Spring 2015

2015 (Spring)

University of Dayton. Department of Mathematics

Abstracts of the Colloquium talks: Spring 2015

Date	Speaker and Title	Time/Location
Monday, Feb 2	Gabriela Martinez, Cornell University Augmented Lagrangian Methods for Solving Optimization Problems with Stochastic-Order Constraints	3:00 PM, SC 323
Wednesday, Feb 4	Mark Tomforde, University of Houston Using results from dynamical systems to classify algebras and C*-algebras	3:00 PM, SC 323
Thursday, Feb 5	Kevin McGoff, Duke University Statistical inference for dynamical systems	3:00 PM, SC 323
Tuesday, Feb 10	Alan Veliz-Cuba, University of Houston Practical and theoretical aspects of modeling gene networks	3:00 PM, SC 323
Thursday, Feb 19	Alaa Almansour, University of Dayton Boundary Value Problems at Resonance for Ordinary Differential Equations	3:00 PM, SC 323
Thursday, Feb 26	May Mei, Denison University Modeling Quasicrystals with Dynamical Systems	3:00 PM, SC 323
Thursday, Mar 19	Carl Mummert, Marshall University What is "reverse" mathematics?	3:00 PM, SC 323
Tuesday, Mar 24	Patrick Chadowski, University of Dayton Existence and Uniqueness of Solutions in Nonlinear Differential Equations	3:00 PM, SC 323
Thursday, Mar 26	Zak Mesyan, University of Colorado Colorado Springs Infinite-Dimensional Diagonalization	3:00 PM, SC 323
Thursday, Apr 9	Peixian Han, University of Dayton Valuation of a Passport Option	3:00 PM, SC 323
Thursday, Apr 16	Fatimah Alahmadi and Shruq Alharbi, University of Dayton Boundedness of Solutions in Volterra integro differential Systems	3:00 PM, SC 323
Thursday, Apr 16	Abeer Algethami and Huachun Yu, University of Dayton Exponential Stability And Instability In Nonlinear Volterra Integro-differential Equations With Functional Delay	3:30 PM, SC 323
Tuesday, Apr 21	Lawrence Kondowe, University of Dayton Estimating Value-at-Risk and Expected Shortfall with Extreme Value Theory	3:00 PM, SC 323
Tuesday, Apr 21	Martin Morris, University of Dayton Case Studies on Market Explosion	3:30 PM, SC 323

Thursday, Apr 23	Tianhui Zhang, University of Dayton Comparison of Optimal Consumption-Investment Models using Monte-Carlo Simulation	3:00 PM, SC 323
Thursday, Apr 23	Yidan Shi, University of Dayton Valuation of a Stock Loan	3:30 PM, SC 323

Augmented Lagrangian Methods for Solving Optimization Problems with Stochastic-Order Constraint
Gabriela Martinez
Abstract: We investigate risk-averse stochastic optimization problems where riskaverse preferences are modeled with a stochastic order constraint. We propose augmented Lagrangian methods for the numerical solution of problems with multivariate and univariate stochastic order relations. The methods constructs finite-dimensional approximations of the optimization problem whose solutions converge to the solution of the original problem. In case of univariate order, we define augmented Lagrangian functions based on different formulations of the stochastic-order constraint. The performance of the methods is compared to other numerical algorithms, and shows the advantage of the augmented Lagrangian framework.

Using results from dynamical systems to classify algebras and C*-algebras
Mark Tomforde
Abstract: In the subject of symbolic dynamics, the shift spaces of finite type arise as edge shifts of finite directed graphs. The classification of these shift spaces was used in the 1980's to classify certain C*-algebras constructed from directed graphs, known as Cuntz-Krieger C*-algebras, and moreover, the dynamical systems methods were key ingredients in the proofs. More recently, similar techniques have been used to classify certain algebras constructed from directed graphs, which are known as Leavitt path algebras. In this talk I will give an overview of the dynamical systems results, describe how they have led to methods for classifying C*-algebras and algebras, and discuss the current status of these classification programs and existing open problems.

Statistical inference for dynamical systems
Kevin McGoff
Abstract: Dynamical systems arise frequently as mathematical models of physical and biological systems that evolve over time. In this talk, I will discuss several questions regarding the theory and practice of performing statistical inference from time-series observations of dynamical systems. In particular, I will focus on the question of system inference; that is, how should one estimate the structure or parameters of a model using timeseries data? Recent theoretical results show that under suitable hypotheses maximum likelihood estimation (MLE) yields consistent estimates of the model as the number of observations tends to infinity. However, in some applied settings, MLE may be computationally intractable. In the specific setting of inference of gene regulatory networks from time-series gene expression data, I will discuss a recently developed estimation method that is computationally tractable. This talk is based on two projects: one is joint work with S. Mukherjee, A. Nobel, and N. Pillai, and the other is joint with X. Guo, A. Deckard, A. Leman, C. Kelliher, S. Haase, and J. Harer.

Practical and theoretical aspects of modeling gene networks

Alan Veliz-Cuba

Abstract: Models of gene networks typically focus on the average dynamics of a population or single cell behavior. However, in cases where a gene network is inside a cell that grows and divides, such approaches cannot capture the rich dynamical properties that a population has. In this talk I will present a novel framework to model gene networks that captures the dynamics of populations of cells. In the second part of the talk I will present a theoretical approach to solve the network inference problem. This problem consists in inferring the structure of a gene network from time series. Our results guarantee that given enough data, the structure of a gene network can be recovered with zero errors.

Boundary Value Problems at Resonance for Ordinary Differential Equations

Alaa Almansour

Abstract: We consider boundary value problems at resonance for ordinary differential equations. We invert the problem on an appropriate proper subspace of a Banach space and construct fixed point operators. We apply the contraction mapping principle and the Schauder fixed point theorem to several families of boundary value problems at resonance.

Modeling Quasicrystals with Dynamical Systems

May Mei

Abstract: The Nobel Prize-winning discovery of quasicrystals has spurred much work in aperiodic sequences and tilings. In this talk, we will discuss Cantor sets that appear as spectra of discrete Schrodinger operators with potentials given by primitive invertible substitution sequences, an example of a one-dimensional model for quasicrystals. These operators are moderated by a real parameter lambda and we will study the Hausdorff dimension of the spectrum as a function of lambda. We also present preliminary numerical data on the spectrum of the discrete Laplacian on the Penrose tiling and octagonal tiling.

What is "reverse" mathematics?

Carl Mummert

Abstract: Reverse Mathematics is a program in mathematical logic that studies the axioms used to prove well-known theorems of mathematics. The program, now entering its 4th decade, initially focused on the undergraduate core theorems of analysis and algebra such as the Heine-Borel theorem. It has flourished in the past decade as the scope broadened to include combinatorics and topology. I will explain the core ideas of the program and some of its history. Along the way, we will look at examples of Reverse Mathematics results in graph theory and topology.

Existence and Uniqueness of Solutions in Nonlinear Differential Equations

Patrick Chadowsk

Abstract: The existence and uniqueness solutions of the following initial value problem (I.V.P.)

$$x'(t) + a\,x(t) = f\big(t, x(t)\big) + r(t), x(0) = x_0, t \geq 0,$$

is studied in this paper. First, this I.V.P. is inverted to an equivalent integral equation. The existence of solutions is then obtained from the equivalent integral equation. Banach Space, Schauder's fixed point theorem, Gronwall's Inequality and the contraction mapping principle are used in the analysis. Under certain conditions in f, Schauder's Fixed Point Theorem is used to obtain the existence of at least one

solution of this I.V.P. on [0, ∞). Then, employing Gronwall's Inequality, it is shown that if f is globally Lipschitz, then the I.V.P. has indeed a unique solution on [0, ∞). Finally, the existence of a unique solution of this I.V.P. is obtained by employing the Contraction Mapping Principle, however; a restrictive condition is shown to be required in this method. This restriction will not be required in the method that involves Schauder's Fixed Point Theorem and Gronwall's Inequality.

Infinite-Dimensional Diagonalization

Zak Mesyan

Abstract: Classical linear algebra shows how to determine when a matrix is diagonalizable, and when sets of matrices are simultaneously diagonalizable. I will discuss generalizations of these results to linear transformations of infinitedimensional vectors spaces.

Valuation of a Passport Option

Peixian Han

Abstract: In this paper we examine the problem of valuing a derivative known as the passport option. It is a special case of zero strike European call option, in which the option buyer has some control through a trading strategy. And the value of it is a function of the holder's strategy. We not only provide a BlackScholes type model which is a continuous time valuation model and use transform methods to produce a solution to the corresponding partial differential equations, but also focus on a discrete Binomial Tree model. We show that the solution of the discrete model converges to the solution of continuous model as the step size approaches to zero.

Boundedness of Solutions in Volterra integro differential Systems

Fatimah Alahmadi, Shuruq Alharbi

Abstract: We use Lyapunov functionals combined with the Laplace transform and obtain boundedness results regarding the solutions of the nonlinear Volterra integro differential equiations

$$y'(t) = A(t)y(t) + f(y) + \int_0^t C(t,s)h\big(y(s)\big)ds + p(t).$$

In addition we use Lyapunov functional to obtain asymptotic stability regarding the zero solution when $p(t)$ is identically zero.

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

Abeer Algethami, Yu Huachun

Abstract: We use Lyapunov functionals to obtain sufficient conditions that guarantee exponential stability of the zero solution of the Volterra integro-differential equation with functional delay

$$x'(t) = -\int_{t-r(t)}^{t} a(t,s)g\big(x(s)\big)ds$$

Where the functions $a(t,s)$ and $g(x)$ are continuous on their respective domains and $0 < r(t) < r_0 = 1/2$. In addition, we will arrive at some conditions that characterize the instability of the zero solution.

Estimating Value-at-Risk and Expected Shortfall with Extreme Value Theory

Lawrence M Kondowe

Abstract We assess the performance of two quantitative measures of risk: Valueat-Risk (VaR) and expected shortfall (ES). We apply the generalized Pareto distribution (GPD), a type of extreme value theory (EVT), to estimate the two measures of risk. Financial asset returns tend to follow fat-tailed distribution. The assumption of normal returns in estimating risk does not present a reliable risk measure, especially for assets returns that exhibit fat- or heavy-tailed behavior. The EVT deals with the distribution of the observations in the tail-end of a return distribution.

Case Studies on Market Explosion

Martin Morris

Abstract: Market sentiment is the herding effect of investors towards or away from a particular asset used by a feeling, an intuition, price movements, and imperfect information which naturally occurs within the market. When investors try to gain a “free lunch” or arbitrage they are attempting to exploit market sentiment. Finding arbitrage opportunities in the market is a difficult task because if abnormalities occur within the market, the market corrects itself and within moments and the opportunity to exploit price inconsistencies disappears. One method of discovering exploitative opportunities in the stock market is through the use of technical analysis. Technical analysis is the study of past market data to assist in the development of an indicator to help predict price movements and there by develop trading strategies. This research will use one of the dual moving average crossover indicators outlined by William A. Brock, Josef Lakonishok, and Blake LeBaron in their 1992 paper Simple Technical Trading Rules and the Stochastic Properties of Stock Returns to attempt to find opportunities for positive returns in different market segments. The research diverges from Brock, Lakonishok, and LeBaron’s original work by applying the strategy to portfolios of assets instead of indexes or market averages, this allows for identification of the presence of weak for efficacy in different market segments. Another method of finding arbitrage opportunities is the use of put call parity applied to options. The put call parity procedure for finding arbitrage profit that will be used is to derive implied stock by structuring a call and put option on the same underlying with identical exercise prices. To measure the performance of the strategy and if an arbitrage profit is possible the Sharpe Ratio and average returns will be examined. The implication of the results of each part of this research is to see which market is more efficient, the options market or the stock market. The most efficient market provides the best information on the actual value of an asset.

Comparison of Optimal Consumption Investment Models using Monte-Carlo Simulation

Tianhui Zhang

Abstract: In this paper, I study three optimal consumption-investment models which are Merton’s portfolio problem, optimal consumption and investment model with habit formation and the Merton problem with a drawdown constraint on consumption. In general, an investor must choose how much to consume and must allocate his wealth between risky assets (usually stocks) and riskfree assets to maximize expected utility depending on consumption. I use Monte-Carlo Simulation to compare these models, afterwards, I apply real data sets to verify whether the models work as expected. According to the analysis of the plots, the Merton’s portfolio problem has a fixed investing fraction and the least stable consumption; the model with habit formation has the most stable but relatively small consumption; and the Merton’s problem with drawdown constraint on consumption is the case between the other two models. Other factors like transaction costs have not been taken into account and are left as future study.

Valuation of a Stock Loan

Yidan Shi

Abstract: In this paper, we examine the problem of valuing a derivative known as a stock loan. Stock loans are business contracts between borrowers and lenders in which the borrower uses shares of stock for collateral for the loan. This paper will list, prove, and analyze formulas for stock loan valuation with the Black-Scholes model, the binomial tree model and the implicit finite difference method. Numerical examples are reported to illustrate the results.