Spring 2013

2013 (Spring)

University of Dayton. Department of Mathematics

Abstracts of the Colloquium Talks: Spring 2013
Department of Mathematics

Date	**Speaker and Title**	**Time/Location**
Tuesday, Feb 5	Dan Ren, Boston University Loss Aversion and Retirement Planning	3:00 PM, SC 323
Tuesday, Feb 14	Yumin Wang, Southern Illinois University Quantile Hedging for Guaranteed Minimum Death Benefits within Variable Annuities	3:00 PM, SC 323
Tuesday, Feb 19	Jonathan Brown, Gonzaga University Infinite dimensional Lie algebra representation theory and finite W-algebras	3:00 PM, SC 323
Thursday, Feb 21	Maxim Bichuch, Princeton University Price of a Contingent Claim Liability in a Market with Small Transaction Costs	3:00 PM, SC 323
Tuesday, Feb 26	Catherine Kublik, University of Texas - Austin Two Novel Algorithms for Dynamic Implicit Interfaces	3:00 PM, SC 323
Thursday, Mar 7	Jean Nganou, University of Oregon An invitation to algebraic logic: MV/BL-algebras	3:00 PM, SC 323
Thursday, Mar 14	Dean Carlson, Mathematical Reviews Fields of extremals and sufficient conditions for the simplest problem of the calculus of variations in *n* variables	3:00 PM, SC 323
Tuesday, Mar 19	Jeffrey Lyons, Nova Southeastern University Characterizing Boundary Data Smoothness for Solutions of Difference, Differential, and Dynamic Boundary Value Problems	3:00 PM, SC 323
Thursday, Mar 21	Vladimir Tkachuk, Metropolitan Autonomous University of Mexico The countable power of any Lindelöf ∑-space is d-separable	3:00 PM, SC 323
Tuesday, Apr 9	Nicholas Haynes, University of Dayton The sinc-collocation method for approximating nonlinear PDEs	3:00 PM, SC 323
Thursday, Apr 11	Kara Biltz, University of Dayton Using Monte Carlo Simulation to Calculate American Option Price	3:00 PM, SC 323
Thursday, Apr 11	Faruc Kilinc and Babatundi Oni, University of Dayton Exponential Stability and Instability in Finite Delay Nonlinear Volterra Integro-Differential Equations	**3:30 PM, SC 323**
Tuesday, Apr 16	Haitham Al Makhzoum and Saeed Althubiti, University of Dayton Periodic solution and stability in nonlinear neutral system with infinite delay	3:00 PM, SC 323

Tuesday, Apr 16	Jack Denterlein, University of Dayton Monte Carlo Simulations for European and American Put Options: Diffusion and Jump-Diffusion Models	**3:30 PM, SC 323**
Thursday, Apr 18	Jiuxin Jiang, University of Dayton A recombining tree method for option pricing in a regime-switching jump diffusion model	3:00 PM, SC 323
Tuesday, Apr 23	Gracie Fasano and Sophia Munyemana, University of Dayton A Comparison of the Merton Jump Diffusion and Kou Double Exponential Model for European Options	3:00 PM, SC 323
Tuesday, Apr 23	Haefa Salem, University of Dayton Exponential decay and unboundedness in finite delay Volterra integro-differential equations with forcing function	**3:30 PM, SC 323**
Thursday, Apr 25	Hala Ali and Nada Alshehri, University of Dayton Boundedness In NonLinear Functional Differential Equations With Applications To Volterra Integrodifferential Equations	3:00 PM, SC 323
Thursday, Apr 25	Rob Deis, University of Dayton Bootstrap method with time series data	**3:30 PM, SC 323**
Friday, Apr 26	Christina Haas, University of Dayton Credit Default Swaps as Risk Indicators at the Firm Level	**3:00 PM, SC 323**
Friday, Apr 26	Linjiang Gui, University of Dayton Fund Flows and US Stock Market Return	**3:30 PM, SC 323**

Loss Aversion and Retirement Planning
Dan Ren
Abstract: We consider an optimal consumption and investment problem, with a representative agent who is more sensitive to declines than to increases in consumption, and investment opportunities are constant. We solve the resulting free-boundary problem in closed form, using a combination of stochastic control and duality methods. Briefly, the optimal consumption remains constant over long intervals, increases gradually as wealth is high relative to its current consumption, and falls below its last recorded maximum when wealth is low.

Quantile Hedging for Guaranteed Minimum Death Benefits within Variable Annuities
Yumin Wang
Abstract: Quantile hedging for contingent claims is an active topic of research in mathematical finance. It play a role in incomplete markets, or when perfect hedging is not possible. Guaranteed minimum death benefits (GMDBs) are present in many variable annuity contracts, and act as a form of portfolio insurance. They cannot be perfectly hedged due to the mortality component, except in the limit as the number of contracts becomes infinitely large. In this talk, I will talk about how to apply ideas from finance to derive quantile hedges for these products under various assumptions.

Infinite dimensional Lie algebra representation theory and finite W-algebras
Jonathan Brown

Abstract: In this talk I will review some results about finite and infinite dimensional Lie algebra representation theory. Then I will explain how one can relate finite dimensional finite W-algebra representations to infinite dimensional Lie algebra representations. I will also give a combinatorial classification of the finite dimensional simple representations of certain classes of finite W-algebras.

Price of a Contingent Claim Liability in a Market with Small Transaction Costs

Maxim Bichuch

Abstract: I price a contingent claim liability using the utility indifference argument. I consider an agent with exponential utility, who invests in a stock and a money market account with the goal of maximizing the utility of his investment at the final time in the presence of positive transaction cost in two cases with and without a contingent claim liability. I provide a rigorous derivation of the asymptotic expansion of the value function in the transaction cost parameter around the known value function for the case of zero transaction cost in both cases with and without a contingent claim liability. Additionally, using utility indifference method I derive an asymptotic expansion of the price of the contingent claim liability. In both cases, I also obtain a "nearly optimal" strategy, whose utility asymptotically matches the leading terms of the value function.

Two Novel Algorithms for Dynamic Implicit Interfaces

Catherine Kublik

Abstract: Tracking the motion of an interface numerically can be challenging, especially when topological changes occur. The level set method (Osher and Sethian, 1988) is a simple and efficient numerical technique for computing motions of curves or surfaces that is capable of handling corners, cusps and topological changes. Nevertheless, computing with implicitly defined interfaces can require considerable thought. In this talk, I will describe two different algorithms for interfaces defined implicitly through a level set function.

I will start by presenting a new, efficient and accurate technique for computing certain area preserving geometric motions of curves in the plane. The method is based on alternating two very simple and fast operations, namely convolution with the Gaussian kernel and construction of the signed distance function, to generate the desired geometric flow in an unconditionally stable manner. I will present applications to large scale simulations of coarsening. This is joint work with Selim Esedoḡlu and Jeffrey Fessler.

The second algorithm is a new implicit interface boundary integral method for solving Poisson's equation. The technique is based on averaging a family of parameterizations of an integral equation defined on the boundary of the domain, where the integrations are carried out in the level set framework using an appropriate Jacobian. By the coarea formula, the algorithm can operate in the Euclidean space. I will present numerical results in two and three dimensions. This is joint work with Nick Tanushev and Richard Tsai.

An Invitation to Algebraic Logic MV/BL-algebras

JEAN B. NGANOU

ABSTRACT Many-valued logic (MV-logic) was introduced in 1920 by J. Lukasiewicz as a generalization of the two-value logic (Boolean logic). Just as Boolean algebras constitute the algebraic counterpart of

Boolean logic, MV-algebras were introduced by C. Chang (1958) as the algebraic counterpart of the MV-logic in order to offer an algebraic proof of the completeness theorem of the MVlogic. Much later and recently (1998), BL-algebras (basic logic algebras) were introduced by P. H´ajek in order to study the basic logic framework of fuzzy set theory. It was then established that MV-algebras are simply BL-algebras whose negations are involutions. The talk will give an overview of the algebraic studies of both MV-algebras and BL-algebras. These algebras have underline structures of distributive residuated lattices and also generalize Boolean algebras. There is also a remarkable connection between these algebras and Archimedean lattice ordered groups that will be highlighted in the talk. The study of MV-algebras has been completely centered around their ideals and their natural algebraic additions. Both items were still not formulated within the BL-algebras framework until very recently. I will discuss our recently introduced notions of ideal and algebraic addition in BL-algebras and related consequences. The most notable applications of MV/BL-logic are found in theoretical Computer Science and Electrical Engineering with complex circuits designs.

Fields of extremals and sufficient conditions for the simplest problem of the calculus of variations in n −variables

D. A. Carlson

Abstract: In a 1967 Note, Leitmann observed that coordinate transformations may be used to deduce extrema (minimizers or maximizers) of integrals in the simplest problem of the calculus of variations. Subsequently, in a series of papers,starting in 2001, he revived this approach and extended it in a variety of ways. Shortly therefater, Carlson presented an important generalization of this approach and connected it to Carathéodory's equivalent problem method. This in turn was followed by a number of joint papers addressing applications to dynamic games, multiple integrals, and other related topics.

For the simplest vector-valued variables problem of the calculus of variations, making use of the classical notion of fields of extremals, we employ Leitmann's direct method, as extended by Carlson, to present an elementary proof of Weierstrass' sufficiency theorem for strong local and global extrema.

Characterizing Boundary Data Smoothness for Solutions of Difference, Differential, and Dynamic Boundary Value Problems

Jeffrey W. Lyons

Abstract. Under certain conditions, we can find differences, derivatives, and delta derivatives with respect to the boundary data for solutions of difference, differential, and dynamic boundary value problems. In turn, we see these newly generated equations solve many different but related boundary value problems. We also explore the history of boundary data smoothness and will see a few recent results and results that are currently in progress.

The countable power of any Lindelöf Σ-space is d-separable

V.V. Tkachuk

Abstract: In 2008 Juhász and Szentmiklóssy established that for every compact space X there exists a discrete set $D \subset X \times X$ with $|D| = d(X)$. We generalize this result in two directions: the first one is to prove that the same holds for any Lindelöf Σ-space X and hence $X^{\omega}$is d-separable. We give a consistent example of a countably compact space X such that X^{ω} is not -separable. On the other hand, we show that for any Lindelöf p-space X there exists a discrete subset $D \subset X \times X$ such that $\Delta = \{(x, x) : x \in X\}$ is

contained in the closure of D; in particular, the diagonal Δ is a retract of the closure of D and the projection of D on the first coordinate is dense in X. As a consequence, some properties that are not discretely reflexive in X become discretely reflexive in $X \times X$.

The sinc-collocation method for approximating nonlinear PDEs

Nick Haynes

Abstract: The sinc-collocation method is a robust, accurate, and efficient meshless method for approximating the solutions to nonlinear PDEs, and using a combination of stability analysis and comparison of efficiency and accuracy to other methods, we argue that it is a very attractive alternative to more standard numerical methods for nonlinear PDEs. After reviewing the standard methods for numerically solving PDEs, we will describe the sinc-collocation method in detail. The method will then be applied to two sample problems. First, we will present the solution to a KdVlike equation with periodic boundary conditions. It has been observed experimentally and shown theoretically that the solutions to this system eventually become periodic, with the same period as the forcing at the boundary, and we demonstrate these results with an efficient numerical algorithm. We will then solve the Kuramoto-Sivashinsky equation and compare the results to other meshless numerical methods.

Using Monte Carlo Simulation to Calculate American Option Price

Kara Biltz

Abstract: The pricing of European options is considered fairly straightforward. However there is no closed-form solution to the pricing of American options, and therefore we must rely on other methods. This paper gives an introduction to the method of Monte Carlo simulation applied to pricing American options. To compute the price of the option, at each time step we compare the payoff of immediate exercise with the conditional expected payoff if the option is not exercised. The simulation method is then extended to spread options.

Exponential Stability And Instability In Finite Delay Nonlinear Volterra Integro-differential Equations

Faruk Kilinc and Babatunde Oni

Abstract We use Lyapunov functionals to obtain sufficiemt conditions that guarantee exponential stability of the zero solution of the Volterra integro-differential equation with uniformly distrubuted finite delay

$$x'(t) = p(t)t\, f\big(x(t)\big) - \int_{t-\tau}^{t} q(t,s) f\big(x(t)\big) ds,$$

where the functions p, q and f are continuous on their respective domains and $\tau > 0$. In addition, we will obtain criteria for instability.

Periodic Solution and Stability in Nonlinear Neutral System with Infinite Delay

Haitham Al Makhzoum and Saeed Althubiti

Abstract: We study the existence and uniqueness of periodic solutions and the stability of the zero solution of the nonlinear neutral equation

$$\frac{d}{dt}\, x(t) = -a(t)x(t) + \frac{d}{dt}\, Q\Big(t, x\big(t - g(t)\big)\Big) + \int_{-\infty}^{t} D(t,s) f\big(x(s)\big) ds$$

In the process we use integrating factors and convert the given neutral differential equation into an equivalent integral equation. Then we construct appropriate mappings and employ Krasnoselskii's fixed point theorem to show the existence of a periodic solution of this neutral differential equation. We also use the contraction mapping principle to show the existence of a unique periodic solution and the asymptotic stability of the zero solution provided that $Q(0,0) = f(0) = 0$.

Monte Carlo Simulations for European and American Put Options: Diffusion and Jump-Diffusion Models

Jack Denterlein

Abstract: Two models will be explained: a diffusion and a jump-diffusion process. For the diffusion model, European Put Options can be valued using the Black-Scholes formula, but there is no such formula for pricing American Put Options. A Monte Carlo approach will be used to simulate different stock price paths and an algorithm will be used to determine when the option corresponding to each stock path will be exercised. The option value received will be discounted and averaged. For the jump-diffusion model, European Put Options can be valued by the method given by Merton, but similarly, there is no explicit formula for pricing American Put Options. The simulation of different stock price paths will also include for jumps in price, which occurs when news breaks in regards to company management or performance.

A recombining tree method for option pricing in a regime-switching jump diffusion model

Jiuxin Jiang

Abstract: In this paper, we develop a discrete time model tree approach for option pricing when the underlying asset price follows a regime-switching jump diffusion process. The tree incorporates the early exercise feature of American option as well as arbitrary jump diffusions considered by Kaushik I. Amin (1993). Meanwhile we use recombining tree to modeling regime-switching process which was constructed by R. H. Liu (2010). As the tree grows at most linearly as the number of time step increases, we can use relatively small time intervals to compute an accurate option price. We consider different jump diffusions for different regimes which can be used in finance to reflect boom and bust. For numerical tests, we build a tree to approximate partial integro-differential equations (PIDE's) results. As an extensive application, we also illustrate characteristics of early exercise boundary of American options with different types of jump distributions in different regimes.

A Comparison of the Merton Jump Diffusion and Kou Double Exponential Model for European Options

Gracie Fasano and Sophia Munyemana

Abstract: The Black-Scholes model has been a useful tool for option pricing, yet it fails to capture two phenomena observed in the stock Market – the leptokurtic feature and the implied volatility smile. Merton introduced a jump diffusion model with a log-normal distribution for the jump sizes to address this issue. Later, Kou also studied the jump diffusion with a double-exponential distribution for the jump size. This research project examines both Merton and Kou's models for option pricing. MATLAB was used to implement the analytic formulas. We computed and compared the values of the European put options as we altered the stock price, time to maturity, volatility, and jump intensity.

Exponential decay and unboundedness in finite delay Volterra integro-differential equations with forcing function

Haefa Salem

Abstract: We use Liapunov functionals to obtain sufficient conditions that ensure exponential decay of all solutions of the linear Volterra integro-differential equation with forcing term

$$x'(t) = p(t)x(t) - \int_{t-\tau}^{t} q(t,s)x(s)ds + f(t)$$

Where the constant τ is positive, the function p does not need to obey any sign condition and p and the kernel p are continuous. Moreover, the function $f(t)$ may be unbounded. In addition, we give a new criterion for unboundedness.

Boundedness In NonLinear Functional Differential Equations With Applications To Volterra Integrodifferential Equations

Hala Ali and Nada Alshehri

Abstract Non-negative definite Lyapunov functions are employed to obtain sufficient conditions that guarantee boundedness of solutions of the abstract nonlinear functional differential system

$$x'(t) = G(t, x(s); -\infty < s \le t) \stackrel{\text{def}}{=} G(t, x(\cdot))$$

where $x \in \mathbb{R}^n, G\colon \mathbb{R}^+ \times \mathbb{R}^n \to \mathbb{R}^n$ is a given nonlinear continuous function in t and x. The theory is applied to nonlinear volterra integro-differential equation with infinite delay of the forms

$$x'(t) = g\big(x(t)\big) + \int_{-\infty}^{t} B(t,s) f\big(x(s)\big) ds$$

Bootstrap method with time series data

Robert Deis

Abstract: We will show how the bootstrap can be used in an auto-regressive model. We will demonstrate bootstrapping using the forward autoregressive model as well as the backward autoregressive model. We will compare the bootstrap method and the Box-Jenkins methodology on parameter estimation and forecast. We will also compare the length of the confidence intervals using the traditional methods and the bootstrap. All programming is done using the statistical software package SAS.

Credit Default Swaps as Risk Indicators at the Firm Level

Christina Haas

Abstract: This paper empirically explores the value of CDS prices as market indicators. Our sample of reference entities consists of 349 different firms taken from the New York Stock Exchange. The observation period covers approximately 8 years. We analyze two risk sources, firm related idiosyncratic risk and systematic risk, and market related market returns, and market volatility for modeling the dynamics of credit default swap spreads. We use the single index model to estimate idiosyncratic and systematic risk. We then measure the effect of these variables on CDS spreads. The model is run several different times to correct for heteroskedasticity and by using subsamples to study the effect the stock market cycle has on CDS prices. A quantile regression is also run to compare how some percentiles of the CDS spreads may be more affected by market and risk factors than other percentiles. We find that market returns and market volatility have the largest effect on the credit default swap prices. Idiosyncratic risk has a larger effect than systematic risk which is the result we expected since idiosyncratic risk is firm-specific.

Mutual Fund Flows and US Stock Market Return

Linjiang Gui

Abstract: This paper investigates the relation between mutual fund flows and two US stock market returns- NASDAQ and S&P 500 respectively. The sample period extends from January 2002 to January 2012. Using Vector Regressive Model (VAR) by pairwise comparison and by constructing a VAR system, analysis results suggest that mutual fund flows are influenced greatly by their previous value of cash flow in each mutual fund selected, and US stock market return also impact on most mutual fund flows change. Whereas the mutual fund flows don’t appear to forecast future stock returns; only world equity and total long term mutual funds seems to have forecasting potential on S&P 500 stock market.