EDGE@ISU presents:

Mathematics and Statistics Opportunities for Undergraduates

November 12, 2011
101 Carver Hall
Iowa State University

Welcome
101 Carver Hall, 10:00am

Dr. Leslie Hogben, Professor, Dept. of Mathematics
Dr. Karin Dorman, Professor, Dept. of Statistics
Jolie Roat, Graduate Student, Dept. of Mathematics

Research Talks
Graduate Student Presentations
101 Carver Hall, 10:10am

Threshold Modeling in the Presence of Measurement Error: Application to Serum Vitamin D
    Maria Joseph

Classification of Potentially Eventually Exponentially Positive Sign Patterns of Small Order
    Marie Archer

Using the package ltm in R for Item Response Theory
    Dai-Trang Le

Preparing for Graduate School
Panel Discussion
101 Carver Hall, 11:30am

Panelists:
    Dr. Wolfgang Kliemann, Professor and Chair, Dept. of Mathematics
    Lauren Herrmann, Graduate Student, Dept. of Mathematics
    Katrina Williams, Graduate Student, Dept. of Statistics
    Jackie Chalmers, Graduate Student, Dept. of Mathematics
    Michelle Lastrina, Graduate Student, Dept. of Mathematics

Mentoring: The Bottomline
Lunch and Mentoring Activity
Carver Hall Lobby, 12:15pm

Mentoring is an important part of advancement in your career and development. Although many students know what a mentor is, they may find it difficult to find a mentor in the field of mathematics or statistics specifically. We will discuss what a mentor is for the individual and some of the different aspects of the mentor-mentee relationship. Undergraduate students will also be introduced to graduate students and faculty members who are possible mentors here at Iowa State. The Bottomline: Mentoring is GREAT!

REUs and Other Undergraduate Research Opportunities
Panel Discussion
101 Carver Hall, 1:45pm

Panelists:
>Katy Nowak, Graduate Student, Dept. of Mathematics
>Marie Archer, Graduate Student, Dept. of Mathematics
>Kim Ayers, Graduate Student, Dept. of Mathematics
>Crystal Peoples, Undergraduate Student, Longwood University
>Sijing Shao, Undergraduate Student, Iowa State University

Research Talks
Undergraduate Student Presentations
101 Carver Hall, 2:40pm

Matrices of Continuous Functions
>Crystal Peoples

Deep-Water Horizon Oil Spill - My First JSM
>Lendie Follett

Invariant Measures for Hybrid Stochastic Systems
>Sijing Shao

Applying to Graduate School/Life in Graduate School
Panel Discussion
101 Carver Hall, 4:00pm

Panelists:
>Dr. Clifford Bergman, Professor and Graduate Director, Dept. of Mathematics
>Dr. Alicia Carriquiry, Professor and Graduate Director, Dept. of Statistics
>Julia Anderson-Lee, Graduate Student, Dept. of Mathematics
>Nicole Kingsley, Graduate Student, Dept. of Mathematics
>Nathan Warnberg, Graduate Student, Dept. of Mathematics
>Devin Bickner, Graduate Student, Dept. of Mathematics

Thank you for attending!

Biographies

Marie Archer received a B.S. degree in Mathematics and a B.A. in Linguistics (focused on Romance Languages) from Columbia College in Columbia, South Carolina. The research she is presenting is a portion of the results from an REU in which she participated at ISU in 2010. Dr. Leslie Hogben was Marie's group's mentor, and they explored the properties of sign patterns, particularly interested in the potential eventual exponential positivity of sign patterns and their corresponding matrices. She is currently a PhD student in Mathematics at Iowa State University, and her current research interests lie in universal, abstract, and linear algebra.

Lendie Follett was born in Columbia, South Carolina on June 17, 1991. When she was seven, she and her family moved to Webster City, Iowa, where she continued school. She attended Webster City High School and graduated in May of 2009. She was then accepted into Iowa State University in the program of Landscape Architecture. She then switched her major several times and ended up majoring in statistics for good. She now plans to graduate in May of 2012.

Maria L. Joseph completed her Bachelor of Arts in mathematics at Kentucky State University. She has earned a Master of Science in Statistics from Iowa State University. Currently, she is a doctoral student in the Department of Statistics at Iowa State University.

Dai-Trang Le is a Ph.D student majoring is statistics and co-majoring in Curriculum and Instructional Technology. Her current areas of interests include Statistics Education, Distance Learning, Data Technologies and Reproducible Research. She graduated from the University of Utah with a B.S. in Math and an M.S. in Math Education as well as obtained an M.S. in Statistics from ISU in the Fall of 2010. Dai-Trang has taught Math and Statistics at various levels including high school, community college, technical college and Iowa State University.

Crystal Peoples is a senior at Longwood University in Farmville, Virginia. She is majoring in math and minoring in sociology. She has attended numerous mathematics programs including: the Carleton College Summer Mathematics Program for Women, the Budapest Semesters in Mathematics, the Iowa State REU 2011, and the Penn State Mathematics Advanced Study Semesters Program. It was at Iowa State that she researched matrices of continuous functions with Justin Cyr, Nathan Meyers, Jason Ekstrand, and Dr. Justin Peters.

Sijing Shao is a senior at Iowa State University double majoring in Statistics and Mathematics. Her research interests include but are not limited to Dynamical System, Time Series and Visualization using R packages.

Research Talk Abstracts
Graduate Student Presentations

Threshold Modeling in the Presence of Measurement Error: Application to Serum Vitamin D

Maria Joseph with Alicia Carriquiry, Wayne A. Fuller, Christopher T. Sempos

Vitamin D is essential to ensure bone hardness and strength. Consequently, insufficient levels of vitamin D can lead to fractures and osteoporosis. Those exhibiting vitamin D deficiency have been characterized by low levels of serum vitamin D (25(OH)D) and elevated levels of serum intact parathyroid hormone (iPTH). A function that has been suggested for the relationship between usual iPTH and usual 25(OH)D, where usual represents the long run average of the daily measurements of these quantities, is the segmented regression function. Simulation is used to assess the effects of measurement error on the estimates of the parameters of this function. An estimation procedure based on likelihood methodology is proposed and yields encouraging results in a simulation study.

Classification of Potentially Eventually Exponentially Positive Sign Patterns of Small Order

Marie Archer, with Rana Haber, Xavier Martinez-Rivera and Antonio Ochoa

A real square matrix A is *eventually positive* if there exists a positive integer k_0 such that for all $k \geq k_0$, $A^k > 0$, where the inequality is entrywise. A matrix A is *eventually exponentially positive* if there exists a positive real number t_0 such that for all $t \geq t_0$,

$$c^{tA} = \sum_{k=0}^{\infty} \frac{t^k A^k}{k!} > 0.$$

Eventually positive matrices have applications to positive control theory. *A sign pattern matrix* (or *sign pattern*) is a matrix having entries in $\{+, -, 0\}$. If A is a sign pattern, the *qualitative class* of A, Q(A), is the set of all matrices A whose entries have signs equal to the entries in A. Qualitative matrix problems were first considered in 1947 by Samuelson in the mathematical modeling of problems from economics. Sign pattern matrices have useful applications in economics, population biology, chemistry and sociology. A sign pattern A is *potentially eventually positive* (PEP) if there exists a matrix $A \in$ Q(A) such that A is eventually positive. A sign pattern A is *potentially eventually exponentially positive* (PEEP) if there exists a matrix $A \in$ Q(A) such that A is eventually exponentially positive. Results regarding the relationship between PEP and PEEP sign patterns are discussed, new families of PEP sign patterns are introduced and a classification of all 2×2 and 3×3 PEEP sign patterns is given.

Using the package ltm in R for Item Response Theory

Dai-Trang Le

This past summer, while searching for a way to measure the attitude of the respondents to a survey questionnaire, I stumbled upon a fascinating statistical method called Item Response Theory. Item Response Theory (IRT) is a statistical method that analyzes discrete response data in order to assess the quality of a test or survey and to evaluate the cognitive processes such as ability, proficiency or attitude of the respondents. These cognitive processes are called latent traits in the sense that they are not directly observable and must be measured indirectly. In this talk, I will explain how to conduct an IRT analysis using the package ltm in R. I will emphasize graphical methods in ltm to visualize IRT output. I will also present an overview of IRT and its application in assessing the attitude of respondents in a national school board survey.

Research Talk Abstracts
Undergraduate Presentations

Matrices of Continuous Functions

Crystal Peoples

We take basic concepts from linear algebra and Banach algebras, such as notions of eigenvalues, eigenvectors, diagonalization, the spectrum and algebraic elements, and find their analogues in matrices of continuous functions. Specifically, we explore the relationship of the spectrum of these elements and show eigenvectors do not always exist for elements in the spectrum. We also provide a characterization of algebraic elements and give a construction for the diagonalization of certain Hermitian elements in the 2x2 case.

Deep-Water Horizon Oil Spill - My First JSM

Lendie Follett

Every other year at the Joint Statistical Meetings, the Graphics Section and the Computing Section join in sponsoring a special Poster Session called the Data Exposition, or the Data Expo. The Data Expo this year was concerned with data on the BP Deep-Water Horizon Oil Spill in the Gulf of Mexico, April - Sept 2010. This spill had not only a huge impact on the environment but also generally on life along the coastal regions of Louisiana and the areas close to the oil rig. I'll talk about my general findings and show a little bit of my work and I'll also speak about my overall experience at the Joint Statistical meetings in Miami Beach, Florida.

Invariant Measures for Hybrid Stochastic Systems

Sijing Shao, with Xavier Garcia, Jennifer Kunze, Thomas Rudelius, Anthony Sanchez and Emily Speranza

Dynamical Systems give one the ability to analyze the way systems evolve through time. Usually these are differential equations that model real world phenomena. Unfortunately, these models are limited in that they cannot account for random events that may occur. However, these random developments may sometimes be modeled with Markov chains and processes. We can unite the two models in order to see how these dynamical systems behave with the perturbation induced by the Markov processes, but in doing so create a hybrid system where we now must simultaneously study the dynamical system and Markov process. Complicating matters, these hybrid systems can be described in either continuous or discrete time. The focus of this presentation is studying the way these hybrid systems behave as they evolve. We begin by defining limit sets for a dynamical system and stochastic processes. We next examine the limit sets of these hybrid systems and what happens as they approach the limit sets. Concurrently, we define invariant measures and prove their existence for hybrid systems while correlating these measures to the flow. In addition, we supply concrete examples with visuals that provide insight to the behavior of hybrid systems.