ABSTRACTS FOR THE KME 41st BIENNIAL CONVENTION

Friday, April 7, 2017

9:30 a.m. **"Modeling the Wind Resource of Southwest Kansas"**

Parker LaMascus, Oklahoma Epsilon, Oklahoma Christian University

Abstract:

Kansas farmers depend on water from the Ogallala Aquifer to water their crops; however, this water is a limited resource and will be depleted without intervention. State legislators proposed a policy solution called wind-for-water trade: farmers would be able to sell wind energy generated on their land to offset the costs of reduced irrigation. Recognizing that the efficacy of this wind-for-water trade would be limited in part by the quantity of wind energy produced, our team investigated the feasibility of such a program.

Our feasibility study consisted of analysis of National Weather Service data and the latest theory of wind energy estimation. We obtained hourly wind data for five years and three sites in Southwest Kansas. We compiled those data into histograms, then multiplied each bin of the histogram by its respective power output for wind turbine (WT) power curves, which we summed to yield Annual Energy Production (AEP). We completed this process for each site, each year, and for six different turbine outputs. Our team compared those AEPs to draw conclusions about the kinds of WTs that were economical for wind-for-water trade in Southwest Kansas. We concluded that Southwest Kansas and geographical locations like it are ideal places for the institution of wind-for-water trade. We further concluded that larger, commercial-size wind turbines were more cost-effective long term, despite their greater upfront cost, so we make recommendations for which types of turbines to use in wind-for-water trade. The optimal type of wind turbines in this scenario holds some implications for the legal measures surrounding independent power generation, so we suggest potential improvements to the legal status quo. Finally, our report notes several ways to further confirm the feasibility of wind-for-water trade that were outside the scope of our project.

9:50 a.m. **"Concerning the Growth of Animal Populations in Minecraft"**

Joshua Stucky, Tennessee Gamma, Union University

Abstract:

Many will be familiar with the popular video game, Minecraft. When playing in survival mode, it is paramount that players establish a sustainable food supply for themselves. This is often done via breeding a population of animals such as pigs or cows. To breed these animals, a pair is selected and fed a specific breeding food, producing exactly one offspring. Left alone, these animals will not die naturally. Our goal is to examine the growth of these animal populations. The calculation of the nth

breeding cycle population is recursive in nature. We first derive an intuitive asymptotic relation for the nth population, then use this relation to prove an exact, closed form expression for the nth population. A generalization of this result is given for populations differing in the required number of parents and number of offspring produced in each breeding cycle.

10:10 a.m. **"Algebraic Structure of Labeled Graphs Joined by j Edges"**

Shahriyar Roshan Zamir, Georgia Zeta, Georgia Gwinnett College

Abstract:

Joining any two labeled graphs with *j* undirected edges can be viewed as a binary operation on the set of labeled graphs. We also define the following relation: two labeled graphs, G_1 and G_2, are *j*-related if and only if for any labeled graph *H*, the determinant of the adjacency matrix G_1 *j*-operated with *H* is the same as G_2 *j*-operated with *H*. The paper, *The Determinant of Graphs Joined by j Edges*, [Gyurov, Pinzon] gives the determinant of the adjacency matrix of *G j*-operated with *H* as a sum of the determinants of the adjacency matrices of variations of *G* and *H*, for any two labeled graphs *G* and *H*. This expression allows us to explore the *j*-relation equivalence classes for the *j*-operations and their algebraic-structure.

10:45 a.m. **"Global Stability Analysis of Zika Virus Dynamics"**

Hayley Hutson, Missouri Alpha, Missouri State University

Abstract:

The very few mathematical models available in the literature to describe the dynamics of Zika virus are still in their initial stage of development, and they were in part developed as a response to the most recent outbreak that started in Brazil in 2015, which has also confirmed its association with Guillain-Barre Syndrome and microcephaly. The interaction between and the effects of vector and human transmission are a central part of these models. This work aims at extending and generalizing current research on mathematical models of Zika virus dynamics by providing rigorous local and global stability analyses of the models. In particular, for disease-free equilibria, appropriate Lyapunov functions are constructed using a compartmental approach and a matrix-theoretic method, whereas for endemic equilibria, a relatively recent graph-theoretic method is used. Numerical evidence of the existence of a transcritical bifurcation and some other simulations using Matlab are presented.

11:05 a.m. **"A Curriculum Guide: Exploring Careers in STEM"**

Ashley Beard, Missouri Beta, University of Central Missouri

Abstract:

From anecdotal evidence, we have seen that high school students have limited knowledge or incorrect perceptions about careers that are available in science, technology, engineering and math (STEM) fields. Many of their teachers also have limited knowledge about such careers and are interested in resources that they can use in their classroom to increase their students' interest in STEM fields. This honors project consists of curriculum that teachers around the globe can use to help students explore four major career paths in STEM fields. My curriculum guide will provide educators with resources, activities, lessons, and videos that they can share with their students. Educators will be able to implement this curriculum in the best way for their classroom and students. They can decide how in depth they would like to take this curriculum depending on their time limit. I have suggested different ways to implement this curriculum into the classroom, such as bellwork, few day unit, or mini real world lesson. School districts and educators can decide how to best incorporate this into the classroom. The flexibility of this curriculum will allow more students to explore careers in STEM.

11:25 a.m. **"Coloring $\mathbb{R}^n$"**

Zach Bowen, Landis Duff, Jacob Rowley, Kansas Alpha, Pittsburg State University

Abstract:

Consider the following situation: we are given three colors to assign to every point of three dimensional Euclidean space, $\mathbb{R}^3$. If we assign these colors arbitrarily, will one color attain every distance? More precisely, can we find one color such that, given any positive real distance, there exist points of this color separated by that distance? We answer this question in the affirmative and also show that it generalizes to higher dimensions. Specifically, we show that if we color every point of $\mathbb{R}^n$ with n colors, then there exists one color that attains every distance. To do this, we use induction, the initial cases being that of $\mathbb{R}^2$ and $\mathbb{R}^3$. In the inductive step, we present an algebraic proof that the non-empty intersection of two non-equal $(n-1)$-spheres in $\mathbb{R}^n$ is either an $(n-2)$-sphere or a single point.

Further, we ask the question: what is the minimum number of colors we need to exhibit a coloring of $\mathbb{R}^n$ in which for every color, there exists an unattainable distance. We exhibit such a 2-coloring of $\mathbb{R}^n$, thus showing the minimum is 2 colors when $n = 1$. In addition, we exhibit colorings of $\mathbb{R}^2$ and $\mathbb{R}^3$ that provide tentative upper bounds for the minimum number of colors. Problems like this fall in the category of Euclidean Ramsey Theory.

11:45 a.m. **"Detecting Point Radiation Sources Using Distributed Sensors"**

Chelsea Mitchell, Virginia Alpha, Virginia State University

Abstract:

The problem of detecting a radioactive source is considered, in which a network of emission count sensors is used to make a detection of radioactive material. Previous works were studied to determine the methods used to detect a point radiation source with minimal detection delay after the source has been introduced. One method discussed was detecting point radiation sources using decentralized detection architecture, which multiple sensor nodes collect radiation counts at their site, makes the detection decision and sends the response to the fusion center. We focused on studying two specific problems when a centralized detection architecture is considered in which multiple sensor nodes send radiation counts to a fusion center, which makes a detection decision. These radiation counts are assumed to follow a Poisson distribution, which shifts at a time γ once a radiation source has been introduced. The study is broken down into the analysis of two random processes: the first random process being the measure of background or base-level radiation, and the second random process being the measure of an introduced radioactive source. The problem then becomes to detect whether or not this second random process occurs, and if so, where it occurs, which is our definition of γ. Numerous methods are compared to determine the method that best minimizes the false-positive rate and detection error.

Workshops:

2:30/3:45 p.m. **"Calculus Limits via Infinitesimals (they're easier!)"**

Bryan Dawson, Tennessee Gamma, Union University

Abstract:

Hyperreal numbers (including infinitesimals) will be introduced informally, followed by the infinitesimal definition of limit. Examples of limits will then be computed. The presentation will be interactive, and after one example students will be calculating limits. The material presented in this workshop will be part of a paper that will be submitted soon to an MAA journal.

2:30/3:45 p.m. **"Bell-y Math: Connections between Mathematics and Change Ringing"**

Cynthia Huffman, Kansas Alpha, Pittsburg State University

Abstract:

We will take a hands-on look at some of the mathematics behind change ringing of church tower bells. Change ringers seemed to be familiar with elementary group properties and cosets before mathematicians were. The workshop will begin with a presentation on ringing cosets on handbells that includes audience participation. Permutations, groups, and cosets are some of the mathematical concepts which will be investigated. Exposure to abstract algebra will not be assumed. Students will then be divided into groups of 4 or 5 to devise their own change ringing composition, practice it, and then perform it for the other groups. For the second part of the workshop, we will look at some connections between graph theory (Hamiltonian circuits) and change ringing. Well-known change ringing compositions will be analyzed and demonstrated by the workshop participants.

2:30/3:45 p.m. **"Shapes and Smiles"**

John C.D. Diamantopoulos, Oklahoma Alpha, Northeastern State University

Abstract:

We will begin the workshop by playing a couple of very funny clips (from tv or movies) in which mathematics is referenced. We will then pass out the necessary 12 squares of multi-colored paper for all students/attendees and we will go through step-by-step instructions for the first 2 or 3 squares showing students precisely how we need to fold all 12. We will then assemble them into 4 shapes using 3 of these shapes apiece. We'll take a break and play one last funny math video and then finish the workshop showing how these 4 shapes go together to make a very cool shape, a stelated octahedron!

2:30/3:45 p.m. **"Using R for Simulation Studies"**

Angela Crumer, Jason Shaw, Kansas Delta, Washburn University

Abstract:

Data simulation is an emerging and effective way to investigate mathematical and statistical models. As part of a two part sequence, we provide an introduction to R coding, simulating data, and model fitting. In part 1 of this workshop, students will be introduced to basic R coding and given the opportunity to produce their own code in R. We will also discuss the importance of data simulation and help the students simulate their own normal and binomial datasets. This portion will be offered at 2:30.

Part 2 of this workshop will discuss common analytic techniques such as aggregation, truncation, and transformation. We will also introduce basic linear regression and model fitting for normally distributed data. Students will work in groups to perform some common analytic techniques and linear model fitting procedures to the data simulated in part one. Finally, student results will be discussed as a group and results will be compared. This portion will be offered at 3:45. While both parts go hand-in-hand, students are able to participate in either part alone and still gain valuable coding, simulating, and modeling knowledge.

Keynote Address **"A Mathematical Art Gallery Tour"**

Eve Torrence, Randolph-Macon College, Ashland, Virginia

Abstract:

Over the past several decades there has been a revolution in using the arts to express, display and explain mathematical concepts. The international Bridges Organization organizes annual conferences that celebrate the connections between mathematics, art, music, architecture, education and culture. There are wonderful exhibits of mathematical art at these conferences and at the Joint Mathematics Meetings every year. We will take a tour of some of my favorite pieces from these shows and see the incredibly creative ways mathematicians and artists are making mathematics visible.

Saturday, April 8, 2017

8:30 a.m. **"Application of SVD: Information Retrieval and Document Ranking"**

Blake Jackson, Chris Mount, Alabama Theta, Jacksonville State University

Abstract:

Information retrieval is the process of searching for information within a collection of documents most relevant to a user's query. Information retrieval algorithms are being used in many public libraries including university libraries to provide their patrons with access to books and documents. Web search engines are the most prevalent information retrieval applications. A certain form of vector space method was introduced and developed by analyzing the so called term-by-document matrix as early as 1960. In 1990, an improved information retrieval system, Latent Semantic Indexing, replaced the vector space model. It uses singular value decomposition (SVD) of the term-by-document matrix, and creates a low rank approximation from the SVD. This study will review and investigate the theoretical and computational aspects of information retrieval and document ranking.

8:50 a.m. **"Housing Market Time Series Analysis – Before and After Housing Bubble"**

Katelynn Robinson, Kansas Delta, Washburn University

Abstract:

Many real estate developers were in for a shock in 2007 when the housing market crashed faster than they could wrap up current projects and stop building new homes. House sales have a cyclical pattern that may allow a time series analysis of housing data to predict the peak and fall of the crash.

Both regional and national housing sales data was obtained from US Census Bureau. Data prior to the 2007 housing market crash was analyzed using several different time series methods including multiplicative decomposition and Box-Jenkins models.

Alternate approaches were tested to find the best model for predicting monthly house sales across the U.S., and to determine the timing of the housing market crash. Next, the full data set was analyzed to see which of these models handle the sudden shock of the crash and the subsequent slow recovery. Finally, these models were used to make predictions regarding where the housing market is going in the near future.

9:10 a.m. **"Elliptical Illusion"**

Catherine Ross, Missouri Theta, Evangel University

Abstract:

In Calculus dealing with quadratic surfaces, there exist special cases of the ellipsoid whose formula is $x^2/a^2 + y^2/b^2 + z^2/c^2 = 1$. Specifically, the sphere, where $a = b = c$. Through analysis of a tilted ellipsoid, where $a \neq b \neq c$ and is centered at the origin, we show that the ellipsoid gives the illusion of a sphere when viewed from a certain perspective.

For preliminaries, we use Linear Algebra and Calculus to derive a formula used to show that there exists a tilt-angle along the *z*-axis that results in the trace of a circle on the *xy*-plane. We conjecture from our result that there exists an angle that results in a circular projection of the ellipsoid onto the *xy*-plane. We prove our conjecture to be true using Descriptive Geometry. We illustrate our discoveries using visuals to demonstrate that the ellipsoid can be tilted at such an angle that it indeed appears to be a sphere from a certain perspective.