Winter 2008

2008 (Winter)

University of Dayton. Department of Mathematics

Abstracts of the Colloquium Talks: Winter 2008
Department of Mathematics

Date	Speaker and Title	Time/Location
Thursday, Jan 24	Youssef Raffoul, University of Dayton	3:00 pm, SC 323
Tuesday, Jan 29	Soma Roy, Ohio State University Estimating Percentiles in Computer Experiments	3:00 pm, SC 323
Thursday, Jan 31	Murat Adivar, Izmir Universityof Economics Existence results for periodic solutions of integro-dynamic equations on time scales	3:00 pm, SC 323
Tuesday, Feb 5	Jessica Kohlschmidt, Ohio State University Ranked Set Sampling: An Alternative to Simple Random Sampling	**3:15 pm**, SC 323
Thursday, Feb 7	Joe Mashburn, University of Dayton, Finite dimensional spaces of quantum states as partially ordered sets	3:00 pm, SC 323
Monday, Feb 11	Andrada Ivanescu, Florida State University Revealing Sparse Signals In Functional Data	3:00 pm, **SC 224**
Thursday, Feb 14	Joe Mashburn, University of Dayton, Finite dimensional spaces of quantum states as partially ordered sets	3:00 pm, SC 323
Thursday, Feb 21	Joe Mashburn, University of Dayton, Finite dimensional spaces of quantum states as partially ordered sets	3:00 pm, SC 323
Thursday, Feb 28	Shaaban Abdallah, University of Cincinnati Mesh Free Technique in Finite-Difference Formulations	3:00 pm, SC 323
Tuesday, Mar 11	Yu Yue, University of Missouri-Columbia Spatially adaptive priors	**3:15 pm, SC 313**
Thursday, Mar 13	Jake Wildstrom, University of Louisville Limited-knowledge service-provision with mobile resources	3:00 pm, SC 323
Friday, Mar 14	Devrim Biligili, Northern Illinois University Quantitative trait locus detection using an accelerated failure times cure model for survival data	**3:30 pm, SC 323**
Thursday, Mar 27	Jeffrey Neugebauer, University of Dayton Qualitative Properties of Nonlinear Volterra Integral Equations	3:00 pm, SC 323
Thursday, Apr 3	Edward Timko and Zachary Martinsek, University of Dayton A solution to Problem B of the 2008 Mathematical Contest in Modeling	3:00 pm, SC 323
Tuesday, April 8	Fares Ghannam, University of Dayton Periodic Solutions in Nonlinear Neutral Difference Equations with Functional Delay	3:00 pm, SC 323

Thursday, Apr 10	Jinyang Sun, University of Dayton Double Barrier Option Pricing in Regime-Switching	**3:00 pm, SC 323**
Thursday, Apr 10	Lanre Oriowo, University of Dayton Strategic Trading when Paradigm Shifts	**3:30 pm, SC 323**
Tuesday, April 15	Xiaobo Zeng, University of Dayton Pairs Trading and Cointegration	3:00 pm, SC 323
Thursday, Apr 17	Christopher Augeri, Air Force Institute of Technology On Some Results in Unmanned Aerial Vehicle Swarms	3:00 pm, SC 323
Tuesday, Apr 22	Rusty Rizzotte, University of Dayton Using a constructivist approach in teaching pre-service elementary teachers how to teach mathematics	**3:00 pm, SC 323**
Tuesday, Apr 22	Carol Parete, University of Dayton The Association Between the Cognitive Level of the Instructor's Questions and Corresponding Student Responses -- Implications for Improving Instruction	**3:30 pm, SC 323**
Thursday, Apr 24	Melissa Mattson, University of Dayton Valuing American Put Options with Regime Switching	**3:00 pm, SC 323**
Thursday, Apr 24	Casey Klaus, University of Dayton Volatility Trading on Special Events	

Estimating Percentiles in Computer Experiments

Soma Roy

Abstract: Computer code is often used to study complex physical processes. The running of such code at a few chosen input settings comprises a computer experiment. The goal is to always use as few runs as possible to keep costs low. Most of the work done in this area focuses on either estimating the unknown complex input-output relationship or finding the maxima/minima of the output. My talk is about estimating percentiles in a computer experiments setting. I consider the case in which there are multiple inputs and a single output. I assume that the inputs have some known distribution and wish to estimate, say, the p^{th} percentile, Q_p, of the induced distribution of the output. The proposed algorithm uses a sequential design methodology. The code is observed at an initial design of a few carefully chosen points. These data are used to estimate the input-output relationship and Q_p. Next, I use specially developed criteria to sequentially add points to our design to improve our estimate of the relationship and refine the estimate of Q_p. I stop when the budget has been expended, and use all available data to obtain the final estimate Q_p^* and the input settings that would produce Q_p^*. I compare results from using a sequential design to those obtained from a fixed design approach. I also look at the case when two types of input variables may be present: control and environmental.

Existence results for periodic solutions of integrodynamic equations on time scales

Murat Adivar

Abstract: Using topological degree method and Schaefer's fixed point theorem, we deduce the existence of periodic solutions of nonlinear system of integro-dynamic equations on periodic time scales. Furthermore, we provide several applications to scalar equations, where we develop a time scale analogue of Lyapunov's direct method. Therefore, we improve and generalize the corresponding results

in [T. A. Burton, P. W. Eloe, and M. N. Islam, Nonlinear integro-differential equations and a priori bounds on periodic solutions, Annala di Matematica pura ed applicata, Vol. CLXI (1992) 271-283].

Ranked Set Sampling: An Alternative to Simple Random Sampling
Jessica Kohlschmidt
Abstract: Simple random sampling (SRS) is widely used for sampling purposes. We will discuss SRS and some of the variations that are accepted methods of sampling. An alternative sampling method, ranked set sampling (RSS), has been receiving considerable attention in the statistics literature. Researchers have shown that ranked set sampling outperforms simple random sampling in many situations by reducing the variance of a parameter estimator, thereby providing the same accuracy with a smaller sample size than is needed in simple random sampling. Ranked set sampling involves preliminary ranking of potential sample units on the variable of interest using judgment or an auxiliary variable to aid in sample selection.

The various forms of RSS will be described. We will discuss some advantages and disadvantages to using this ranking procedure. In some situations, RSS may be of more use if we select units in a fashion that is unbalanced for each group. RSS is thought to have the most impact on sampling when the cost of actually collecting measurements on the variable of interest for each individual is costly. If we can use ranking to reduce the number of units needed in the sample, then we can save considerable time and money in the process of sampling.

Date: Tuesday February 5, 2008
Place: University of Dayton, Science Center 323
Time: Refreshments at 2:45 PM in Science Center 313, Talk at 3:15PM in Science Center 323

Finite dimensional spaces of quantum states as partially ordered sets
Joe Mashburn
Abstract: We will review the partial order which Coecke and Martin defined for finite dimensional spaces of quantum states. The properties of this partial ordered will be explored, especially as they relate to domains and information theory.

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Revealing Sparse Signals In Functional Data
Andrada Ivanescu
Abstract: A novel statistical method to reveal the signal in data consisting of a sample of curves, where each curve is regarded as a realization of a stochastic process will be discussed. In this framework, existing methods for inference include smoothing splines and kernel estimates. Our method successfully adapts to the sparsity of the signal. The methodology involves thresholding, and the threshold level depends on the sources of variability that exist in this type of data. An application of the method to estimate the mean volatility of stock quotes in intra-day trading will be presented.

Date: Monday February 11, 2008

Place: University of Dayton, Science Center
Time: Refreshments at 2:30 PM in Science Center 313, Talk at 3:00 PM in Science Center 224

Mesh free Technique in Finite-Difference Formulations

Shaaban Abdallah[1] and Marshall Galbraith[2]

Abstract: The Mesh free approach for solutions of the Navier-Stokes equations has been advancing well towards becoming one of the classical numerical techniques. However, two issues remain to be examined in details by mesh free methods; the first is the consistency of the numerical approach and the second is application to compressible flows with shock waves. In the present study, we developed a Mesh free method based on a second order polynomial fitting arbitrary set of grid points (at least 9-points in twodimensions). The governing equations are coupled to the polynomial through Lagrange multiplier and the polynomial coefficients are determined from the least square method. The resulting algebraic set of equations can be solved either explicitly or implicitly. Due to the enlarged stencil as compared to the classical 5-point finite-difference methods, the explicit solutions converge faster. In addition, our method has several other advantages over existing Mesh free methods. First, our method leads to a set of algebraic equations very much similar to the classical finite-difference equations that can be analyzed using Taylor's expansion for consistency in Mesh free environment. Second, the method is equally applicable for solutions of compressible and incompressible flow equations. Several test problems are solved to validate the method. These include the driven cavity, flow over a cylinder and compressible flow over a thin airfoil with shock wave.

[1] Professor
[2] Graduate student

Spatially adaptive priors

Yu Yue

Abstract: Smoothing splines and their high dimensional versions, thin-plate splines, have been used successfully for curve fitting and spatial smoothing. A global smoothing parameter, however, fails to adapt to variable smoothness in the function of interest. This is of particular importance in spatial datasets, in which a nonstationary process is often detected. For example, environmental variables, say precipitation or temperature, are likely to be much less smooth in mountainous regions than in flat areas. To overcome this drawback, we propose a class of priors that extend a Bayesian version of smoothing splines, intrinsic Gaussian Markov random fields (IGMRFs), by using a spatially adaptive variance component and taking a further IGMRF prior for this variance function. The adaptive IGMRF prior has appealing properties for Bayesian inference and computation. First, it often improves function estimation since it can adapt to changes in curvature of the underlying function. Second, the method can be easily implemented by Gibbs sampling because the full conditionals are either regular densities or log-concave functions. Finally, the sparseness of the prior yields efficient Markov chain Monte Carlo computation.

Limited-knowledge service-provision with mobile resources

Jake Wildstrom

Abstract: The location of facilities in response to demand has often been viewed as a static problem of optimal situation with respect to a fixed client list; dynamic facility location explores the possibility of a

changing client list over time and the ability of the server to relocate in response to changing demand. This presentation explores problems in dynamic facility location and presents a computational algebraic framework for complete characterization of the optimimal responses to every possible client-queue.

QTL(Quantitative Trait Locus) Detection Using Accelerated Failure Time Cure Model For Survival Data
Devrim Bilgili
Abstract: Many important problems in evolutionary biology begin with observations of phenotypic variation. For example, variation in survival time is partly due to genetic differences among individuals and partly due to environmental factors. Developing statistical methodologies relating the unknown genotype of QTL to the survival time of an individual is important in identifying the disease genes. In some genetic studies with survival end points, the population under study consists of susceptible and nonsusceptible individuals. All susceptible subjects would eventually experience the event in the absence of censoring, while nonsusceptible subjects are not at risk of developing such events and can be regarded as "cured." I will discuss a procedure to detect the QTL locations for survival data using accelerated failure time cure model for survival data.

Date: Friday March 14, 2008
Place: University of Dayton, Science Center 323
Time: Refreshments at 3:00 PM in Science Center 313, Talk at 3:30 PM in Science Center 323

Qualitative Properties of Nonlinear Volterra Integral Equations
JEFFREY T. NEUGEBAUER
Abstract The contraction mapping principle and Liapunov's method are used to study qualitative properties of nonlinear Volterra equations of the form

$$x(t) = a(t) - Z\ t\ 0\ C(t,s)g(s,x(s))\ ds, t \geq 0.$$

In particular, the existence of bounded solutions and solutions with various L^p properties are studied under suitable conditions on the functions involved with this equation.

A solution to Problem B of the 2008 Mathematical Contest in Modeling
Zachary Martinsek and Edward Timko
Abstract: The problem at hand was to create the most efficient and simple algorithm to create a Sudoku puzzle with varying difficulty levels. Sudoku is a 9 x 9 puzzle requiring the player to fill in all rows, columns and boxes to discover a unique solution. Each row, column and box must contain the numbers 1 – 9. Since these groups of numbers must be exclusive, it would seem as though the algorithm contained a fair amount of searching, checking and updating to ensure no conflicts existed. But our model would suggest otherwise. Although we have acknowledged that searching and checking would be necessary to ensure the uniqueness of our puzzles, we have stripped the algorithm of searching to the bear minimum in order to ensure efficiency. But with efficiency comes a small price. With our algorithm we generate a small fraction of every possible unique solution to Sudoku. But a small fraction of a very large number is still a very large number. Our algorithm fills one box making it valid. We proceed to fill every other box in the puzzle with permutation of those same numbers until the board is full. To help ensure a sufficiently large number of possibilities, we jumble the order of rows and columns. After we have made empty a certain number of cells, we check the difficulty of the puzzle with a simple solver. This approach keeps things simple, not just for people but also for computers. This is the biggest

strength of our algorithm. It far eclipses the fact that we can only come up with a small fraction of a very large number.

Periodic Solutions in Nonlinear Neutral Difference Equations with Functional Delay

Fares Ghannam

Abstract: We use Krasnoselskii's fixed point theorem to show that the nonlinear neutral difference equation with delay

$$x(t+)1 = a(t)\,x(t) + c(t)\Delta x(t-\tau) + q(t, x(t-\tau))$$

has a positive periodic solution. To apply Krasnoselskii's fixed point theorem, one would need to construct two mappings; one is a contraction and the other is compact. An example will be provided.

Double Barrier Option Pricing in Regime-Switching

Jinyang Sun

Abstract: We study a double barrier option pricing problem when the underlying asset price follows a new regime-switching exponential mean-reverting process. In this setting, the double barrier option prices satisfy a system of linear second order differential equations with boundary conditions. We numerically solve the system by constructing monotonic sequences of upper solutions and lower solutions that converge to true solutions, respectively. This method is tested by numerical examples and compared with Monte-Carlo method.

Strategic Trading when Paradigm Shifts

OLANREWAJU T. ORIOWO

Abstract: Dr F. Albert Wang's paper suggests the introduction of a new asset valuation paradigm and examines how it affects the strategy played by new and existing market participants. The Bayesian Nash Equilibrium offers a tool to observe how one particular participant, the Sophisticated trader who is an early adopter of the new paradigm, attempts profit maximization in an environment of continuous trading against various Naïve traders entering the market at different times. The trading activities of the numerous Naïve traders serve as a modeling device to create persistent noise in the market.

Pairs Trading and Cointegration

Xiaobo Zeng

Abstract: As a trading strategy, statistical arbitrage is a heavily quantitative and computational approach to equity trading. It involves data mining and statistical methods, as well as automated trading systems. In this paper, I introduce two methods (pairs trading and cointegration) for trading against statistical arbitrage, and run a simulation over a particular set of data, namely the 20 equities from 11/3/2003 to 10/12/2007. The result of simulation shows that the performance of cointegration is more impressive and persistent than that of pairs trading and therefore more suitable to incorporate into an automated trading system.

On Some Results in Unmanned Aerial Vehicle Swarms

Chris Augeri†

Abstract We first summarize our results on managing data in unmanned aerial vehicle swarms, such as development of a co-simulation environment, a study of Extensible Markup Language (XML) data compression engines, and a k-dimensional extension to the skip graph data structure for querying data

stored at the mobile nodes. The third result motivated research on canonically ordering nodes in the swarm using more robust methods than the z −order space-filling curve applied in the k-dimensional extension of the skip graph data structure. We opted to explore how to canonically order the nodes using the PageRank algorithm applied in certain search engines to order query responses. A key reason is that the PageRank vector canonically orders vertices of nearly all random graphs, which is a result of the relationship an equitable partition has with the eigenvector yielded by the PageRank algorithm. An equitable partition can be obtained by applying 1 −dimensional Weisfeiler-Lehman stabilization to the graph and can be implemented in $O(m \cdot logn)$ time, where $m = |E|$ and $n = |V|$, as established by Paige and Tarjan, and separately, by Cardon and Crochemore. We use the equitable partition to eliminate a class of errors in PageRank values, which ensures vertices that are equivalent in a given equitable partition have equal values and also facilitates early termination of the power method. The equitable partition yields many other methods of reducing the number of computations, such as computing one PageRank value for equivalent vertices. We also explore estimating PageRank values using the quotient graph induced by an equitable partition. We conclude by describing future research avenues, including generalizing a lemma applied in this work to k −dimensional Weisfeiler-Lehman stabilization, building a library of graphs based on given values of k, and implementing a method that decides graph isomorphism by leveraging multiple processors.

†Work performed as a Ph.D. candidate under the supervision of Barry Mullins, Rusty Baldwin, Dursun Bulutoglu, and Leemon Baird III

Using a constructivist approach in teaching pre-service elementary teachers how to teach mathematics

Rusty Rizzotte

Abstract: According to the Principles and Standards for School Mathematics, the need for mathematical knowledge and understanding is increasing. Students in all grades need to learn more mathematics and therefore require more effective teaching. The distinction between conceptual and procedural knowledge of mathematics has received a great deal of discussion and debate throughout the years. The purpose of this study is to examine whether students learn mathematics more successfully by instruction using a constructivist approach to gain conceptual knowledge about mathematics or by the more typical procedural approach. This study was conducted at a mid-sized accredited private university in southwest Ohio during the fall 2003 semester. The students were all pre-service elementary teachers enrolled in a mathematics education course. Overall the findings demonstrated a remarkable change in the methods used by the pre-service teachers. The results established that most of the teachers in the experimental group felt mathematics should be taught conceptually as opposed to procedurally after completing the mathematics education course.

The Association Between the Cognitive Level of the Instructor's Questions and Corresponding Student Responses Implications for Improving Instruction

Carol Parete

Abstract: Educational research has indicated that a positive association exists between the cognitive level of written questions asked by instructors and the cognitive level of the students' written responses. In this study, instructor's oral questions and corresponding students' responses in nine

introductory level college math, science, or engineering courses were assessed and categorized using the revised Bloom's Taxonomy. Results showed there was significant correlation between the cognitive level of the question asked and the cognitive level of the response given. The results could alter the role of questioning within instructional periods in classrooms.

Valuing American Put Options with Regime Switching

Melissa Mattson

Abstract: We look at two different models for pricing an American put option, on a non-dividend paying stock, with regime-switching. Here we study the two regime case. First, we value the option using an implicit finite difference method on a pair of partial differential equations and the free boundary conditions. We then value the option by constructing a pentanomial tree, a method created by Bollen. Finally, we compare the two methods and their results.

Volatility Trading on Special Events

Casey Klaus

Abstract: It has long been observed that volatility increases around a firms quarterly earnings along with increased trading volume. Stock returns and trading volume tend to be positively correlated. Stocks tend to rise on high volume and decline on low volume. Option prices are relatively overvalued during this time due to the high volatility. In this paper, I introduce a trading strategy that capitalizes the relatively overvalued options using implied volatility. By collecting all of stock data from 2006, I was able to run simulations to see how the implied volatility was affected by earnings announcements. The results of the simulation show how trading during earnings announcements can be very effective.