Fall 2012

# 2012 (Fall)

University of Dayton. Department of Mathematics

## Abstracts of the Colloquium Talks: Fall 2012
## Department of Mathematics

| Date | Speaker and Title | Time/Location |
|---|---|---|
| Thursday, Sep 13 | Ruihua Liu, University of Dayton<br>Merton's Investment and Consumption Problem in Regime-Switching Model | 3:00 PM, SC 323 |
| Thursday, Sep 20 | Vladimir Tkachuk, University of Dayton<br>Reflecting topological properties in small continuous images | 3:00 PM, SC 323 |
| Thursday, Sep 27 | Aparna Higgins, University of Dayton<br>Sequences of Polygons | 3:00 PM, SC 323 |
| Thursday, Oct 11 | Thaddeus Tarpey, Wright State University<br>Interpreting Meta-Regression: Application to Recent Controversies in Antidepressant Efficacy | 3:00 PM, SC 323 |
| Thursday, Oct 18 | Art Busch, University of Dayton<br>Hamiltonian Spider Intersection Graphs are Cycle Extendable | 3:00 PM, SC 323 |
| Thursday, Oct 25 | Saleh Tanveer, The Ohio State University<br>Structual stability, well-posedness and global existence in models of physical problems | 3:00 PM, SC 323 |
| Thursday, Nov 1 | Paul Eloe, University of Dayton<br>Some calculations related to the Riemann Zeta function for integer values | 3:00 PM, SC 323 |
| Thursday, Nov 8 | Dan Zhang, University of Dayton<br>Application of Radial Basis Function to the Numerical Solution of Option Pricing Models | 3:00 PM, SC 323 |
| Thursday, Nov 8 | Junyao Zhang, University of Dayton | 3:30 PM, SC 323 |
| Thursday, Nov 15 | Michael Radin, Rochester Institute of Technology<br>Boundedness Character of solutions, Monotonic Character of solutions and Existence of Periodic Solutions of a Non-Autonomous Rational Difference Equation | 3:00 PM, SC 323 |
| Tuesday, Nov 27 | Beverly Ali, University of Dayton<br>Assessing Risk of Hedge Fund Investments using Value-at-Risk | 3:00 PM, SC 323 |
| Tuesday, Nov 27 | Joshua Craven, University of Dayton<br>A Numerical Method for Determining Bifurcation Curves | 3:30 PM, SC 323 |
| Thursday, Nov 29 | Carl Mummert, Marshall University<br>Stationary and convergent strategies in Choquet games | 3:00 PM, SC 323 |
| Thursday, Dec 6 | Faridah Alruwaili, University of Dayton<br>Transfer Function Models | 3:00 PM, SC 323 |
| Thursday, Dec 6 | Ariel Zheng, University of Dayton<br>The Ability of Credit Default Swap to Predict Corporate Default | 3:30 PM, SC 323 |
| Monday, Dec 10 | Arthur Zeyda, University of Dayton | Noon, SC 062 |

**Merton's Investment and Consumption Problem in Regime-Switching Model**

Ruihua Liu

**Abstract:** In this work we study the Merton's optimal investment and consumption problem in a continuous-time regime-switching model. The market consists of one bond and n correlated risky assets (stocks). An investor distributes his/her wealth among these assets and consumes at a non-negative rate. The market parameters (the interest rate, the appreciation rates and the volatilities of the stocks) and the utility are assumed to depend on a continuous-time Markov chain with finite number of states. The objective is to maximize the expected discounted total utility of consumption and the expected discounted utility from terminal wealth. We solve the optimization problem by stochastic control methods for regime-switching models. Under suitable conditions, we prove a verification theorem. We apply the theorem to a specific class of power utility functions and obtain, up to the solution of a system of ordinary differential equations, an explicit solution of the value function and the optimal investment and consumption policies.

**Reflecting topological properties in small continuous images**

Vladimir V. Tkachuk

**Abstract:** When we try to find out whether a "big" topological space has a given property, then it is often useful to check whether some "small" subspaces of the space have this property. In many cases this suffices to determine whether the space itself has the property in question. For example, if all subspaces of cardinality at most $w_1$ of a compact space $X$ are metrizable then $X$ itself is metrizable. This topic is well-developed and still features a lot of activity both in USA and in Europe. In our talk we will show that topological properties can also be reflected in "small" continuous images, i.e., if all "small" continuous images of a space $X$ have a property $\boldsymbol{P}$ then $X$ itself has $\boldsymbol{P}$ For example, a compact space $X$ is metrizable if and only if all continuous images of $X$ of weight at most $w_1$ are metrizable. This topic is new: we will present a systematic development and some applications.

**Sequences of Polygons**

Aparna Higgins

**ABSTRACT**: At a mathematics meeting several years ago, two students who attended different schools and who did not know each other presented talks that were variations of the same problem. The student from UD spoke of the result of alternately inscribing regular polygons and circles, while the other spoke of the result of alternately circumscribing regular polygons and circles. Recently, I heard a talk on other variants of this theme, and I found myself still intrigued by the questions. I am delighted when I see problems that are simple to state, yet have an element of surprise. I will use GeoGebra to help us explore some of these problems. This talk will be accessible to undergraduates.

**Interpreting Meta-Regression: Application to Recent Controversies in Antidepressant Efficacy**

Thaddeus Tarpey

**Abstract:** The efficacy of modern antidepressants has been called into question on the basis of some recent high profile publications which used the methodology of meta-regression. In this talk, the meta-regression model with a continuous outcome is contrasted with a subject-level model using finite and infinite mixture models. Several antidepressant trials, for which subject-level data are available, are used for illustration. We show that the meta-regression analysis differs dramatically from the subject-level analysis for these depression trials, a difference that is due in part to the ecological fallacy.

**Hamiltonian Spider Intersection Graphs are Cycle Extendable**

Art Busch

**Abstract:** A cycle $C$ of length $k$ is extendable if there is a cycle $C'$ of length $k+1$ with $V(C)$ contained in $V(C')$. A graph $G = (V, E)$ of order n is cycle extendable when every cycle $C$ of length $k < n$ is extendable. A chordal graph is a spider intersection graph if it admits an intersection representation which consists of subtrees of a sub-divided star (or spider). In 1990, Hendry conjectured that all hamiltonian chordal graphs are cycle extendible, and this conjecture remains unresolved. We show that all hamiltonian spider intersection graphs are cycle extendable, generalizing known results on cycle extendability in interval graphs and split graphs.

This is joint work with Atif Abueida and R. Sritharan.

**Structual stability, well-posedness and global existence in models of physical problems**

Saleh Tanveer

**Abstract:** In modeling a physical system, it is common to ignore terms that appear small in order that the mathematical problem remains manageable. Yet, one has to be careful in throwing away terms, since small terms in the equation need not always mean small effects on the resulting solution. There is a need for solution to be continuous with respect to changes of initial/boundary conditions and parameters in a suitable norm. This is fundamental for any mathematical model to be physically realistic. One or more potential regularizing terms that have been ignored in the simplified model need to be re-introduced even when they appear very small formally.

We illustrate this notion in a number of physical problems like viscous fingering. We will show that naive formal perturbation expansion can lead to incorrect conclusions. We will also note in terms of some simple models how a problem that is close to structurally instability or is nearly ill-posed can display a rich variety of phenomena including unexpected cross-overs in the parameter space that could not be predicted based on the size of terms in the physical domain.

For evolution problems, that is otherwise locally well-posed, we briefly discuss how singularity formation dictate the kind of regularization that need to be included near singularity formation time in order to get physically realistic prediction. In this context, the open problem for 3-D Navier-Stokes will be discussed.

**Some calculations related to the Riemann Zeta function for integer values**

Paul Eloe

**Abstract:** $\zeta\ (s) = \sum_{i=0}^{\infty} \frac{1}{1^s}\ (s > 1)$ is the Riemann Zeta function. If $s = 2n$, an even integer, $\zeta(s)$ can be calculated, recursively. Methods are not known to calculate $\zeta(s)$ if $s = 2n + 1$, an odd integer. We show some calculations for $s = 2n$ and then derive a viable method to approximate $\zeta(3)$ using the values for $\zeta(2n)$. Some historical context is given.

**Application of Radial Basis Function to the Numerical Solution of Option Pricing Models**

Dan Zhang

**Abstract:** Radial Basis Functions (RBF) were conceived by Hardy during the 1970's as an effective multidimensional scattered interpolation method. A radial basis function is a real-valued function whose value depends only on the distance from the origin or some other point. Any function ϕ that satisfies the property ϕ (x) = ϕ (‖x‖) or ϕ (x,c) = ϕ (‖x-c‖) is a radial function. RBF are mean to approximate multivariable functions by linear combinations of terms based on a single variable function (the radial basis function). RBF are natively high-dimensional, mesh free and can produce smooth approximations not only for the unknown function but also for its derivatives. It offers an accurate numerical solution method for a wide variety of PDEs. In this talk, the author will apply RBF in both European option and American option and compare the results with analytical solutions.

**Boundedness Character of solutions, Monotonic Character of solutions and Existence of Periodic Solutions of a Non-Autonomous Rational Difference Equation**

Michael A. Radin

**Abstract:** Our aim is to investigate the boundedness character, the periodic character and the monotonic character of the non-negative solutions of the following nonautonomous rational difference equation.

**Assessing Risk of Hedge Fund Investments using Value-at-Risk**

Beverly Ali

**Abstract:** This paper explores different methods used to analyze the risk associated with hedge fund investments, including several techniques based on the concept of value-at-risk (VaR). Due to the competitive nature of hedge funds, the flow of information between the manager and investors is fairly poor. As a result, it is quite difficult to adequately capture the risks of hedge funds. The value-at-risk based on the traditional approaches (empirical and parametric) is generally misleading as it severely underestimates expected losses. This issue is generally related to false assumptions about the nature of the distribution of the returns as well as an over-reliance on historical data.

For VaR calculation, the assumption of normal distribution is known to ignore the larger jumps in the returns and consequently it leads to extreme tail risk. Ways to circumvent this issue have been the subject of several academic researches. For example, the Cornish- Fisher VaR models better the fat tails by taking into account the third and fourth moments of the return distribution. In this capstone project, we focus on a less known approach to analyze the risk of hedge funds based on the concept of stress value-at-risk or stress VaR. Other VaR computations, using Non-Gaussian distributions are also explored. We also describe several risk-adjusted return (RAR) metrics to gauge the performance of hedge funds.

**A Numerical Method for Determining Bifurcation Curves**

Joshua Craven

**Abstract:** A numerical methodology for determining and verifying the bifurcation curves of specific differential equations is presented. Matlab is used to find critical points for given conditions and also determine the stability of these points. Although there are a couple of programs (e.g. AUTO bifurcation software package) that can create these bifurcation curves, they are all a black box. It is advantageous to have a code that can be altered to suit the user's needs, so an open box methodology has been designed. This "open box" methodology is applied to two papers (Panday et. al and Maccari) where the bifurcation curves are known. The plots are compared for accuracy, and then the methodology is

applied to Korteweg-de Vries type equation. Effects of controls on bifurcation curves are investigated. The development of the methodology from its original form to its current version is also discussed.

**Stationary and convergent strategies in Choquet games**

Carl Mummert

**Abstract:** We study a family of games that generalize the strong Choquet game from descriptive set theory. Two types of winning strategies for the second player are of interest: stationary strategies, in which the strategy only depends on the most recent move of the first player, and convergent strategies, in which the second player tries to make the intersection of the sets played as small as possible. We prove a sufficient topological condition for the existence of a stationary winning strategy in the strong Choquet game, and obtain a characterization of the spaces for which the second player has a convergent winning strategy. This is joint work with François G. Dorais.

**Transfer Function Models**

Faridah Alruwaili

**Abstract:** We introduce transfer function models as an alternative method to the BoxJenkins methodology when the Box-Jenkins methodology fails. The term transfer function model refer to a model that predicts future values of a time series called output series based on past values of this series and based on one or more input variables (regressors) that is time dependent. We present a procedure for building transfer function models. This will involve identifying a model to describe the input series, identifying a preliminary transfer function model describing the output series and using the residuals for the preliminary model to identify a model describing the error component and to form a final transfer function model.

**The Ability of Credit Default Swap to Predict Corporate Default**

Ariel Zheng

**Abstract:** Credit default swap (CDS) was intended to work as credit insurance when it was brought to the market. However, the hedging ability of CDS was in doubt after the 2008 subprime crisis in which many large financial institutions and hedge funds reported big loses on CDS holding. The aim of this paper is to examine the CDS ability to predict corporate default using VAR model and quantile regressions. We construct the probability of default by expected default frequency (EDF) according to KMV-Merton model, which is based on Merton's (1994) bond pricing model and subsequently developed by the Moody's corporation. Our results show that CDS spread leads probability of default for some firms, which suggests that CDS is useful to predict corporate default under certain circumstances. In the quantile regression analysis, the higher the quantile of the default probability distribution is, the more significant the correlation between CDS spread and default probability. We conclude that CDS spread predicts default better when the corporation has weaker financial strength, hence high probability to default. CDS spread has little relation with the default probability when the firm performances well.