

**Location:** Royall Hall, room 211 (Unless otherwise noted)

**Day & Time:** Fridays, 3:00-3:50 pm (Unless otherwise noted)

[Campus Map for Talks](#) (PDF Format)

**Organizer:** [Dr. Noah Rhee](#), 235-2854

**Email:** rheen@umkc.edu

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### Dates, Titles, Speakers (with Abstracts as available)

- **Friday, Feb. 4**

**Econometric Analysis via Filtering for Ultra-High Frequency Data**

**Yong Zeng**, Department of Mathematics & Statistics, UMKC

We propose a general nonlinear filtering framework with marked point process observations incorporating other observable economic variables for ultra-high frequency (UHF) data. The approach generalizes several existing models and provides extensions in new directions. We derive filtering equations to characterize the evolution of the statistical foundation such as likelihoods, posteriors, Bayes factors and posterior model probabilities. Given the computational challenge, we provide a powerful convergence theorem, enabling us to employ the Markov chain approximation method to construct consistent, easily-parallelizable, recursive algorithms to calculate the fundamental statistical characteristics and to implement Bayesian inference in real-time for streaming UHF data. The general theory is illustrated by a specific model built for U.S. Treasury Notes transactions data from GovPX. We show that in this market, both information-based and inventory management-based motives are significant factors in the trade-to-trade price volatility. This is a joint work with David R. Kuipers and Xing Hu.

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- **Friday, Feb. 18**

**Approximating Stationary Densities of Frobenius-Perron Operators**

**Noah Rhee**, Department of Mathematics & Statistics, UMKC

Frobenius-Perron operators are infinite dimensional analogue of column stochastic matrices. As stationary vectors for column stochastic matrices have many applications, so stationary densities of Frobenius-Perron operators have many applications. In this talk, we discuss how we can approximate stationary densities of Frobenius-Perron operators.

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- **Friday, Mar. 4**

**The Two-phase Stefan Problem**

**Charles Moore**, Department of Mathematics, Kansas State University

The two-phase Stefan problem is a nonlinear partial differential equation which models the flow

of heat within a substance that can be in a liquid phase or a solid phase, and for which there is a latent heat to initiate phase change. This allows for the presence of a mushy zone, that is, a region which is between the liquid and solid phases. Although related to the heat equation (for which much is known), far less is known for this equation and other similar nonlinear equations. I will discuss existence, uniqueness and regularity of solutions.

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- **Friday, Mar. 11**

**Cancelled.** (may be rescheduled for later date.)

**Quantification of Aging: State of Art**

**Ibrahim A. Ahmad**, Department of Statistics, Oklahoma State University

Mathematical quantification of ageing has been subject of intensive research for well over half a century. In this talk we present the most important concepts of ageing that have been used in areas such as life testing, survival analysis, statistical reliability and actuarial science. Of the most important notions, is the “residual life time”. We shall offer some recent advances based on this early fundamental notion and then will introduce some new notions of ageing based on it that have come to use in recent decade or two and now occupy major space in research. One such recent notion we shall introduce, is the concept of “idle time” or time since failure. We shall show how this notion can make strides of developments in such areas as Forensic Science, Anthropology and Actuary among others.

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- **Friday, Mar. 18**

**Detecting Financial Bubbles in Real Time**

**Philip Protter**, Department of Statistics, Columbia University

After the 2007 credit crisis, financial bubbles have once again emerged as a topic of current concern. An open problem is to determine in real time whether or not a given asset's price process exhibits a bubble. Due to recent progress in the characterization of asset price bubbles using the arbitrage-free martingale pricing technology we are able to propose a new methodology for answering this question based on the asset's price volatility. We limit ourselves to the special case of a risky asset's price being modeled by a Brownian driven stochastic differential equation. Such models are ubiquitous both in theory and in practice. Our methods use sophisticated volatility estimation techniques combined with the method of reproducing kernel Hilbert spaces. We illustrate these techniques using several stocks from the alleged internet dot-com episode of 1998–2001, where price bubbles were widely thought to have existed. Our results support these beliefs. The talk is based on joint work with Robert Jarrow and Younes Kchia.

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- **Friday, Mar. 25**

**Change Point Analysis and Its Application in Genetics**

**Jie Chen**, Department of Mathematics & Statistics, UMKC

In this talk, I will first provide an overview on parametric statistical change point analysis, and then will introduce some recent applications of change point methods in genetics based on my recent work with my collaborators. Statistically, a change point is defined as, in a broad sense, the unknown point  $k$ , such that observations before point  $k$  are different from observations after point  $k$ . Multiple change points can be similarly defined. One of the key features of statistical change point analysis is to estimate the unknown change point for various statistical models. This analysis can be done through a hypothesis testing process, a model selection perspective, a Bayesian approach, among other methods. One of the recent applications of change point analysis is in the study of NDA copy number changes or copy number variations (CNVs) based on high throughput data. It turns out that identifying boundaries of CNV regions on a chromosome or a genome can be viewed as a change point problem of detecting changes presented in the genomic data. We propose to use two change point models to detect the loci of CNVs in such genomic data. The approaches are illustrated on fibroblast cell line data and the breast cancer/tumor data, and CNV regions are successfully detected.

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- **Friday, Apr. 8**

- **Asymptotic Properties of Maximum Likelihood Estimators in Models with Multiple Change Points**

**Heping He**, Department of Mathematics, University of Kansas

Models with multiple change points are used in many fields; however, the theoretical properties of such models have received relatively little attention. The goal of this paper is to establish the asymptotic properties of maximum likelihood estimators of the parameters of a multiple-change-point model for a general class of models in which the form of the distribution can change from segment to segment and in which, possibly, there are parameters that are common to all segments. Consistency of the maximum likelihood estimators of change points is established and the rate of convergence is determined; the asymptotic distribution of the maximum likelihood estimators of the parameters of the within-segment distributions is also derived. Since the approach used in single change-point models is not easily extended to multiple change-point models, these results require the development of new tools for analyzing the likelihood function in a multiple change-point model.

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- **Friday, Apr. 15**

- **Canards and Mixed-Mode-Oscillation in a Neuronal Competition Model**

**Rodica Curtu**, Department of Mathematics, University of Iowa

Mixed-mode oscillations (MMOs) are temporal periodic activity patterns characterized by notable changes in amplitude: during each cycle, there is an alternation between small-amplitude oscillations and large, fast excursions of relaxation type. MMOs arise in a variety of physical systems; in particular, they were observed in in-vitro experiments at both individual neuron and neuronal population levels and, more recently, they were also found in

computational neuroscience models.

Canards are complex mathematical solutions that were first discovered and reported by French mathematicians (E. Benoît, J. F. Callot, F. Diener, M. Diener [1981]; Chasse au canard; *Collectanea Mathematica* 31-32 (1-3), 37-119) while studying the van der Pol oscillator. The canard phenomenon consists in a transition from a small amplitude oscillatory state to a large amplitude relaxation oscillation and it is characterized by the fact that the solution remains for a finite time in a repelling region of the phase space. Canards in two-dimensional systems show sensitivity to control parameter and noise, so they are hard to detect in experiments and simulations. However, in higher dimensional systems canards persist under small parameter changes and their dynamics can be detected. In this talk I will show the existence of canards and MMOs in a firing rate neuronal competition model of four ordinary differential equations. The model involves slow negative feedback and gain function nonlinearities, and depends on a control parameter associated with external constant stimuli. In this system, I investigate canards numerically and theoretically and I show they form the underlying mechanism of the MMOs.

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- **Friday, Apr. 22**  
**Epistasis Enriched Network and Risk Score Modeling of Continuous Multifactor Dimensionality Reduction**  
**Hongying Dai**, Senior Biostatistician, Children's Mercy Hospital and Clinics

Multifactor Dimensionality Reduction (MDR) has been widely applied to detect gene by gene (GxG) interactions associated with complex diseases. Several extensions (OR-MDR, G-MDR, etc.) have also been developed. Existing MDR methods summarize disease risk by a dichotomous predisposing variable, which may not be biologically plausible and which may limit accuracy in predicting who will be affected by a disease. We herein propose a Continuous Multifactor Dimensionality Reduction (C-MDR) method that exhaustively searches for and detects significant GxG interactions to generate an epistasis enriched network. A continuous epistasis enriched risk score, which takes into account several GxG interactions simultaneously, replaces the dichotomous predisposing variable and provides more resolution in the quantification of disease susceptibility. The proposed C-MDR is thus more capable of distinguishing between affected and unaffected subjects, especially in small samples. New GxG interaction measures including predisposing odds ratio (pOR), relative risk (pRR), and chi-square test statistic (pChi) are introduced and, along with techniques for generating p-values (with or without adjustments for multiple comparisons) and confidence intervals, obviate the cross validation inherent to the original MDR. Covariates can also be incorporated to reduce confounding bias, a topic pursued at length in a separate paper. The C-MDR method was applied to a data set on Juvenile Idiopathic Arthritis patients treated with Methotrexate (MTX). Numerous GxG interactions in the folate pathway were implicated in whether the patients responded to MTX. The epistasis enriched risk score that pooled information from 82 significant GxG interactions distinguished MTX responders from non-responders with 82% accuracy.

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**Organizer:** [Kamel Rekab](#) , 235-5746

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- [Previous Semester Schedule of the Graduate Seminar Series](#)
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### **Dates, Titles, Speakers (with Abstracts as available)**

- **Friday, Sep. 16**

#### **Changepoints in the North Atlantic Tropical Cyclone Record**

**Dr. Michael Robbins**

**National Institute of Statistical Sciences**

In this talk we examine the North Atlantic tropical cyclone record for statistical discontinuities (changepoints). Specifically, we look for changes in the strength (wind speed) and frequency of storms. This is a controversial area and indeed, our end conclusions are opposite of those made in Dr. Kelvin Droegemeier's July 28, 2009 Senate testimonial. The methods developed here should help rigorize the debate. Elaborating, we develop level-alpha tests for a changepoint in a data sequence of counts sampled from a Poisson distribution and in a categorical data sequence sampled from a multinomial distribution. The proposed test statistics may be expressed as the maximum of Pearson chi-square statistics. These test statistics are linked to cumulative sum statistics which allows null hypothesis asymptotic distributions to be derived in terms of the supremum of a functional of Brownian bridges. We study the tropical cyclone record in the North Atlantic Basin over the period 1851–2008, and we find changepoints in both the storm frequencies and their strengths. While some of the identified shifts can be attributed to changes in data collection techniques, the hotly debated changepoint in cyclone frequency circa 1995 also appears to be significant.

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- **Friday, Sep. 30**

#### **HEPATITIS C INFECTION IN THE HUMAN LIVER: VIRAL DYNAMICS, TREATMENT AND RELATED SIDE-EFFECTS**

**Dr. Swati Deb Roy (UMKC)**

Hepatitis C virus (HCV), causes chronic infection in the human liver, which can lead to cirrhosis, fibrosis and ultimately necessitate liver transplant. The available treatment for HCV is only suboptimal, being

successful in only 50% of treated patients. Also, it is expensive and fraught with treatment limiting side-effects.

Our goal in this research is focused on using ordinary differential equation models to help doctors decide whether a patient will be cured post treatment or not. We use the bistability property of our model to determine the long-term outcome of treatment. In addition, we evaluate for how long the patient should be treated and with what efficacy of treatment. Moreover, we model the side-effect of hemolytic anemia in context to HCV therapy to estimate the tolerable level in a particular patient. In case, the patient is likely to encounter anemia, we estimate what efficacy of an anti-anemia drug needs to be administered to avoid the side-effect but achieve cure from HCV. Lastly, we formulate a partial differential equation model for HCV and show that it also has the possibility of bistability property which can be used in the future to estimate the above more accurately.

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- **Friday, Oct. 7**

### **Implicit Sampling for Particle Filters**

**Dr. Xuemin Tu**

**Department of Mathematics University of Kansas**

Applications of filtering and data assimilation arise in engineering, geosciences, weather forecasting, and many other areas where one has to make predictions based on uncertain models supplemented by a stream of data with noise. For nonlinear problems filtering can be very expensive since the number of the particles required can grow catastrophically. In this talk, a particle-based nonlinear filtering scheme will be presented. This algorithm is based on implicit sampling, a new sampling technique related to chainless Monte Carlo method. This implicit filter reverses the standard procedure. It first assigns a probability to each particle and then find a sample that assume it. Therefore, the global estimation of the posterior densities is not necessary. This filter focuses particle paths sharply so as to reduce the number of particles needed for nonlinear problems. A high dimensional example for a stochastic Kuramoto-Sivashinski equation with observations that are sparse in both space and time will be given.

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- **Friday, Nov. 11**

### **A Strong Maximum Principle for Reaction Diffusion Systems**

**Dr. Chris Evans**

**Department of Mathematics University of Missouri**

The strong maximum principle says that for solutions to certain PDE, if a solution achieves its maximum/minimum in the interior of its domain then it must be constant. I will explain Weinberger's extension of this principle to reaction diffusion systems and my extension of his result to arbitrary convex sets.