Dates, Titles, Speakers (with Abstracts as available)

Spring 2014

- **Friday, Jan. 31**

Modeling the influence of social interactions and disease-related mortality during epidemics in small communities: an agent-based approach

Dr. Lisa Sattenspiel [University of Missouri, Columbia]

When populations are very small, it is difficult to design and analyze appropriate mathematical models to address important questions about the spread of disease at the population level. One relatively new approach to this problem is to develop agent-based computer simulation models that can incorporate the most essential characteristics of the population as well as the stochasticity that is an essential feature in small populations. This talk describes the structure of an agent-based model designed to study the spread of the 1918-19 influenza pandemic in a fishing community in the Canadian province of Newfoundland and Labrador. Selected results from sensitivity analyses of the model are presented, including how different assumptions about the nature of social mixing, aggregation of the population during events such as church services, or social characteristics of the initial case may influence epidemic patterns.

- **Friday, Feb. 7**

A plea for adaptive data analysis

Dr. Norden E. Huang [National Central University, Zhongli, Taiwan]

Data analysis is indispensable to every scientific endeavor. The existing data analysis methods are all developed by mathematicians based on their rigorous rules. In pursue of the rigor, we are forced to make idealized assumptions and live in a pseudo-real linear and stationary world, in which data analysis is relegated to data processing. But the world we live in is neither stationary nor linear. As scientific research getting increasingly sophistic, the inadequacy of mere processing data becomes glaringly obvious. In fact, the frequency defined from the traditional Fourier analysis can be proved to lack mathematical and physical meanings. To get the truth containing in the data, we have to break away from these limitations; we should let data speak for themselves so that the results could reveal the full range of consequences of nonlinearity and nonstationarity. To do so, we need new paradigm of data analysis methodology without a priori basis to fully accommodating the variations of the underlying driving mechanisms. The solution lies in adaptive data analysis approach. One example is the Empirical Mode Decomposition method and the associated extensions of timefrequency representation. We will show that, with the adaptive method, we can also determine trend objectively. In fact, we can only define true frequency with adaptive method, which would lead to quantify nonstationarity and nonlinearity. Examples from classic nonlinear system and recent climate change data will be used to illustrate the prowess of the new approach.

- **Friday, Feb. 14**

Anisotropic Mesh Adaptation in Image Representation and Scaling

Dr. Xianping Li [UMKC Department of Mathematics & Statistics]

Triangular mesh has gained much interest in image representation and has been widely used in image processing. Currently available content-based adaptive sampling methods are lack of clear mathematic framework. This paper introduces a particular anisotropic mesh adaptation (AMA) method for triangular meshes, which has been successfully applied in solving partial differential equations, to image representation and image scaling. The AMA method is based on metricspecified mesh adaptation and finite element interpolation for Delaunay triangles. An initial triangular mesh is generated using the amount of sample points that is much less than the original image points. Then the mesh is adapted based on a computed metric tensor that controls the size, shape and orientation of the triangles in the mesh. Finally, the image is reconstructed from the mesh using finite element interpolation. This AMA method has clear mathematical framework and can improve computational efficiency and accuracy.

- **Friday, Feb. 21**

Dr. Xiaoming He [Missouri University of Science and Technology]

Multi-physics domain decomposition methods for Stokes-Darcy model

The Stokes-Darcy model arises in many interesting real world applications, including groundwater flows in karst aquifers, interaction between surface and subsurface flows, industrial filtrations, oil reservoir in vuggy porous medium, and so on. This model describes the free flow of a liquid by the Stokes or Navier-Stokes equation and the confined flow in a porous media by the Darcy equation; the two flows are coupled through interface conditions. For the problems mentioned, the resulting coupled Stokes-Darcy model has higher fidelity than either the Darcy or Stokes systems on their own. However, coupling the two constituent models leads to a very complex system.

This presentation discusses multi-physics domain decomposition methods for solving the coupled Stokes-Darcy system. Robin boundary conditions based on the physical interface conditions are utilized to decouple the Stokes and Darcy parts of the system. A parallel iterative domain decomposition method is first constructed for the steady state Stokes-Darcy model with the Beavers-Joseph interface condition. Then two parallel non-iterative domain decomposition methods are proposed for the time-dependent Stokes-Darcy model with the Beavers-Joseph-Saffman interface condition. Numerical examples are presented to illustrate the features of these methods and verify the theoretical results.

- **Friday, Feb. 28**

A New Semiparametric Quantile Panel Data Model with Estimating the Growth Effect of FDI

Dr. Zongwu Cai [Department of Economics, University of Kansas]

In this paper, we propose a new semiparametric quantile panel data model with correlated random effects in which some of the coefficients are allowed to depend on some smooth economic variables while other coefficients remain constant. A three stage estimation procedure is proposed to estimate both constant and functional coefficients and their asymptotic properties are investigated. We show that the estimator of constant coefficients is root-N consistent and the estimator of varying coefficients converges in a nonparametric rate. A Monte Carlo simulation is conducted to examine the finite sample performance of the proposed estimators. Finally, the proposed semiparametric quantile panel data

model is applied to estimating the impact of foreign direct investment (FDI) on economic growth using the cross-country data from 1970 to 1999. This is a join work with Linna Chen and Ying Fang.

- **Friday, March 7**

Borrowing information across genes and experiments for improved error variance estimation in microarray data analysis

Dr. Tieming Ji [University of Missouri - Columbia]

Statistical inference for microarray experiments usually involves the estimation of error variance for each gene. Because the sample size available for each gene is
often low, the usual unbiased estimator of the error variance can be unreliable.
Shrinkage methods, including empirical Bayes approaches that borrow information across genes to produce more stable estimates, have been developed in recent years. Because the same microarray platform is often used for at least several experiments to study similar biological systems, there is an opportunity to improve variance estimation further by borrowing information not only across genes but also across experiments. We propose a lognormal model for error variances that involves random gene effects and random experiment effects. Based on the model, we develop an empirical Bayes estimator of the error variance for each combination of gene and experiment and call this estimator BAGE because information is Borrowed Across Genes and Experiments. A permutation strategy is used to make inference about the differential expression status of each gene. Simulation studies with data generated from different probability models and real microarray data show that our method outperforms existing approaches. A similar idea can also be adopted for analyzing RNA sequencing experiment data, which is an on-going research.

- **Friday, March 14**

A Numerical Method for Calculating Minimum Distance to Near Earth Objects

Dr Noah Rhee [UMKC Department of Mathematics & Statistics]

In the Calculus book written by Anton, Bivens and Davis there is a project called “Comet Collision.” They began their project as follows: “The Earth lives in a cosmic gallery of comets and asteroids. Although the probability that the Earth will be hit by a comet or asteroid in any given year is small, the consequences of such a collision are so catastrophic that the international community is now beginning to track near Earth objects.” In this talk we discuss the problem of calculating minimum distance between
the Earth and a coplanar comet or asteroid.

- **Friday, April 4**

Mathematical model of cell polarization

Dr Boris Rubinstein, Stowers Institute for Medical Research

Cell polarization is critical stage in cell cycle preceding the cell division and the understanding of its mechanism is important for the analysis of many morphological processes. We consider a minimalistic mass-conserved model in which the polarization emerges as the result of symmetry breaking of the nonpolarized state. We discuss the general approach to the description of the Turing instability and

apply its results to a specific model of polarization in budding yeast cells. The predictions of the model were tested against the experiment showing a qualitative correspondence to the observed behavior.

- **Friday, April 11**

Tilings of the Plane and Aperiodic Order

Dr. William Kalahurka [UMKC Department of Mathematics & Statistics]

Loosely speaking, planar tilings are said to exhibit aperiodic order if any given finite pattern of tiles is repeated with some regularity, but the tiling as a whole is not a translate of itself. Aperiodic order occurs naturally in quasicrystalline structures. The study of aperiodic order spans many areas of mathematics, including logic, topology, dynamical systems, and harmonic analysis. This talk is intended as a survey therein. We will define some properties that we want our tilings to have, show how to construct tilings with said properties, and explain how such tilings relate to some of the aforementioned areas of math, while sprinkling in a small dose of history and lots of pretty pictures.

- **Friday, April 18**

Modeling Malaria and Typhoid Fever Co-infection Dynamics: a case study in Kenya

Mr. Jones M. Mutua [UMKC Department of Mathematics & Statistics]

Malaria and typhoid are among the most endemic diseases, and thus, of major public health concerns in developing countries. In particular, individuals in the tropics are at a greater risk of contracting one or both of these diseases due to poor sanitation and health care. In addition to true co-infection of malaria and typhoid, false diagnosis due to similar signs and symptoms, and significant false positive in common testing methods, resulting in improper treatment and /or care, are the major challenges on managing these diseases. In this talk, I will present a novel mathematical model that describes the coinfection dynamics of malaria and typhoid. I will show mathematical analysis of our single-disease and co-infection models, formulating the basic reproduction numbers and establishing the stability conditions of equlibria. Furthermore, I will discuss illustrative numerical results using a case study in Eastern Province of Kenya. In Kenya, despite having higher prevalence of typhoid, malaria is more problematic in terms of new infections and disease deaths. We find that both false diagnosis and false positive – with a higher chance of false diagnosis for typhoid than malaria – cause significant devastating impact in Kenyan societies. Our results demonstrate that both diseases need to be simultaneously managed for successful control of co-epidemics.

- **Thursday, April 24**

TB Treatment Programs for Controlling HIV-TB Co-infections

Mr. Phuc V. Dang (Jason) [UMKC Department of Mathematics & Statistics]

IV and TB are two of the deadliest diseases that have been wreaking havoc to human race for a long time. More importantly, significant co-infections of these two diseases pose a huge challenge to their controls. Mathematical models can provide useful insights into the disease dynamics that help formulate better policies for mitigating disease burdens. In this talk, I will present an HIV-TB co-infection model that incorporates TB treatment programs. Using this model, I will explain the mathematical derivation to obtain an expression for the basic reproduction number, which provides a threshold for

the stability of the disease free equilibrium, and show how TB treatment programs affect this threshold. I will further discuss numerical simulation results to evaluate the effectiveness of TB-treatment programs on reducing HIV and TB co-infections.

- **Friday, April 25**

Dr. Jiongmin Yong [Department of Mathematics, University of Central Florida]

Stochastic Optimal Control --- An Introduction and Some Recent Results

Stochastic optimal control is to study optimization problems governed by some controlled stochastic dynamic systems, with certain performance functional. There are many interesting applications motivate this subject, mathematical finance, population dynamics, various engineering systems, to mention a few. Besides the existence of optimal solutions to the problems, people are interested in some necessary conditions and/or some characterizations of optimal solutions. There are two major approaches, called Pontryagin type maximum principle (variational approach) and Bellman's principle of optimality (dynamic programming approach). In this talk, we will briefly survey some of the relevant topics. Also, we will briefly highlight some recent results relevant to the time-inconsistent problems.

- **Friday, September 5, 2014**

Dr. Vincent Staggs, Research Assistant Professor, Department of Biostatistics, The University of Kansas Medical Center

Small-Sample Inference in the Linear Mixed Model: Comparison of Analytic and Parametric Bootstrap Approaches

ABSTRACT

In mixed models, the mean squared error (MSE) of empirical best linear unbiased estimators cannot be written in closed form in general. Unlike traditional methods of inference, which can perform poorly for small samples, parametric bootstrap intervals do not require approximation of the MSE or of the sampling distribution of the test statistic. Two simulation studies were conducted to compare confidence interval coverage rates for three parametric bootstrap intervals: Efron's percentile, Hall's percentile, and the bootstrap-t, to two analytic intervals based on the naïve MSE approximation or the method of Kenward and Roger. Results and minimum sample size recommendations will be discussed.

- **Friday, September 19, 2014**

Dr. Jo Wick
Assistant Professor, Department of Biostatistics
The University of Kansas Medical Center

Evaluation of Online Graduate Statistics Education using Bayesian Statistics and Meta-Analysis

ABSTRACT

Distance learning can be useful for bridging geographical barriers to education in rural settings. However, empirical evidence on the equivalence of distance education and traditional face-to-face (F2F) instruction in statistics and biostatistics is mixed and its interpretation is not clear due to a lack of randomized, controlled studies. Despite the difficulty in randomization, we minimized the intra-instructor variation between F2F and online sections in seven graduate-level biostatistics service courses in a synchronous (live,real time) fashion; that is, for each course taught in a traditional F2F setting, a separate set of students were taught simultaneously via online learning technology, allowing for two-way interaction between instructor and all students enrolled in the course. Our primary objective was to compare student performance between the two teaching modes among the seven courses. We present a novel comparison using a Bayesian hierarchical model to perform a meta-analysis of equivalence test. The frequentist mixed model approach was also conducted for reference. The results of Bayesian and frequentist methods agree and suggest equivalence in student performance. Finally, discussion is given to barriers to instruction and learning using the applied online teaching technology.

Key words: educational statistics, Bayesian hierarchical modeling, distance learning

- **Friday, September 26, 2014**

Dr. Jason Frank
Professor, Mathematical Institute
Utrecht University, Utrecht, the Netherlands

Thermostating Stationary and Nonstationary Measures

ABSTRACT

Thermostats are employed in computational statistical mechanics to ergodically perturb the trajectories of a dynamical systems such that they sample a target invariant density. For example, in molecular dynamics they are used to model a many-particle system at constant temperature. I will describe a recently developed stochastic thermostat that can be applied to general nonautonomous differential equations and general smooth invariant measures. Additionally, I will discuss how the method can be applied when the target measure is nonstationary to "hit a moving target" in the case of data assimilation.

Key words: Thermostats, dynamical systems, stochastic processes

- **Friday, October 3, 2014**

Dr. Yaozhong Hu
Professor, Department of Mathematics
University of Kansas

Parameter Estimation for Long Memory Ornstein-Uhlenbeck Process

ABSTRACT
Consider an Ornstein-Uhlenbeck process, $dX_t = -\theta t\, dt + \sigma t\, dB^H_t$, driven by fractional Brownian motion B^H with known Hurst parameter $H \geq 0.5$ and known variance ψ. Assume the parameter θ is unknown. Assume that the process is observed at discrete time increments $t=h, 2h, \ldots, nh$. We construct an estimator θ' of θ that is strongly consistent. Namely, θ'_n converges almost surely to θ

as n gets large. We also obtain a Central Limit-type theorem and a Berry-Esseen type theorem for this estimator when $0.5 \leq H \leq 0.75$. The tool we use is a recent result on Central Limit Theorems for multiple Wiener integrals through Malliavin calculus. It should be pointed out that no condition on the step size h is required, contrary to the existing conventional assumptions. This is joint work with David Nualart, Fei Lu, and Jian Song.

Key words: stochastic calculus, Ornstein-Uhlenbeck process, Brownian Motion, Central Limit Theorems

- **Friday, October 10, 2014**

Dr. Hongguo Xu
Professor, Department of Mathematics
University of Kansas

Solutions of a Classical Poisson-Nernst-Planck Model for Ionic Flow

ABSTRACT
Ion channels are small holes embedded in cell membranes. They open and close to control a flow of ions. In this way, cells function properly. The Poisson-Nernst-Planck (PNP) model is a mathematical model commonly used for studying ionic flow. In this talk, a classical PNP model is considered. We show that the system has a unique solution. The proof is constructive. With singular perturbation analysis, the problem is reduced to an inverse problem of a first order linear system with boundary conditions. Then, with the help of matrix theory, it is further reduced to a root problem of a meromorphic function, which is solved by a Cauchy Argument Principle. We show how matrix eigenvalue theory is used to solve the problem. This is joint work with Weishi Liu.

Key words: Ion channels, Poisson-Nernst-Planck model, Cauchy Argument Principle

- **Friday, November 7, 2014**

Dr. Atanas Stefanov
Professor, Department of Mathematics
The University of Kansas

Spectral Stability of Solitary Waves in Second-Order Partial Differential Equations: Theory and Case Studies

ABSTRACT
I will give an easy description of a recently developed abstract theory to treat the linear stability of special solutions of second-order in-time evolutionary partial differential equations, which treats examples beyond the reach of the standard Grillakis-Shatah-Strauss stability theory. The goal is to characterize completely the ranges of the wave speeds that give rise to stable waves. To that end, I will present straightforward computations that apply the theoretical results to the stability/instability of ground states (and some excited states) of the Klein-Gordon Equation as well as ground states of the Klein-Gordon-Zakharov system. This is based on a series of recent works with Stanislavova and Stanislavova and Hakkaev.

Key words: Partial Differential Equations, stability theory, wave speeds, stable waves

- **Friday, November 14, 2014**

Dr. Hongyuan Cao
Assistant Professor, Department of Statistics
University of Missouri

Analysis of the Proportional Hazards Model with Sparse Longitudinal Covariates

ABSTRACT

Regression analysis of censored failure observations via the proportional hazards model permits time-varying covariates that are observed at death times. In practice, such longitudinal covariates are typically sparse and only measured at infrequent and irregularly-spaced follow-up times. Full likelihood analyses of joint models for longitudinal and survival data impose stringent modeling assumptions that are difficult to verify in practice and are complicated both

inferentially and computationally. In this talk, a simple kernel-weighted score function is proposed with minimal assumptions.
Two scenarios are considered: half-kernel estimation, in which observation ceases at the time of the event, and full-kernel estimation for data where observation may continue after the event, as with recurrent-events data. It is established that these estimators are consistent and asymptotically normal. However, they converge at rates that are slower than the parametric rates that may be achieved with fully-observed covariates, with the full-kernel method achieving an optimal convergence rate that is superior to that of the half-kernel method. Simulation results demonstrate that the large sample approximations are adequate for practical use and may yield improved performance relative to the last value carried forward approach and the joint modeling method. The analysis of the data from a cardiac arrest study demonstrates the utility of the proposed methods.

Key words: Kernel-weighted regression, longitudinal studies, survival analysis

- **Friday, November 21, 2014**

Dr. Erik Van Vleck
Professor, Department of Mathematics
The University of Kansas

Orthogonal Integration and Some Applications

ABSTRACT

In this talk we consider matrix differential equations with solutions that are orthogonal (or in the complex case unitary) matrix functions. Numerical methods that preserve the orthogonal nature of the solution are discussed and some applications presented in which matrix differential equations with orthogonal solutions have proven useful. Among these are the approximation of stability spectra such as Lyapunov exponents and Sacker-Sell spectrum, decoupling transformations for dimension reduction of differential equations, data assimilation techniques where assimilation is focused on the unstable subspace, and time dependent stability theory for numerical time stepping techniques.

Key words: Orthogonal Integration, Lyapunov Exponents, Dimension Reduction