine

Friday August 6 2010

9:00-9:20 AM   **Welcome and Overview** (Yifeng Zhu & Bruce Segee, Program Coordinators)

9:20-10:20 AM   **Session 1** *Scientific Visualization* (Moderator: Yifeng Zhu)

- "Input devices and magnification software to improve the usability of a high resolution monitor wall", Catherine Sullivan, Rochester Institute of Technology (Advisor: Dr. Bruce Segee)
- "Feasibility Study of High Resolution Viewshed Creation In Virtual Reality Applications", Timothy McGrath, University of Maine (Advisor: Dr. Nicholas Giudice)
- "Linear Climate Model", Matthew Edwards, University of Maine (Advisor: Sean Birkel, Dr. Peter Koons)

10:20-10:40 AM   **Break**

10:40-11:40 PM   **Session 2** *Computing Systems* (Moderator: Segee Bruce)

- "Performance Evaluation of the Parallel I/O Support for Hadoop", Matthew Dunn, University of Maine (Advisor: Dr. Yifeng Zhu)
- "Scientific Grid Portal", Gerry Shannon, University of Southern Maine (Advisor: Dr. Phillip Dickens)
- "Performance Study of Multi-GPU Acceleration of LU Factorization Algorithm", Brandon Abbott, University of Denver (Advisor: Dr. Yifeng Zhu)

11:40-1:00 PM   **Lunch**

1:00-2:20 PM   ## Session 3 *Scientific Modeling* (Moderator: Peter Koons)

- "Probabilistic Modeling of 2D Foci Counts with Respect to 3D radial Distribution", Craig Verrill, University of Maine (Advisor: Dr. Andre Khalil)
- "Ising Model of Spin Glass", Zachary Smith, Rensselaer Polytechnic Institute (Advisor: Dr. Susan McKay, Tom Stone)
- "Disease Spread Modeling on an Adaptive Network", Breana Coyle, Saint Anselm College (Advisors: Dr. Susan McKay, Tom Stone)
- "Fish model on GPU", Kevin Demers, University of Maine, (Advisors: Dr. Fei Chai, Dr. Huijie Xue, and Steve Cousins)

Awards & Concluding Remarks (Yifeng Zhu & Bruce Segee)

Major Research Findings in 2010

Input devices and magnification programs to improve the usability of a high resolution monitor
Project by: Catherine Sullivan
Advisor: Dr. Bruce Segee

High-resolution data visualization is good when attempting to look at large scale data but it is necessary to preserve the details at the same time. Using a grid of monitors such as the one at the Innovation Center at the University of Maine makes this possible. However having such a large screen makes user input extremely difficult using only the normal wired keyboard and mouse. The goal of my research was to look into various input methods and applications that would make the display wall more user-friendly and implement them. It was found that the best input device for the wall is a simple hand- held, wireless, trackball mouse accompanied by a keyboard with a long cord so that it can be used from a distance. This enables the user to have a better angle for viewing the wall in its entirety, and still have complete control over the desktop. The magnifying application running on the display wall is called MAGNIFYING GLASS, a free application from the WORKERS COLLECTION. It creates a magnifying window that follows the cursor, magnifying whatever is underneath it. It allows the user to stand back from the wall and still be able to read the text on the screen.

Parallel Peruvian Anchovy Bioenergtics Model
Project By:Kevin Demers
Advisors: Fei Chai, Huijie Xue, Steve Cousins

Modern Graphics Processing Units (GPUs) contain a massive amount of computation power for a very low price. They are designed to quickly complete a large number of computations in a short amount of time across many parallel threads. With recent developer tools, the power of GPUs can be harnessed for general computation needs. This project involves acceleration of an Individual Based Mode l(IBM) designed to analyze the growth and movement of Peruvian Anchovies as a function of water temperature and food concentration levels. The goal of this project was to

harness the parallel processing power of a modern GPU through Fortran and Cuda to increase the performance of the program. For an expanded data set, a performance increase of 1.5 was realized, reducing total run time from 46 hours to 30 hours.

Viewshed Creation In Virtual Reality Applications
Project by: Timothy McGrath
Advisor: Dr. Nicholas Giudice

The focus of this project is to investigate the effec- tiveness of using Virtual Reality (VR) to represent a Viewshed (a view from a particular location and direction). This 3D rendering will give the user a fully immersive experience of the location being viewed and will be much more realistic, and easier to relate to, than current 2-Dimensional Viewshed maps. One application of this method would be to create 3-Dimensional simulations of the Viewsheds surrounding potential wind farms in Maine and offshore. This approach could apply to any prototyping project that requires a view of the product in it's environment before actually being built and placed on site.

The project will utilize campus resources (the VEMI lab) to create a data display that uses virtual reality to present immersive information in three full dimensions. Using a head-mounted display (HMD) and interactive tools, users can walk around in the display and interact with data in real time. More specifically, the goal of this project is to build a 3D object using elevation information that can be overlaid with terrain maps and/or utility maps to create a 3-Dimensional model of a region of interest and update the display based on the users physical movement. Ideally, users would also be able to use a tool to select locations of interest and display additional information about them.

Performance study of multi-GPU acceleration of LU factorization algorithm
Project by: Brandon Abbott
Advisors: Dr. Yifeng Zhu

As the industry demands more powerful GPUs for graphical applications, many have taken advantage of their computational power for more general purposes, a practice known as GPGPU (General Purpose computation on Graphics Processing Units). In many cases, parallel code running on a GPU will out-perform sequential code running on a CPU using similar algorithms or

benchmarks; however, communication between the CPU and GPU does generate some overhead with regard to the total computation time. For this project, a simple LU decomposition was implemented in three manners: sequentially on the CPU, in parallel on a single GPU and in parallel using multiple GPUs. A high-resolution timer was set up to find the rate of data transfer between main memory and the device's memory and to time how long the CPU, GPU, and GPUs spend doing work on the decompositions. Ultimately, this project seeks to display that one may obtain better performance by using multiple GPUs for large amounts of work, but for smaller data sets, the overhead in communication and synchronization quickly becomes time-expensive.

Scientific Grid Portal: Dynamic and Interactive Models
Gerry Shannon
Advisor: Dr. Phillip Dickens

The Scientific Grid Portal is meant to be an interactive tool for building and implementing models based on experimental data thus giving a physical visual result to theorized conclusions. The purpose of this portal is to provide the client with a simple, user-friendly web page that connects and combines data and information available on an array of different servers. The Grid Portal will allow a client access to a graphics processing unit (GPU) and supercomputer for the purposes of uploading and accessing models through an easy to use interface. The portal will provide a level of functionality, content and visualization based on the variables found in the model and parameters set by the user of the model. The primary server is part of a larger group of server databases that can all be accessed from a secure location after a user has been authenticated as a viable client. Security is an important feature to consider when developing the architecture of this portal. It is crucial that the only access point to the servers and system be from the portal's server, through which the client has already been authorized. The portal will give users the ability to access projects, save data and render results from anywhere an internet browser is available.

Linear Climate Model Matthew Edwards, SuperME REU Student

Project by: Matthew Matthew Edwards

Advisor: Sean Birkel

Abstract—The Linear Climate Model (LCM), originally programmed on Matlab by PHD candidate Sean Birkel, is a model of global climate which creates high resolution dynamic images. The original web page implementation was received in an incomplete, skeletal state. The current web page LCM is easy to use, dynamic, and visually compelling. It creates up to 30 second data resolution images of varying sizes. Also, the image generation has been accelerated to over twenty times its original speed. Moreover, many bugs have been removed from the original web page implementation. And finally, many new input options have been added.

Disease Spread Modeling

Project by: Breana Coyle (Saint Anselm College)

Advisors: Dr. Susan McKay, Tom Stone (Department of Physics, UMaine)

Adaptive networks have recently been introduced [1- 5] to more realistically model a population's contact network structure. In these adaptive networks, links can rewire in response to the current dynamics occurring on the network. For example, in a disease spreading model, a susceptible individual may break their social link with an infected one in order to avoid contracting the disease. To maintain the connectivity of the network, the susceptible typically creates a link with another susceptible node, or simply a random node. In this project, we study a susceptible-infected-recovered-susceptible (SIRS) model that occurs on an adaptive network. However, unlike previous work, after some finite time, the original links are remade, thus preserving the underlying topology of the community. We shall determine how relevant quantities, such as the average number of infected agents, respond to varying amounts of adaptive rewiring and reconnection times.

Parallel I/O Testing for Hadoop

Project by: Matthew Dunn, University of Maine, Computer Engineering Major

Advisor: Dr. Yifeng Zhu

Hadoop is a cloud computing program cre- ated to deal with the growing demands of modern com- puting and storage of massive amounts of data. Hadoop consists of its own file system, HDFS, and the Hadoop MapReduce engine. Hadoop uses the HDFS to divide files among several

nodes, with the processor of each node only working off their own storage. The goal of this project is to compare how Hadoop performs with a parallel file system, like PVFS2 with its standard file system, HDFS. PVFS2 (Parallel Virtual File System 2) chops the files up so that several different nodes have a small piece of a larger file. This may improve the performance of Hadoop by having the nodes share storage instead of working separately.

Correlated Spin Networks in the Cubic-Lattice Ising Model with Competing Interactions
Zachary R. Smith
Advisors: Prof. Susan Mckay, Thomas Stone, and Michael Mihalco
This paper discusses electron spin relationships as networks in a block of magnetic material using the Monte Carlo method with the Metropolis Algorithm modified to handle a cubic lattice. We focus on the network behavior in the 3D spin-glass phase where, in the case of the simulation, the properties of alloys create frustration in a ratio of ferromagnetic to antiferromagnetic bonds. Highly correlated spins are linked in a network, which have unique properties. These networks are displayed three-dimensionally for analysis that will be used to study the spin glass phase.

Probabilistic Modeling of 2D Foci Counts with Respect to 3D Radial Distribution
Project by: Craig Verrill
Advisor: Dr. Andre Khalil
The purpose of this project is to provide experimental evidence that the radial positioning of small spherical foci within a larger 3D cell nucleus influences the number of foci that can be clearly identified in the 2D maximum projection of the nucleus. Several biomedical labs are currently using 2D maximum projection as a tool for determining foci counts without realizing the way in which radial distribution of foci plays a influences in the number of foci able to be identified in a 2D maximum projection. Based on the results of this study, we argue that a high number of randomly positioned foci could yield the same count in a 2D projection as a nucleus with much fewer foci with peripheral positioning. We argue that this phenomenon must be taken into account in future studies utilizing the 2D maximum projection technique.

2009 NSF *SuperMe* REU SYMPOSIUM

8:45 AM to 2:00 PM, Friday, August 7, 2009
Arthur St. John Hill Auditorium, Barrows Hall
University of Maine
Orono, ME 04469

Time	Sessions and Topics	Chairs and Speakers
8:45 – 9:00 am	**Welcome and Overview**	
Session 1: Scientific Modeling		
9:20 – 9:40 am	Modeling Disease Spread in a Dynamic Small World Network	Matthew Jones
9:40 – 10:00 am	Modeling Polypeptides in Carbon Nanotubes	Dylan Suvlu
10:00–10:20 am	Implementation of the University of Maine Ice Sheet Model in a Simple Online Interface	Elliott Moy

Coffee Break (10:20–10:30 am)

Session 2: Parallel and GPU Computation		
10:30–10:50 am	Improving UMISM Performance Through Bottleneck Minimization	Sara Doan
10:50–11:10 am	GPU-Acceleration in Matlab	Robert King
11:10–11:30 am	Performance Optimization on Fish Modeling Software	Stephen Beery
11:30–11:50 am	Increasing Performance of a High-Resolution Monitor Wall	Jason Monk

Lunch (12:00 – 1:00)

Session 3: Scientific Visualization		
1:00 – 1:20pm	Visualization Walls Using Commodity Clusters: Rocks Viz Roll	Aaron Robinson
1:20 – 1:40pm	Visualization of Whale Migration	Stacey Gomm
1:40 – 2:00pm	Visualization of Lobster Larvae Migration in the Gulf of Maine	Nash Kellaway

Awards (2:00pm)	Adjournment – Concluding Remarks	Yifeng Zhu / Bruce Segee

Major Research Findings in 2009

CUDA Performance Optimization Fish Modeling
Stephen Beery
Computer Science
Benedictine College, Atchison, Kansas
Advisors: Steve Cousins, Prof. Fei Chai and Prof. Huijie Xue

This project is to utilize the processor power of an nVidia 8800 GTX graphics card to enhance computing performance on the current fish modeling research, using her existing code and findings to produce a velocious and efficient method for compiling and representing data. Performance gain is the primary goal of the project, by incorporating code to make use of the existing computing power. Any languages used here should be inter-compatible, with FORTRAN as the primary.

Project URL: http://triton.umeoce.maine.edu/wiki/index.php/Fish_model_on_GPU

Parallelization of Climate Change Models
Sara Doan
Computer Science
Allegheny College, Meadville, PA
Advisors: Prof. Phillip Dickens and Prof. Peter Koons

This project will consist of parallelizing the code of a model, specifically UMISM. Therefore the model will be faster and easier to use. Also, the model will be available on the Web in such a way that is accessible and operable by a non-technical person.

Project URL: http://arch.eece.maine.edu/superme/index.php/Parallel

Visualization of Whale Migration
Stacey Gomm
Civil Engineering
University of Maine, Orono, ME
Advisors: Prof. Fei Chai and Steve Cousins

We have run model simulations of whale migrations and have some understanding of what goes

on. We are interested now in how they find food. The next step is to put some "food" into our models in likely locations in the Gulf of Maine and come up with some algorithms for modeling how whales search for food. We will run the models and analyze the results both statistically and visually.

Project URL: http://arch.eece.maine.edu/superme/index.php/Ocean_modeling1

Modeling Disease Spread in a Dynamic Small World Network
Matt Jones
*Electrical and Computer Engineering*
University of Maine, Orono, ME
Advisor: Prof. Susan McKay and Tom Stone

Dynamic small world (DSW) networks are often used to model spreading processes on networks, such as rumor propagation, information flow, and disease outbreaks. The objectives of this project are to incorporate "super-spreaders" into the standard DSW disease model and to investigate the effects of random and targeted vaccination programs in this model. Quantities of interest include infectives as a function of time, peak and total outbreak times, and determination of which parameter values lead to an endemic state.

Project
URL: http://arch.eece.maine.edu/superme/index.php/Modeling_Disease_Spread_in_Dynamic_Small_World
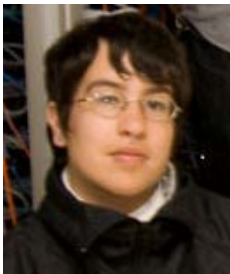
Visualization of Lobster Larvae Migration in the Gulf of Maine
Nash Kellaway
Computer Science
Wellesley College, Wellesley, MA
Advisors: Steve Cousins, Prof. Fei Chai and Prof. Huijie Xue

A valuable tool in accessing migration of a large amount of creatures is to visualize simulation data. Simulation data has already been collected for the migration of lobster larvae in the Gulf of Maine. The visualization of this data will provide a way to see the effects of the currents on the lobster larvae in different regions of the Gulf of Maine. This project investigates a methodology and series of code developed to visualize this simulation data.

Project URL: http://arch.eece.maine.edu/superme/index.php/Lobster_Visualization

GPU-Acceleration in Matlab
Robert King
Electrical and Computer Engineering
University of Maine, Orono
Advisors: Prof. Yifeng Zhu and Prof. Bruce Segee

This project investigates the GPU acceleration in Matlab. Matlab is a very powerful computer program used to solve complicated mathematical problems. In order to speed up Matlab the toolboxes will be studied and profiled to find the main bottlenecks in the sequential code. Then a MEX-file will be written including CUDA code to decrease the completion time of the Matlab functions. The parallel code will run in many threads on an NVIDIA graphical processing unit. By decreasing the completion time of the longest part of the code the largest performance increase can be achieved.

Project URL: http://arch.eece.maine.edu/superme/index.php/Matlab_cuda

High-resolution Data Visualization
Jason Monk
Electrical and Computer Engineering
University of Maine, Orono, ME
Advisors: Prof. Bruce Segee

GPUs (Graphics Processing Units) have developed into processors that can perform large amount of algebraic calculations in parallel, similar to the design of a supercomputer. CUDA is the architecture recently implemented in NVidia graphics cards that allows users to compile and run C/C++ code in parallel on their GPU. The added computational power from the GPU(s) allows problems that could normally require a supercomputer to run on a graphics card in comparable time. The goal of my research will be to increase the performance of the high-resolution display wall found in the innovation center by harvesting unused GPU computational power. Of particular interest will be a CUDA enhanced version of virtualGL allowing faster rendering at high resolutions.

Project URL: http://arch.eece.maine.edu/superme/index.php/Visualization1

**Modeling Mass Balance effects on Glaciers**
Elliott Moy
Computer Science
University of Massachusetts Lowell

Advisor: Prof. Peter O. Koons and Prof. Phil Dickens

This project focuses on applying supercomputing to model the effects of atmospheric conditions and mass balance on glaciers. The supercomputer is given mathematical functions and initial data to iterate, generating maps of the effects on glaciers over time. The geological models used currently can only reasonably cover a small area in detail, but supercomputing will enable modeling of a much larger area. In addition, another focus of this project will be making supercomputing power for mathematical problem solving available to scientists that don't specialize in supercomputing by creating a simple user interface.

Project URL: http://arch.eece.maine.edu/superme/index.php/Mass_balance_effects_on_glaciers
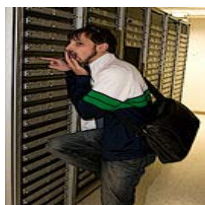
Performance Optimization on Display Wall
Aaron Robinson
Computer Science and Mathematics
High Point University, High Point, NC
Advisors: Prof. Bruce Segee

High-resolution data visualization is an import scientific tool which gives the viewer the ability to view the finer details while still having visual access to the big picture. The goal of this summer research is to document different forms of high-resolution data visualization in use today and determine the best way to benchmark display walls given the intent of the display. The visualization wall at UMaine's Innovation Center will be tested under a number of configurations. Any software improvements which are developed while doing this research will be presented to the open source community.

Project

URL: http://arch.eece.maine.edu/superme/index.php/Performance_optimization_on_display_wall

Modeling Small Proteins in Carbon Nanotubes with Molecular Dynamics
Dylan Suvlu
Chemistry
University of Maine, Orono
Advisors: Prof. Jay Rasaiah

Many theoretical and experimental studies have recently been focused on determining the behavior and conformation of proteins in confined and crowded molecular environments because of the relevance to a number of biological systems. Due to the importance of qualitatively determining the nature of this behavior, molecular dynamics simulations are studied here on five separate polypeptides in four different environments: bulk, two hydrophobic carbon nanotubes with diameters of 14.9 and 20.3 Å, and a nanotube with altered charges to mimic hydrophilicity.

Project URL: http://arch.eece.maine.edu/superme/index.php/MD_confined_peptides

2008 NSF *SuperMe* REU SYMPOSIUM

8:30 AM to 2:00 PM, Friday, August 1, 2008
Arthur St. John Hill Auditorium, Barrows Hall
University of Maine
Orono, ME 04469

Time	Sessions and Topics	Chairs and Speakers
8:30 – 8:55 am	**Registration/Continental Breakfast**	
9:00 – 9:15 am	**Welcome Remark**	
Section 1: Data Visualization		
9:20 – 9:40 am	Geological Data Visualization	Andrew Pellett University of Maine
9:40 – 10:00 am	High-resolution Data Visualization	Jessica David University of Evansville
10:00–10:20 am	Interactive Visualization of Oceanic Data An Application of the Keyhole Markup Language	Omar Padron Kean University
Coffee Break (10:20–10:30 am)		
Section 2: Scientific Applications		
10:30–10:50 am	Harmful Algal Bloom Dynamics in the Gulf of Maine	Jennifer Brown University of Maine
10:50–11:10 am	ST. Elias Erosion/tectonics Project	Donald Lewis University of Maine
11:10–11:30 am	Modeling Water to Calculate its Chemical Potential in the Bulk Phase	Dan Dorman LeTourneau University
11:30–11:50 am	Monte Carlo Simulation on Spin Glass	Wen Luo University of Nebraska
Lunch (12:00 – 1:00)		
Section 2: Computing Systems		
1:00 – 1:20pm	Real-Time Visualization of Ice Sheet Data in the Classroom	Kara West University of Maine
1:20 – 1:40pm	Design of an Upgraded System for Controlling the Trimming of the Sole of a Shoe	Craig Harrison University of Maine
1:40 – 2:00pm	Development of an Energy-Optimal Offline Cache Replacement Algorithm	Tim Russell Eastern Illinois University
2:00pm	Adjournment – Concluding Remarks	Yifeng Zhu / Bruce Segee

Major Research Findings in 2008

Geological Data Visualization
Andrew Pellett
Electrical and Computer Engineering
University of Maine
Orono, ME
Advisors: Prof. Peter Koons, Sean Birkel,

This project involved the design of a MATLAB Graphical User Interface (GUI) and the underlying program for generating visualizations of climate data. The program works with data in the netCDF format from the NCEP/NCAR reanalysis project to create the visualizations. The visualizations can be output as AVI video, still images, and still images with map projections applied. Integration with Google Earth is also available using the non-projected still images and the corresponding KML output file.
Project website: http://arch.eece.maine.edu/superme/index.php/Projects/Gedavi

High-resolution Data Visualization
Jessica David
Computer Engineering
University of Evansville
Evansville, IN
Advisors: Prof. Bruce Segee, Jason Withee, Nathan Bourgoin

High-resolution data visualization is useful when wanting to look at data on a larger scale while maintaining finer details. While using a projector helps show information on a larger scale, the pixels are only enlarged and detail is lost due to the inflated pixel size. By using a grid of monitors, however, one gains a higher resolution and still maintains the details, as well as being able to display more information than a single monitor. The research in this paper focuses on using VNC (Virtual Network Computing) to create high-resolution displays and for the monitor wall in the Innovation Center at the University of Maine in Orono and dynamic walls using students' and teachers' laptops for the MLTI (Maine Learning Technology Initiative) program. Edits were made to allow the VNC client to access a specific region of the server's desktop, and tests were performed to discover the performance differences between RealVNC and TightVNC on both of the walls.
Project website: http://arch.eece.maine.edu/superme/index.php/Visualization

Interactive Visualization of Oceanic Data An Application of the
Keyhole Markup Language
Omar Padron
Computational Mathematics & Physics
Kean University
Union, New Jersey

Advisors: Prof. Huijie Xue and Steve Cousins
A framework for visualizing the numerical results derived from simulations using oceanic models is presented. The core functionality is provided by the Keyhole Markup Language and geospatial applications that conform to the KML specification. Additional critical components include a portable and robust file format for the storage and retrieval of simulation data, an efficient data plotting scheme for the creation of graphics, and an automated process for the creation of KML compliant packages to be loaded by client applications compatible with the KML file format. In addition, the feasibility of a framework for serving dynamically generated KML over network streams is explored. Initial development in an implementation of this service is presented as well as discussion for areas for improvement, the implications of such a service, and the need for further research in the applications of utilizing bidirectional network links to serve geospatial imagery.

Project website: http://arch.eece.maine.edu/superme/index.php/Ocean_modeling

Harmful Algal Bloom Dynamics in the Gulf of Maine
Jennifer Brown
Biological Engineering
University of Maine
Orono, ME
Advisor: Prof. Fei Chai

In the Gulf of Maine (GoM), the phenomenon called harmful algal bloom (HAB) or "Red Tide" is caused by the toxic dinoflagellate phytoplankton *Alexandrium* fundyense. Previous models of A. fundyense dynamics exclude the dynamics of other phytoplankton species such as diatoms and zooplankton. Using Stella modeling software, real-time data from the online GoMOOS database, and known values relating to the growth of *A. fundyense* and other plankton species in the GoM, a simulation is produced which includes interactions between A. fundyense and the GoM ecosystem. The Stella model output is then compared with a 3-Dimensional version created by Dr. Fei Chai's post-doctoral fellow, Dr. Guimei Liu, using visualizations from both models.

Project website: http://arch.eece.maine.edu/superme/index.php/Hab_modeling

Installation and Configuration of Gale for Geological Modeling on a Beowulf Cluster
Donald Lewis
Electrical and Computer Engineering
University of Maine
Orono, ME
Advisors: Prof. Peter Koons and Benjamin P. Hooks

The St. Elias Erosion/Tectonics Project(STEEP) is a study into the creation and properties of the St. Elias Mountains, located in southern Alaska and northwestern Canada. The goal of the STEEP is to create a model for the orogeny of the St. Elias Mountain range. The research being done at the University of Maine is primarily concerned with the plate tectonics of the boundary between the North Pacific Plate and Alaska, and how it contributes to the orogeny. To study this, a 2D and 3D computer simulation, Gale, can be used. Gale is a finite element model capable of modeling

both2D and 3D geological simulations. It can model subduction, rifting, orogenesis with the ability to be linked to surface erosion models. For the Beowulf cluster, the use of a direct solver provided the best performance. For large simulations, on the order of 500 time steps or more, the direct solver was found to be at least 6 times faster. During the testing of this project, a 500 time step 3-D simulation was run using the direct solver. The simulation took 13 hours, while with the GMRES method it was not completed in a reasonable amount of time. The GMRES method ran for 78 hours before the cluster killed the job due to wall time errors. The direct solver is required for large simulations.

Project website: http://arch.eece.maine.edu/superme/index.php/STEEP

Modeling Water to Calculate its Chemical Potential in the Bulk Phase
Dan Dorman
**Biomedical Engineering**
LeTourneau University
Longview, Texas
Advisors: Prof. Jay Rasaiah and Dr. Guogang Feng

Water is necessary for life on earth, and it possesses some amazing properties that require a great deal of research. The ultimate goal of this project is to contribute to the research of one of these properties-the behavior of water molecules in the confined systems of hydrophobic protein cavities and the role the water molecules play in the functionality of these proteins. However, in order to understand the behavior of water molecules in confined systems, it is first necessary to research the behavior of water in the bulk phase. Then the behavior of water in confined systems can be researched and then contrasted with the behavior of water in the bulk phase. In this phase of the research I have calculated and verified the chemical potential of water in the bulk phase. I used the supercomputer clusters at the University of Maine to build a model and to simulate the experiments. The software package Amber was utilized on the supercomputer for building an experimental model and completing the molecular dynamics simulations using the TIP3P water molecule model. The simulations were done using the particle insertion and removal method to calculate the excess chemical potential of water in the bulk phase. The excess chemical potential of TIP3P water in the bulk phase was calculated and compared to the excess chemical potential of real water. I found that the results of the TIP3P water were very close to those of real water.

Project website: http://arch.eece.maine.edu/superme/index.php/Water_modeling
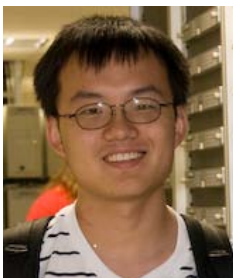
Monte Carlo Simulation on Spin Glass
Wen Luo
Computer Science & Math
**University of Nebraska-Lincoln**
Lincoln, NE
Advisors: Prof. Susan McKay, Tom Stone, and Mike Mihalco

Spin glass materials exhibit disordered systems with high magnetic frustration. These characters cause the system to have a rough free energy landscape, which in turn results in their peculiar

static and dynamical behavior. We study the geometrical description of the landscape to lead to a understanding of spin glass. We apply Monte Carlo method in order to obtain replicas of equilibrium energy states, and apply the overlap method to analyze the replicas. It is concluded that the spin-glass system is able to keep certain memory of different ground states if the system is kept in its spin-glass phase, and a spin-glass system will always be stuck at a low energy equilibrium state if it has been cooled down suddenly from its paramagnetic phase. We also found out that there is no direct relationship between the internal energy difference and the overlap of replica ground states.

Project website: http://arch.eece.maine.edu/superme/index.php/Physics_modeling
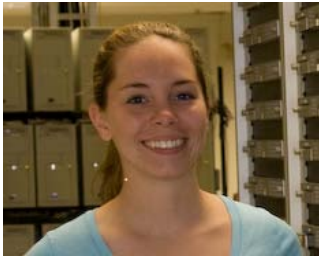
Real-Time Visualization of Ice Sheet Data in the Classroom
Kara West
Computer Science
University of Maine
Orono, ME
Advisor: Prof. Phil Dickens and James Campbell

Real-time rendering is a problem concerned with performance. While most scientific models focus on post processing videos and graphs, real-time focuses on results as they become available. This type of rendering is most akin to that found in 3D video games as they are played and run in a real-time environment. This is interesting because it allows people to the results of the model as they become available, and allows them to change relevant parameters on the fly with instant results.

Project website: http://arch.eece.maine.edu/superme/index.php/Grid_computing

Design of an Upgraded System for Controlling the Trimming of the Sole of a Shoe
Craig Harrison
Electrical and Computer Engineering
University of Maine
Orono, ME
Advisors: Prof. Richard Eason

Due to the rapid development of new technology, hardware and software systems quickly become obsolete. The software and hardware controlling this shoe sole trimming machine were originally designed over thirteen years ago to run under the MS-DOS operating system with limited memory, display capabilities, and processing power. The software was modified to run under the GNU/Linux operating system with a new touch screen interface. Concurrently, the old computer system and motion controller cards were replaced with more contemporary equivalents and the software was updated to be compatible with this new hardware. The resulting system is network accessible, easier to maintain, and more user-friendly. These changes will increase operator efficiency, save company money, and allow the sole trimming system to continue functioning in the face of new technology for years to come.

Project website: http://arch.eece.maine.edu/superme/index.php/Robot_sst

Development of an Energy-Optimal Offline Cache Replacement Algorithm
Tim Russell
Math & Computer Science
Eastern Illinois University
Charleston, IL

Advisors: Prof. Yifeng Zhu and Jianhui Yue

Energy efficiency in computing is becoming a paramount concern as large-scale data storage and high performance computing become increasingly prevalent. Additionally, small-scale mobile devices benefit from energy efficiency as the demand for smaller footprint drives manufacturers to use smaller power sources, while still attempting to deliver more features. We seek to develop an energy-optimal offline page replacement algorithm to provide a theoretical upper bound for the energy savings possible for energy-conscious online algorithms. DMA overlapping and memory chip power management were used to achieve power savings. Three approaches to the problem were developed, and one, the Total Overlap Method (TOM), was implemented in an existing buffer simulation program. The performance of TOM was compared to that of LRU by running the simulation on seven disk traces. TOM performed identically to LRU in terms of energy efficiency and hit rate in three traces. LRU outperformed TOM in two traces, with an energy consumption that was 1.8%–9.7% lower than TOM, and a hit rate that was 5.6%–56.2% higher. TOM outperformed LRU on one trace, with an energy consumption that was 5.9%–13.5% lower than TOM, and a hit rate that was 61.4%–448% higher. TOM failed to conclusively outperform an online page replacement algorithm, suggesting that the approach taken here is not viable. It is possible that the traces used did not reflect the request distribution which is useful to TOM. As such, future studies include evaluating the performance of TOM on other disk traces.

Project website: http://arch.eece.maine.edu/superme/index.php/Energy_optimal_cache_replacement_algorithm

IX.   Program Personnel

Senior Personnel

Name	Worked for more than 160 hours	Contribution to Project
Dr. Yifeng Zhu	Yes	Program Director & PI
Dr. Bruce Segee	Yes	Program co-director & Co-PI
Dr. Xiongyi Liu	Yes	Program evaluator
Dr. Fei Chai	No	REU faculty supervisor
Dr. Philip Dickens	No	REU faculty supervisor
Dr. Richard Eason	No	REU faculty supervisor
Dr. Peter Koons	No	REU faculty supervisor
Dr. Susan McKay	No	REU faculty supervisor
Dr. Jayendran C. Rasaiah	No	REU faculty supervisor
Dr. Huijie Xue	No	REU faculty supervisor
Dr. Andre Khalil	No	REU faculty supervisor
Dr. Nicholas Giudice	No	REU faculty supervisor
Janice Gomm	No	Administration Assistant
Susan Niles	No	Administration Assistant

Graduate Students

Name	Worked for more than 160 hours	Contribution to Project
Jason Withee	Yes	Project Assistant
Nathan Bourgoin	Yes	Project Assistant
Jianhui Yue	No	Research Partner
Benjamin P. Hooks	No	Research Partner
Thomas Stone	No	Research Partner
Michael Mihalco	No	Research Partner
James Campbell	No	Research Partner
Tristan Deane	No	Research Partner
Sean Birkel	No	Research Partner

Postdoctoral and Staff

Name	Worked for more than 160 hours	Contribution to Project
Dr. Guogang Feng	No	REU Supervisor
Steve Cousins	No	REU Supervisor

X. Program Evaluation NSF-REU SuperME 2010

Dr. Xiongyi Liu
Assistant Professor, Cleveland State University
Program Evalutor of NSF-REU SuperMe Program

A. Evaluation of Weekly Research Seminars

On a five-point scale, the seminars received average ratings that range from 2.9 to 4.4. Among the eight research seminars, three received an average rating of 4.0 or above, three 3.6 or above, one 3.0 and one 2.9. The seminar titled "Graduate studies from a graduate student perspective" received the highest ratings, with 9 out of all 10 respondents considering it *very informative* or *extremely informative*.

Table 1. Did you learn useful information during the weekly research seminars organized by the REU faculty?

Research Seminar	Extremely informative	Very informative	Informative	Somewhat informative	Not informative	Average rating
Graduate Studies from a Graduate Student Perspective	50.0% (5)	40.0% (4)	10.0% (1)	0.0% (0)	0.0% (0)	**4.4**
Graduate Studies	30.0% (3)	50.0% (5)	20.0% (2)	0.0% (0)	0.0% (0)	**4.1**
Cyber-Infrastructure in Maine	30.0% (3)	40.0% (4)	30.0% (3)	0.0% (0)	0.0% (0)	**4.0**
How to Apply Patents	33.3% (3)	11.1% (1)	55.6% (5)	0.0% (0)	0.0% (0)	**3.8**
How to Make Good Presentation	20.0% (2)	40.0% (4)	30.0% (3)	10.0% (1)	0.0% (0)	**3.7**
Creativity in Sciences	20.0% (2)	30.0% (3)	40.0% (4)	10.0% (1)	0.0% (0)	**3.6**
Literature Search Tutorial	0.0% (0)	20.0% (2)	60.0% (6)	20.0% (2)	0.0% (0)	**3.0**
Data Storage Research	10.0% (1)	10.0% (1)	50.0% (5)	20.0% (2)	10.0% (1)	**2.9**

In terms of the topics covered during the research seminars, all ten participants indicated that the topics are about right, not too advanced or too elementary. When probed further regarding what they liked or disliked about specific seminars, nine participants responded and almost all indicated that they enjoyed the seminars on graduate studies. One student wrote, "I plan on attending graduate school and it is nice to hear perspectives from graduate students and professors." Another student wrote, "There was a lot of information that I had questions about before the seminar and were answered during the seminar." Another student indicated that information about GRE was especially useful. Students enjoyed the seminar on Cyberinfrastructure in Maine because "It's good to see that Maine is trying to get on the map" and they enjoyed the seminar on patents because it helped them to really understand the process, "I just had no idea how intense they can get." "I have come into contact and been curious about the patenting process lately and the seminar was very informative and answered a lot of questions"

Table 2. On average, how would you rate the topics covered during the weekly seminar talks?

	Response % (n)
Much too advanced	0.0% (0)
About right	100.0% (10)
Much too elementary	0.0% (0)

When asked what suggestions they had about next year's research seminars, eight participants responded, among whom three just indicated that the seminars were well done while five gave suggestions. Their suggestions include,

- More extended discussion of the research process, with examples from the faculty members
- Information on what to do when one is stuck while doing research
- Fewer talks on graduate studies
- Making the seminars more relevant to each student

B.   Faculty Evaluation

REU participants gave high ratings to their REU advisor(s). As shown in Table 3, all ten responded to the questions on REU advisors and the average rating ranged from 4.9 to 5.8 on a six-point scale, indicating that students moderately or strongly agree that their advisor(s) provided them with satisfactory guidance and support. In general the students saw strong interest of their advisor(s) in the research that they were conducting and received materials, supplies, background information from their advisor(s) in a timely manner to prepare their research project. Interactions with their advisor(s) were considered intellectual stimulating and rewarding and most participants agreed that their advisor(s) did an excellent job of mentoring, including helping to minimize any anxieties that they had concerning their research, modeling the process of scientific inquiry, and answering questions. Overall, the students seemed to be satisfied with the quality of the mentoring that they received from their advisors, while the amount of mentoring provided could have been improved for a couple of them.

Table 3. Below is a series of statements asking about your relationship with the professor/professors and graduate students assigned to work most closely with you during the REU program.

	Strongly/ Moderately agree	Slightly agree	Slightly disagree	Moderately /Strongly disagree	Average rating
My REU advisor and/or advisors showed interest in the research I was conducting.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.8
My REU advisor and/or advisors supplied me with needed materials and supplies in a timely manner.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.7
Interactions with my REU advisor and/or advisors was both intellectually stimulating and interpersonally rewarding.	90.0% (9)	10.0% (1)	0.0% (0)	0.0% (0)	5.4
My REU advisor and/or advisors provided appropriate background information (reading, lecture, individual discussions) which helped me to understand and prepare my research project.	90.0% (9)	10.0% (1)	0.0% (0)	0.0% (0)	5.4
My REU advisor and/or advisors helped to minimize anxieties I had concerning the research process.	90.0% (9)	0.0% (0)	10.0% (1)	0.0% (0)	5.2
My REU advisor and/or advisors did an excellent job of mentoring during the REU program.	80.0% (8)	20.0% (2)	0.0% (0)	0.0% (0)	5.2
My REU advisor and/or advisors modeled the process of scientific inquiry in a manner that improved my understanding.	60.0% (6)	40.0% (4)	0.0% (0)	0.0% (0)	5.0
My REU advisor and/or advisors were easily accessible to answer questions about my project or discuss research ideas.	70.0% (7)	30.0% (3)	0.0% (0)	0.0% (0)	4.9

C.   REU Research Training

Student perception of various aspects of their research training was very positive. All or almost all participants moderately or strongly agreed that they were encouraged to get involved in an intellectually challenging and stimulating research project from the beginning of the REU program. All agreed that the program provided concrete support, including computers, lab facilities and research supplies, for their research and solid training about research in science and technology. The aspect of the program that remains to be improved is the opportunities to be involved in an interdisciplinary team. While the majority of the participants (seven out of ten) moderately or strongly agreed that they were provided with such opportunities, three only slightly agreed so.

Table 4. Below is a series of statements concerning research training that was provided during the REU program. Please read the statements carefully and rate each statement based on your own experience.

	Strongly/ Moderately agree	Slightly agree	Slightly disagree	Moderately /Strongly disagree	Average rating
The REU program provided concrete support for students' research (e.g., access to computers, access to lab facilities, research supplies).	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.9
I was encouraged to get involved in some aspect of research project from the beginning of the REU program.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.9
The research during the REU program was intellectually challenging and stimulating.	90.0% (9)	10.0% (1)	0.0% (0)	0.0% (0)	5.7
Students in the REU program received training about research in science and technology.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.7
There were opportunities during the REU program to be involved in an interdisciplinary team.	70.0% (7)	30.0% (3)	0.0% (0)	0.0% (0)	5.2

All ten participants responded to the question "*What are the main skills and experiences that you will take away from this program?*" Computer knowledge and computer program skills were cited most often (seven out of ten) by the participants, followed by the experience and ability to conduct independent research and collaborate with others in team work (three out of ten). Two participants indicated that they were better able to integrate computer science in other disciplines. Other skills/experiences were also mentioned, including public speaking and presentation skills and an understanding of graduate studies. Below is a list of the specific skills and experiences and the number of participants that mentioned them.

- Computer knowledge and computer programming skills (n = 7)
- Ability to conduct independent research (n = 3)
- Ability to work in a team and collaborate with others (n = 3)
- Ability to integrate computer science in other disciplines (n =2)
- Public speaking and presentations skills (n = 1)
- Understanding of graduate studies (n = 1)

Nine participants responded to the question "*Do you have any publication ideas that you plan to work on after the REU program?*" Among them four indicated that they had no plan for publication, while five planned to continue working with their advisor(s) and eventually submit a paper based on their REU project for publication as at an academic conference or on a journal. As one student put it, "publication of the paper would be a great accomplishment for this research."

D.   Program Events/Activities

Students were satisfied with the weekend events and field trips arranged by the REU coordinators. Among all ten, seven found such activities highly enjoyable and three found them enjoyable (see Table 5).

Table 5. Did you find it enjoyable to participate in the weekend events/activities and field trips that the REU coordinators arranged? Please rate them using the following scale.

	Response % (n)
Highly enjoyable	70.0% (7)
Enjoyable	30.0% (3)
Somewhat enjoyable	0.0% (0)
Not enjoyable at all	0.0% (0)

When asked about particular REU events/trips that they liked or disliked, eight participants responded and six of them listed white water rafting as the best activity. Participants also enjoyed camping and other activities. One student indicated that they activities would have been more fun if their advisors had come along. Such a feeling was shared by two other students when presented with the question "*What suggestions do you have for the REU faculty and staff to make their events/trips more enjoyable for future students?*" Other suggestions include trying to get all REU students involved, giving more advanced notice about events, and regulating the behavior of disruptive students. It was noticed that local students had less interest in REU events. By and large the students were highly satisfied with the program events and simply suggested the program staff "keep up the good work!"

E.   Program Impact

The REU program had a variety of positive impact on the ten participants. As shown in Table 6, all strongly or moderately agreed that they had fun in the REU program for most of the time, and that the program fostered important research knowledge and skills, prepared them for entering into graduate studies, and encouraged them to pursue further education or a career in STEM disciplines.

Eighty percent of the participants also strongly or moderately agreed that they benefited from the program in three other aspects, including making future educational/career choices, understanding scientific research careers, and improving writing/presentation skills.

Table 6. Below is a series of statements about the impact of REU program on you. Please read the statements carefully and rate each statement.

	Strongly/ Moderately agree	Slightly agree	Slightly disagree	Moderately /Strongly disagree	Average rating
For most of the time, I had fun in the REU program.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.9
The program prepared me for entering into graduate studies when I want to.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.4
The program encouraged me to pursue education or a research career in science, mathematics, engineering, or technology.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.4
I developed important research knowledge and skills during the program.	100.0% (10)	0.0% (0)	0.0% (0)	0.0% (0)	5.4
The program helped me get a better idea of what a career in scientific research might be like.	80.0% (8)	10.0% (1)	10.0% (1)	0.0% (0)	5.3
The program assisted me in making future educational and career choices.	80.0% (8)	20.0% (2)	0.0% (0)	0.0% (0)	5.2
I improved my writing or presentation skills during the program.	80.0% (8)	20.0% (2)	0.0% (0)	0.0% (0)	4.9

With such high ratings of program impact, it is not surprising that the participants also gave high *overall ratings of their summer experience*. As shown in Figure 1, all ten answered the question on their satisfaction of the REU experience. Seven considered the program as "excellent" and three considered it as "good". No participant gave the program a "fair" or "poor" rating.

What did the students enjoy most in the program?

For most students it was the experience of being able to choose a topic of interest and conduct independent research work on the topic. Students indicated that they enjoyed the "work environment", the "freedom offered by the program", and "building a program from scratch". As one student wrote, "I worked almost independently. I was given a task/project, told what the problem was, provided with the resources to do the research, and was then allowed to work on the project with only guidance rather than direct assistance or instruction." Of course, learning was not the only thing that students found enjoyable. They also enjoyed communicating with their advisors, making new friends, and participating in the weekend events. In their own words, "I was able to get out and experience Maine, as well as do great work on campus."

What influence did the SuperMe REU program have on you in terms of making your future educational and career choices?

All ten students responded to the question. All but one indicated that the program had some positive influence on them. The influence is related to confirming educational plans and strengthening committeemen to attempt graduate school in one way or another. Overall students felt more comfortable and confident about pursuing a graduate degree as a result of the REU experience. The REU program helped to prepare them for their educational goals from multiple aspects, including learning about what graduate school is like and how to apply for it, gaining relevant research experience and skills, developing new research ideas and interests, and networking with other researchers. For the participants, SuperMe showed them "how to step outside the box" and was "a definite step in the right direction". As one student wrote, "SuperMe addressed some of my concerns about graduate school and answered some of my questions. Also, I realized how much I would enjoy the graduate school environment."

Figure 1. Overall, are you satisfied with your summer REU experience?
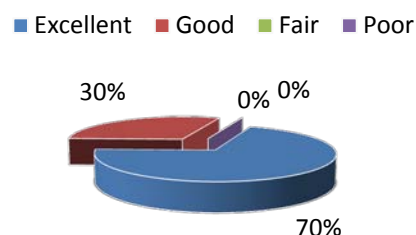
When asked "*What is the ultimate degree that you plan to pursue?*"Four wanted to pursue a doctoral degree, five master's degree, and one a bachelor's degree. Five were somewhat confident and five were very confident that they will obtain their ultimate degree. When asked "Upon obtaining your Bachelor's degree, which of the following are you currently inclined to do?" 9 out of 10 selected enter a graduate program in STEM-related disciplines (STEM = Science, technology, engineering, and mathematics), among whom four also indicated getting into industry and one indicated both getting into industry and entering teaching profession. One student selected finding a job in industry and pursuing entrepreneurship.

Nine students answered the question **"*What thoughts do you have regarding your ultimate career goal?*"** While most of them were still not sure what they wanted to do, the REU experience seemed to have stimulated their interest in certain research areas and thus helped them become open to more options. More than one students indicated a willingness to try a new career path that involves the integration of computer technology. One wrote "I hope that my research would have an impact on our understanding of nature and I would like to help create the technology that frees us from the dependence on carbon based energy." Another student wrote "I wouldn't mind finding a way to incorporate CS into the realm of marine sciences." Two students clearly indicated that they wanted to pursue a doctoral degree. One student expressed interested in graduate studies but worried about obtaining admission and finding an advisor.

Has this REU experience changed your perception of scientific research in general?

Nine students responded to this question. From their responses, it is obvious that the impact of the program varied. For some students it merely confirmed their perception: "I expected it to be challenging and it was"; "I've always known that scientific research was great." For a few students, it was the first time they have developed any real understanding of scientific research: "I didn't really know what research would be like, so I didn't have any perceptions formed. This program was just a good way to introduce me to the research field." There were also a few students who changed their previous perception of scientific research in significant ways: "I think it is more enjoyable now than I previously thought it

would be"; "I didn't realize the importance of the collaboration of ideas and opinions on completing original work."

Overall would you recommend this program to others? What kind of students do you think would benefit most from such a program?

All ten students responded to this question. All ten indicated that they would recommend this program to others. Specifically, they believed that students who are interested in attending graduate school, enjoy computer related work, but feel uncertain about future plans would benefit most from a program like SuperMe.

What suggestions do you have for the REU faculty and staff to improve the summer REU experience for future participants?

Eight students responded to this question. While students mostly indicated that the project faculty did a great job this year and just needed to "keep up the good work", some suggested minor improvements. Two students suggested AGR might not be a good housing solution and one of them recommended on-campus dorms such as Patch or DTav. Two students suggested a little more organization in the research projects so that students could pick and start on them sooner. One student suggested that the advisor provide more guidance and communicate "an expected workload (hours per day) that should be spent on research."