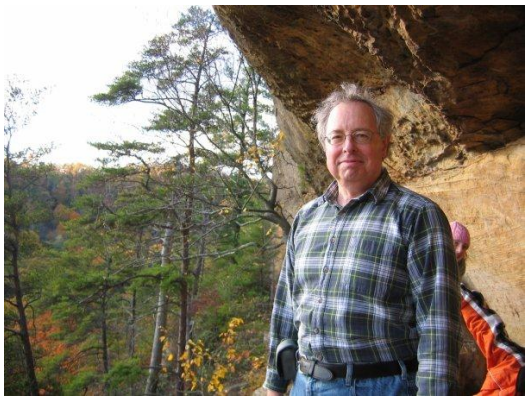
Invited Talks: Abstracts and Biographical Information

Paul Zorn, "Extreme Calculus"

Paul Zorn is a professor of mathematics at Saint Olaf College and, until recently, President of the Mathematical Association of America (MAA). Born and raised in India, Zorn moved to the U.S. to attend Washington University in Saint Louis, focusing on mathematics and English. He did his PhD, in several complex variables, at the University of Washington, Seattle, under the direction of Edgar Lee Stout. In 1981 he joined the faculty of St. Olaf, where he chaired the Department of Mathematics, Statistics, and Computer Science. He has also taught at Purdue University.

His professional interests include complex analysis, mathematical exposition, textbook writing, and the role of mathematics among the liberal arts. He is also interested in using computer graphics and computer algebra systems to help students learn, explore, and "own" mathematical ideas. Zorn has served on many MAA committees and programs over the years. From 1996 to 2000, he was Editor of MAA's expository journal Mathematics Magazine. His latest textbook, Understanding Real Analysis, was published by AK Peters in 2010.

Abstract: There is more to elementary calculus than may first meet the eye, especially to those of us who teach it again and again. With appropriate help from graphical, numerical, and algebraic computing, well-worn calculus techniques and topics---polynomials, optimization, root-finding, methods of integration, and more---often point to deeper, more general, more interesting, and sometimes surprising mathematical ideas and techniques. I'll illustrate my thesis with figures, examples, and a lot of e-calculation, aiming to take elementary calculus to its interesting extremes.



Carl Lee, "Game, Set, and Match"

I grew up in an extended family of academics. One of my earliest memories of the love of mathematics was in second grade when my mother taught me how to multiply with a slide rule. As I grew older I devoured some of my father's recreational math books, encountering flexagons, polyhedra, stitching of conic sections, and many more lifelong friends. Gardner, Steinhaus, Ball and Coxeter, and Cundy and Rollett were my silent mentors who complemented my wonderful public school teachers. I couldn't find the polyhedra in college (Yale), but learned where they were lurking in graduate school (Cornell), and now I surround myself (sometimes physically) with higher dimensional ones. I was welcomed by the University of Kentucky, Department of Mathematics in 1980, where I have found a supportive environment for my interests in discovering, teaching, learning, and playing with mathematics.

Abstract: Reflecting upon my own mathematical journey, I realize that (even starting in elementary school) I was strongly influenced, motivated, excited, intrigued, and delighted by mathematics outside of the standard school curriculum. Much of my exposure was through recreational mathematics, which included mathematical games. As a result, when I was in junior high school and high school I already had a much broader sense of mathematical landscape. Therefore, in this talk, I will offer a collection of games. Each one, in its own way, offers connections to interesting, and often "serious" mathematical content and practice. I hope this will promote some additional discussion on the extent to which these games can support K-12 or K-16 curricula.

Ron Gould, “Math and Marriage - Don't Call a Lawyer Yet”

Ronald J. Gould received his Ph.D. from Western Michigan University in 1979. He is currently Goodrich C. White Professor of Mathematics and Computer Science at Emory University, where he has been for over 30 years. His research interests focus on extremal and structural graph theory, but also include combinatorics in general. He has published over 150 research papers and written two books, Graph Theory (recently re-released by Dover) and Mathematics in Games, Sports and Gambling. He has directed 23 Ph.D. students and 25 MS students. He has won several teaching awards including the Distinguished Teaching Award from the Southeastern Section of the MAA.

Abstract: Beginning with Philip Hall's famed “Marriage" Theorem in 1935, the study of marriages (or matchings) has seen significant development, both theoretical and algorithmic. Taking a graph theoretic point of view, we will consider a number of “marriage" questions including: When can a set of k marriages be found? When we can find a set of k marriages, are there ways to optimize the pairings? Here we consider the famed stable marriage theorem. What ways are there to generalize the idea of marriage? The roommate problem and multi-matchings will be considered. What can we say about these generalizations? Is there an optimum form of marriage?

Abstracts of Contributed Talks

(u)=undergraduates, (g)= graduate, (f)= faculty member

Mary Bennett (u), Laura Hochstetler (u), Andrew Sweigard (u), Asbury University
Network Modeling of Wildfire Suppression in Earth's Forests
The interaction of wildfire suppression with multiple forest health factors is effectively characterized using a discrete network model. We present a model that accurately reflects the effects on forest health caused by wildfire suppression strategies over the past decades. Furthermore, the model suggests for current and future policy-makers a practical approach to resetting unhealthy high-density forests to a healthy wildfire cycle.

Jeremy Bivins (u), Kentucky Wesleyan College
Newton's Early Work
Sir Isaac Newton made major contributions to mathematics and science in his lifetime. Arguably, the most important of these contributions was calculus. Newton's progress towards the development of calculus took place around 1666. The aim of the project is to study the life of Isaac Newton and to present Newton's development of differential calculus by looking at his development of the binomial theorem. This presentation will include a short biography of Newton's life, an outline of Newton's development of the binomial theorem and its effect on the derivative, and an assessment of the mathematical climate at the time that produced such arguments and ideas.

Katey Bjurstrom (g), University of Louisville
Acyclic and Indifference-Transitive Collective Choice Functions
Arrow's classic theorem shows that any collective choice function f satisfying independence of irrelevant alternatives (IIA) and Pareto (P), where the range is a subset of weak orders, is based on a dictator. Recent work in social choice theory has shown that if the range is changed to the set of acyclic, indifference-transitive relations on the set of alternatives, X, then the outcome is instead a weak dictator. In this talk, we will investigate the particular case where the number of voters is limited to 2, and $|X|=4$.

Jorge Chang (u), Morehead State University
Content-Based Image Retrieval using Multi-Histogram Approach
The purpose of this project is to develop and optimize a content-based image retrieval system that can be used to compare an input image against a database of images to retrieve similar images. The similarity will be based on the actual contents of these images. A number of popular image processing techniques that can be used to extract important features from images were considered to increase the matching performance. We propose a multi-histogram approach that includes standard, global and semi-global edge histogram, and color histogram. In this presentation, we take a look at how these different techniques work along with their strengths and weaknesses in order to find a good balance for a functional content-based image retrieval system.

Doug Chatham (f), Morehead State University
The rook's independence separation problem
For an n-by-n chessboard, the rook's independence separation number s(m, n) is the smallest number of pawns needed so that some placement of those pawns on the board produces a board for which the independence number (the maximum number of nonattacking rooks that can be put on the board) is m. We determine the rook's independence separation number for $m \leq n$ and for many cases in which $m > n$. We also consider what happens when edges of the board are identified to form cylinders and tori. (This is joint work with Paul A. Burchett.)

Yin Chen (u), Northern Kentucky University
Creating and Breaking 4-Digit Superciphered Code
JN-11 was a 4-digit superenciphered code used by the Imperial Japanese Navy as a convoy cipher during World War II. US Navy codebreakers developed techniques to break JN-11 using an error-detection feature that the Japanese had built into the cipher. However, as JN-11 evolved, its error-detection feature was dropped, and it was necessary for Navy codebreakers to develop new techniques to attack it. This presentation will describe the construction of a 4-digit superenciphered code that was modeled on JN-11 with error-detection and will describe a technique developed by Navy codebreakers -- exploiting the error-detection feature -- to align ciphertext against recovered additives.

Naod Chichaibelu (u), Kentucky State University
Th Cognition of Mathematics
Numerical cognition is a discipline that studies the neural basis of numbers and how the human mind is able to understand mathematics. Mathematics is a cognitive process that involves the arrangement of imagery and language. Scientists have been studying the human brain and which parts of it are responsible for this very complex process. In this presentation I will discuss how the human mind processes this system of understanding and reasoning quantities. I will explain how our brains are capable of doing mathematics as it relates to everyday cognition. Finally I will briefly talk about how the understanding of mathematical cognition is opening door to new technologies such as human-machine interaction.

Chris Christensen (f), Northern Kentucky University
A "Practical" Optimization Problem
What is the optimal base of a number system? Computer pioneer Howard Aiken solved this problem in 1951. Many solutions exist. Some after Aiken's but also some before. "Everyone considers themselves to have done it for the first time." We'll solve it … again.

Ranthony Clark (g), Eastern Kentucky University
Gaussian Amicable Pairs
Amicable pairs are two integers where the sum of the proper divisors of one is the other and vice versa. Since the Gaussian integers have many of the properties of the regular integers, we sought to discover whether there exist any pairs of Gaussian integers with the same property. It turns out that they do exist. In fact, some of the normal amicable pairs carry over as Gaussian amicable pairs. Also discovered are pairs that have a complex part.

John Cliburn (u), Western Kentucky University
Exponential Functions on Bigger Spaces
Given a real-valued exponential function f(t)=e^(at), then we think about its characteristics like f '(t)=af(t) or f(t+s)=f(t)f(s) and f(t)=∑(at)^(n)/n! as n goes from 0 to ∞. Using these characteristics, we generalize the concept of exponential functions when their range is in other spaces like complex plane, n-dimensional, or even infinitely dimensional spaces. Many results from calculus can be obtained from properties of generalized exponential functions, including the Taylor Series formulas.

Bryan Conn (u), Jennifer Birriel (f), Ignacio Birriel (f), Morehead State University
A Model to Reduce Light Pollution and Increase Efficiency of Outdoor Lighting on Morehead State University's Campus
Light pollution is a problem not only for astronomers but for city budgets and climatologists alike. Astronomers see light pollution as a way of preventing them from viewing the cosmos above, while the city budget committee should see light pollution as cutting into their bottom line. By lighting the sky with inefficient light fixtures we are burning unnecessary fuel, spending unnecessary funds, and blocking the stars from our sight. As a way of modeling this problem and finding an inexpensive solution, a scale model of a small area around the Bell Tower on Morehead State University's campus was built by a previous student. However, the student did not have sufficient time to design an electrical circuit that met the current and voltage restraints of each lamp. We present here our design and analysis of the circuit. We compare our theoretical calculations to the measured currents and voltages. We conclude by briefly discussing how this model is to be used in conjunction with a light meter to find the best configuration of light fixtures to reduce power consumption and light pollution while simultaneously providing the safest lighting environment in the area.

Jared Cordray (g), Jennifer Birriel (f), Morehead State University
Using GaN Data in a High School Mathematics Classroom
Globe at Night (GaN) is an annual, global citizen science project designed to increase awareness about light pollution. Individual participants observe the naked-eye limiting magnitude of a preselected bright constellation and then submit data through an online interface. The data for each year's campaign is freely available online in several different formats. Using this data in the high school math setting allows students a chance to see topics they are not familiar with and to see a global collaboration project. Students read about light pollution and the GaN project and then perform a statistical analysis of data from the years 2006-2012. The goal is to have a group of Advanced Topics in Mathematics students learn how to use MS Excel as a data analysis tool, learn about histograms and basic statistical concepts and to look for trends in time. We will report our results and comment on the impact that this project had on the understanding and appreciation of math applied to a real world problem.

Daniel J. Curtin (f), Northern Kentucky University
The KYMAA 1917-2013
The Mathematics Section of the Association of Kentucky Colleges and Universities was founded in 1909. In May 1916 it was decided to apply to become a Section of the new MAA. This admission was accepted in February of 1917 and the first meeting of the new Kentucky section was held at Berea College that May. Since then the section has been very active with annual spring meetings and rare fall meetings. Speakers have come from both private and public institutions, and many nationally known mathematicians have given invited addresses. Mathematicians who are women have been very active. Elizabeth LeSturgeon was Chairman in 1923 and our second section governor was Aughtum Howard in 1951. Mathematicians of all types have given talks and participated in panels throughout the history of the section.

Rob Donnelly (f), Murray State University
The cos(1) scandal
The cos(1) scandal centers on this question: What numerical method do we provide our pre-Calculus or Calculus I students for computing, or even reasonably approximating, the cosine of 1? The answer, it seems, is that we don't. That seems at least a little bit scandalous, doesn't it? Maybe we can do better.

Carl Durcholz (u), Asbury University
2's a Party, 3's a Crowd, 50 Billion is Too Much
When tasked with modeling an aspect of global health, our team chose to forecast human population trends and how they will impact various aspects of global health.

Claus Ernst (f), Western Kentucky University
The effect of confinement on knotting and geometry of random polygons
Motivated by a DNA strand in a viral capsid we create a model of an equilateral random polygons of length n in a confinement sphere of radius R>1. In this talk we discuss how knotting probabilities and geometric properties of the random polygons change as a function of both n and R. Even for relatively small length (in our study we use polygons of a length up to 90 steps) such random polygons are knotted with very high probability - and the knots obtained are very complex (i.e. the knots have more than 16 crossings and cannot be identified).

Ryan Fette (u), Thomas More College
Hirota Derivatives in Soliton Theory
The Hirota Derivative is a differential operator that acts on two functions f and g, reducing a soliton equation into bilinear form. These transformations offer insight to finding multi-soliton solutions. We are especially interested in the case where two functions f and g are equal. When f=g, we can produce n-soliton solutions from a linear combination of n+1 terms, each of which is the exponentiation of a linear combination of the variables. Furthermore, if Σm_i is odd, then the Hirota Derivative, Dx1^m1…Dxn^mn(τ·τ)=0, and therefore it cannot be used to find soliton solutions.

K.Renee Fister (f), Murray State University
Optimal Control of Rift Valley Fever
"Rift Valley Fever (RVF) virus is a mosquito-born pathogen that infects livestock but it also has the capability to infect humans through direct or indirect contact with blood or organs of infected animals and by bites from infected mosquitos. Through a compartment model depicting the interactions leading to the spread of RVF in mosquitos and a livestock population, an optimal control problem is developed to minimize the number of vaccinated livestock at the final time while minimizing the negative effects of the infected mosquitos and the cost of the vaccination process. The unique optimal vaccination strategy is analyzed for given high transmission parameters and numerical results portray that vaccination depends on the level of effectiveness of the protocol."

Erika Foreman (g), University of Louisville
Counts of Residuated Maps on Two Interesting Lattices
It is well known that residuated maps on complete lattices are simply the join homomorphisms. This straightforward characterization allows us to fairly easily classify the residuated maps on some well-known lattices. Here we present a count of the residuated maps on the modular, non-distributive lattice M_3, the non-modular lattice N_5, and their generalizations M_n and N_k

C.J. Fryer (u), Thomas More College
Solitons and Rank One Matrices
We modify the formula for the 1-soliton τ-function of the Bilinear KP Hierarchy by replacing arbitrary scalar constants with matrices. The resulting matrix equation
τ=det(A exp[Sum(C^i * t_i] + exp [Sum(B^i * t_i)]) is a solution of a Bilinear KP Hierarchy if and only if the matrices A, B and C satisfy AC – BA = R, where R is a matrix of rank 1. In this case, if A is invertible, then the matrices $A'=A^{-1}$, B'=C and C'=B also correspond to the exact same solution u of the KP Equation.

Will Garcia (u), Nathaniel Clause (u), Bruce Kessler (f), Western Kentucky University
Circulant Matrices and Cryptography
Simple ciphers, like the Caesar cipher, make an encoded message difficult to read, but it is relatively easy to decode, since it preserves the relative frequencies and positions of the letters. For example, the letter “e” is always changed into the same symbol and that symbol would be the second character when the word “test” was encoded. There are many different ciphers that obscure frequencies and positions of encoded characters, and one of the methods that Dr. Kessler always works into his Linear Algebra course is the use of invertible matrices to encode and decode messages.

This talk will show the work of a student in the class doing an Honors augmentation in improving on the matrix method discussed in class, and the separate work of a team of Gatton Academy students to decode a message encoded using the improved method. The new idea was to use different matrices to encode the message, much in the way different shifts are used in the Vigenére cipher based on a keyword. The connection of the different matrices is that they are all circulant matrices, using different “rotations” of the same 3-vector. The talk will highlight the theory used in choosing the matrix entries, and the steps taken by the code-breaking team to decode a 960-character message.

Rebecca Gaul (u), Wesley Gaus (u), Asbury University
Lost in De-Nile
This year, our team participated in the 2013 COMAP competition, an international mathematics competition. Our team was given three different real life problems to choose from. We had to choose one, come up with a solution to the problem by using equations to model it, write up our findings, and submit it all within four days. We choose to come up with a solution to the fresh water shortage in Egypt. To address the issue of the projected water crisis in Egypt in 2025, we constructed a model that not only provides for the increasing demand of water, but also the transportation of the fresh water. To fulfill the requirements of purifying enough water in Egypt, we propose to create new desalinization plants across the Mediterranean coast and Red Sea coast. This is the only realistic solution for creating water for the Egyptians since there is a limited amount of water that can be acquired with their current technology from the Nile River, other fresh water sources, and the current desalinization facilities. After the fresh water is produced from these new facilities, transporting this resource is critical and needs to be addressed to provide a realistic solution for all Egyptians. We propose a railway solution to the transportation problem. Trains can store and deliver plenty of water and meet the daily population need of fresh water in a cost efficient manner.

Our model provides extensive flexibility for political decision-makers. They will be able to adjust the number of new desalinization facilities that need to be constructed to meet the fresh water need. Or they can input the amount of fresh water that Egypt needs which will determine the number of desalinization facilities to meet this need. By creating more desalinization facilities and an improved railway transportation network, jobs will be created and new industries supported which will help Egypt's economy and stabilize it. Overall, the solution to the water crisis will take time and resources but, using desalinization facilities to make fresh water and trains to transport that water will provide constant access to critical resources for the entire country.

Peter Hamburger (f), Western Kentucky University
Bézout's Theorem Revisited
"Bézout's Theorem" states that if gcd(a,b)=d is the greatest common divisor of two integers a and b, then there are integers s and t such that sa+tb=d. The integers s and t are called B\'{e}zout's Coefficients. The known proofs of Bézout's Theorem are investigated and a simple algorithm providing an alternative proof is suggested. Our algorithm is simple and provides the Bézout coefficients in a straightforward manner. It is independent of the Continuing Fraction Algorithm, the Euclidean or of the Extended Euclidean Algorithm, but performs slower than those, a trade for its simplicity.
Joint work with: Gyorgy Petruska, Department of Computer Science, Indiana University Purdue University Fort Wayne, Fort Wayne, Indiana.

Mu He (g), Western Kentucky University
Torsion of Random Walk
In this talk, we will study the torsion angle of an n-step equilateral random walk in two cases: with and without a confining sphere. Intuitively torsion can be defined as follows: Given three consecutive edges a, b, and c of the random walk then the edges a and b define a plane and the edges b and c define a second plane. The angle between the two planes is called the torsion angle of the three edges. We demonstrate an explicit integral expression for the expected mean torsion value in

both cases. Then we show that the expected torsion angle obtained by the integral agrees with the numerical average torsion obtained by a simulation of random walks.

Erich Hohenstein (u), Morehead State University
Design and Implementation of Parallel Data Mining Algorithms
Data mining extracts implicit, previously unknown, and potentially useful information from datasets. The goal of this research project is to design and implement parallel algorithms that can be used for a wide range of data mining applications to mine large databases. In this research, we focus on the parallel implementation of the Apriori algorithm in order to improve its performance. We use OpenMP to support shared-memory parallel programming in C++. We utilize the set of compiler directives, library routines, and environment variables that are provided by OpenMP.

Lucas Hoots (g), University of Louisville
May's Theorem on Median Semilattices
"In 1952, Kenneth May published a set of necessary and succinct conditions that characterized simple majority rule in the case of 2 alternatives. We extend May's Theorem beyond the classical setting by using the theory of ordered sets and, in particular, the theory of median semilattices."

Heather Hunt (g), University of Louisville
A Functional Equation Arising from Stochastic Distance Measure
Let G be any arbitrary group and K a field of characteristic not equal to 2. Using the general solution of the functional equation $f(pq) + f(qp) = 2f(p) + 2f(q)$ for all p, q in G, we will present all functions f, g from GxG to K that satisfy the functional equation $f(pr, qs) + f(ps, qr) = 2f(p, q) + 2f(r, s)$ for all p, q, r, s in G. We will also look at generalizations of the functional equation and their solutions.

Rasitha Jayasekare (g), University of Louisville
Poisson Mixture Model for Discrete Stock Price Changes.
"A mixture of Poisson distributions is proposed to model the discrete changes in stock price. The parameters are estimated using the Expectation – Maximization (EM) algorithm with a mixing probability which depends on order size. A parametric bootstrap procedure is proposed to test whether the mixing probability depends on the order size. The current work about the proposed model will also be discussed. (Joint work with Dr. Ryan Gill and Dr. Kiseop Lee)

Dani Kane (u), Transylvania University
Weirdness (Almost) Everywhere
Weird fractions are fractions that enjoy a correct invalid digit-based reduction. In this talk, we motivate a method to enumerate weird fractions and use it to discuss the prevalence of these fractions. We will show that weird fractions are rather abundant and hence maybe not so weird after all.

Eric Kaper (u), Transylvania University
Composite Sequences: The Search for the Smallest Seed
Take a positive integer ***n*** and a digit d. Consider the sequence whose j-th term is n with j copies of d appended on the right. We tackle the question of when the resulting sequence consists entirely of composite numbers. In particular we discuss an attempt to find the smallest such ***n*** for each of the digits 1, 3, 7 or 9.

Byriah Loper (HS student) Wilmore, KY
Application of Basic POV-ray to Polyhedral Origami Design
In my presentation, I will explain how mathematics and the computer program POV-ray can be used to design a polyhedron compound that can be rendered in origami. The presentation will focus on the design process for one of my original polyhedral designs from conception through completion. This will include basic POV-ray (computer raytracing program), and an expanded form of the linear distance formula specialized for origami design, but in the end will focus on how these can be used to create beautiful origami polyhedral compounds.

Meagan Lovins (u), Northern Kentucky University
Measuring Performance Peaks in Sports
Did Craig Biggio use PEDs? Is Albert Pujols really only 33? This project investigates age ranges in which athletes perform at their highest levels. We consider the use of various sport-specific statistics to estimate performance level; and subsequently employ analysis of variance methods to estimate age ranges for peak performance among the sports baseball, basketball, and golf.

George H. Lytle (u), Cali Thomas (u), Aaron A. Hill (u), Asbury University
Maximizing Brownie Points: a Functional Approach
In this presentation, we seek to develop an objective function for measuring the effectiveness of a brownie pan of various shapes. The heat distribution is modeled through applying the Separation of Variables technique to the two-dimensional heat equation with Dirichlet boundary conditions. The objective function also takes the geometry of the pan into account, seeking to maximize the number of pans that can fit in a standard conventional oven. Based on a sample selection of brownie pan types, we apply the objective function to determine the best choice of pan for making this delectable dessert.

Andy Martin (f), Kentucky State University
That Does not Compute.
A collection of puzzling and surprising lies told to me over the years by Computer Algebra Systems and my usually trustworthy TI calculator.

How to Teach Precollege Mathematics and Enjoy it.
"At the 2010 KYMAA meeting I spoke of the structure of my MAT 111 (Contemporary Mathematics) course, the liberal arts math requirement at KSU for all non-STEM majors. I did not address the content of the course, and why I enjoy teaching it. In this talk I will do so, and will update my record of success."

Jason McGinnis (u), Jennifer Birriel (f), Morehead State University
The Mathematics of Astronomical Spectral Reduction and Analysis
Astronomical spectral reduction and analysis involves as much mathematics as it does physics. Analyzing the data requires liberal use of numerical methods to interpolate the data. The most used methods are spline interpolation and Chebyshev polynomials. These methods use the discrete data points collected and interpolate them to create a continuous spectrum. With this spectrum we can learn things about the object we are interested in. Using Statistical analysis on the spectrum we get from the interpolation can yield us several valuable insights. Fitting spectral lines to normal curves

the flux and center wavelength can be determined. With this information the species of atom or molecule can be determined. Finally using the Doppler shift we can find out the velocity of the atoms as they emit the photons that create the spectral lines.

Mikayla McKenzie (u), Kentucky Wesleyan College
The Mathematics of Escher's Paintings
M. C. Escher was a Dutch graphic artist who created paintings and other types of art that are optical illusions. There are mathematical underpinnings to many of Escher paintings. This talk will examine a few of his paintings and the underlining mathematics that were applied to create them.

Zane G. McQueary (u), Morehead State University
Applications of the Unihedron Sky Quality Meter
This (u) Research Fellowship focuses on the light pollution present on the campus of Morehead State University. The contribution due to natural sky brightness and light pollution and will be examined when analyzing the SQM-LE data results. Furthermore, a comparison between the Morehead campus and other SQM-LE locations will be utilized.

Alan Meeks (u), Kentucky State University
An Animated Discussion of Mathematics
In this talk, I will discuss how mathematics and physics have played an integral role in the development of modern animation and movie graphics. I will examine the history of this development, as well as take a look at the mathematics that enables these amazingly realistic and complex creations to be brought to life.

D. Scott Nettleton (u), Morehead State University
Preliminary Work on the Whipstitch Game Engine
The Whipstitch Game Engine is a work-in-progress 3D game engine, developed in C++. It utilizes OpenGL and a variety of other multiplatform open source libraries in order to create an accessible, modern, open source (MIT licensed) game development framework, both for commercial and non-commercial purposes. This talk provides a brief overview of the game engine, as well as a description of the current state of the project.

Lan Nguyen (f), Western Kentucky University
How big is a dense set?
A subset S in a metric space X is a dense set, if for any point x in X and any $\varepsilon > 0$, the ball B with the center x and radius ε contains (at least) one point in S. Many statements which hold for a dense set will automatically hold for the whole space. For each metric space we look for smallest dense sets. We find out that some spaces have dense sets with the same cardinality as the set of natural numbers. We use Weierstrass's approximation theorem to find one such set.

Ngoc Nguyen (f), Western Kentucky University
Truncated Skewed Laplace Distribution in Stochastic Frontier Analysis
The stochastic frontier analysis (Aigner et al. and Meeusen and van den Broeck, 1977) has been widely used to estimate technical efficiency of firms. The basic idea lies in the introduction of a composed error term consisting of a noise V and an inefficiency term U. From there, technical efficiency of each firm is estimated by utilizing distributional assumptions on the two error components. In the literature, V is usually assumed to be normally distributed and the distribution of

U can be exponential, truncated normal or Gamma. In this study, we will consider the truncated skewed Laplace distribution for U and a Normal distribution for V. This is a generalize model of Normal-Exponential case in the literature.

Bryce Norris (g), Murray State University
Math, Cholera, and Human Trafficking: One of these things is not like the others...?
Differential equations serve as particularly powerful tools for bridging the gap between mathematics and the "real world." As one would expect from closely allied fields, examples of differential equations in physics and chemistry continue to become more commonly known. However, mathematical approaches to biological and sociological questions may be of greater general concern. This talk will expose the audience to a specific example of mathematical epidemiology and propose an alternative approach for studying the world-wide problem of human trafficking.

~~**Fariba Nowrouzi Kashan (f), Kentucky State University**~~
~~***Curving Grades***~~
~~One of the common questions that students ask in the first day of the class is if we curve the grades at the end of a semester. Is it true that as a result of curving Grades all students get the same or higher grade? What do we mean as an instructor when we talk about curving grades in a class? What do students expect when talk about curving grades? And …~~ Cancelled

Sierra O'Bryan (u), Thomas More College
The Nonlinear Schrodinger Equation and Applications to Optical Solitons
The Nonlinear Schrodinger Equation (NLS), defined by: $i\,\partial q/\partial x+1/2\ (\partial^2 q)/(\partial t^2)+|q|^2 q=0$, is a soliton equation which can only be used in the context of complex numbers. In this equation, x represents the distance along the direction of propagation and t represents time in the group velocity frame. An envelope of the light wave, or an optical soliton, travelling through special fibers satisfies NLS. We derive the Lax form of NLS defined by L' = [M,L], where M and L are matrix differential operators. We illustrate our results with a computer animation of a high frequency carrier wave modulated by a soliton envelope.

Allison Perkins (g), University of Louisville
On a sine functional equation with involution on groups
Let G be a 2-divisible, perfect group and C be the field of complex numbers. We present all functions f from G to C that satisfy the sine functional equation with involution.

Jason Ricker (u), Kentucky State University
A (Very) Brief Introduction to the Poincaré Disk Model of Hyperbolic Geometry
I will be introducing Poincaré's Disk and Hyperbolic Geometry on the disk by contrasting common occurrences in Euclidean Geometry with their Hyperbolic Geometry counterparts. This will include parallel lines, perpendicular lines, different types of triangles, and a few interesting occurrences.

Jason Ricker (u), Kentucky State University
When 1 was Prime
Given the common modern definition of prime number, the reaction to the above phrase might be "One was never a prime number." But terms evolve, and this talk will deal with the etymology of the word "prime" as it has been used in mathematics, from Euclid through Goldbach and Hardy, to the present.

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Sam Saarinen (u), Western Kentucky University
A Parameterized Scheme for Generating Random Walks with Stiffness
Modeling the behavior of long polymers is of great interest in physics, chemistry, and biology. Such polymers can be modeled by random walks (a generated set of vectors traversing Euclidean 3-space), and their behaviors under various confinement conditions can be analyzed. One difficult aspect of modeling these polymers is replicating their resistance to bending, or their "stiffness". We present a viable scheme for producing random walks with parameterized stiffness, and derive a function describing the relationship between the parameter and the walks' stiffness. We also discuss various properties of the resulting random walks, such as the distribution of curvature values across the walk.

Timothy Schroeder (f), Murray State University
The actions of right-angled mock reflection groups
A right-angled mock reflection group (RAMRG) is a group that acts isometrically on a connected CAT(0)-cubical complex $\boldsymbol{X}$ such that the action is simply transitive on the 0-skeleton, and the stabilizer of every edge is isomorphic to $\boldsymbol{Z}_2$. These groups have simple presentations and have even simpler combinatorial descriptions. We consider low-dimensional examples and also exhibit results in detecting finite index, torsion free subgroups of RAMRG's.

Steve Seif (f), University of Louisville
Open problems in lattice theory
A lattice is a partially set L such that for each pair of elements u,v in L, u and v contain both a least upper bound and a greatest lower bound. The Finite Lattice Representation Problem (FLRP) asks whether every finite lattice is isomorphic to an upper interval of the subgroup lattice of a finite group. Numerous researchers and research groups are currently working on the problem, but it remains open, some thirty years after it was proposed. The talk will discuss FLRP, and some present some problems involving the asymptotic growth of finite lattices.

Biswas Sharma (u), Morehead State University
Composition of Solutions for the n+k Queens Separation Problem
The n+k Queens Problem requires the placing of n+k Queens and k Pawns on an n x n chessboard in such a way that no two Queens attack each other. It has been proven that the problem has a solution when $n > \max\{87+k, 25k\}$. We attempt to obtain nice patterns and lower this bound on n by composing solutions and partial solutions for smaller values of n to obtain solutions for larger values of n.

R.Duane Skaggs (f), Morehead State University
The Spring Number of a Graph
A set S of vertices in a graph is a dominating set if the open neighborhood of every vertex in the graph contains a member of the set S. A set D of vertices is an identifying code if the intersection of D and the closed neighborhood of each vertex is non-empty and unique for all the vertices in the graph. In general, a minimum dominating set is smaller than a minimum identifying code for a graph. However, for any non-complete graph the addition of some leaves results in a graph in which the minimum number of vertices in a dominating set is equal to the minimum number of vertices in

an identifying code. We consider the minimum number of leaves required, known as the spring number, for various classes of graphs. (Joint work with Julie E. Lang and Lindzey Thacker)

Valerie Sleeth (g), University of Kentucky
Bugs vs Drugs: a mathematical model to determine the cost efficacy of vaccination and mosquito eradication in controlling the spread of yellow fever in an urban setting
Yellow fever (YF) is a viral, hemorrhagic fever endemic to South America and Africa that produces over 50% mortality among symptomatic individuals. No effective treatment exists, so prevention is key in reducing YF associated morbidity and mortality. While mosquito eradication and vaccination campaigns have been used to control the disease, sporadic epidemics still occur in certain urban populations. Unfortunately, because this disease is perpetuated through non-urban cycles in monkey and mosquito populations, complete eradication is presently impossible. However, due to the presence of an effective vaccine, prevention of infection among human populations within endemic regions is the current goal of the World Health Organization.

To control infectious disease it is necessary to understand the pattern of spread. The epidemiologic Susceptible-Infectious-Recovered model estimates the number of individuals in--as well as their rate of movement between—each of these states. However, these models usually only account for human-to-human transmission. To more accurately depict YF, a model incorporating mosquito-to-human and mosquito-to-mosquito transmission was developed. This allowed more accurate cost comparisons of vaccine and mosquito eradication campaigns during an urban outbreak.

In evaluating the model, it was assumed that 1 infected human entered a city with an entirely susceptible mosquito population on day 1 of the epidemic. Values for transmission rates were taken from previous research examining the ***Aedes aegypti*** mosquito, the primary vector for urban YF in Africa. It was found that, for a solitary outbreak, cost per life saved was less using larvicidal methods ($16.00, $7.00, and $4.00 in best, moderate, and worst case scenarios) than conducting a vaccination campaign ($80.70, $33.33, $20.00 in best, moderate, and worst case scenarios). However, for ongoing control, vaccination may be cheaper as larvicide methods require at least annual treatments whereas vaccination is a one-time occurrence per person.

Chris Taylor (u), Kentucky State University
An Investigation of Parallel Transport and Geodesics
In this talk, we will discuss some of the odd happenings that occur when on a curved space. We will begin by examining flat space, quickly explore the idea of curvature, and end by diving into the details of parallel transport and geodesics.

Ryan Therkelsen (f), Bellarmine University
Constant Composition Designs: A New Take on an Old Classic
Suppose a mathematics department offers seven math elective courses, from which all math majors must take exactly three. If there are seven math majors, is it possible for all seven elective courses to have the same number of enrolled students? What if every pair of students must take a course together? Solutions to such problems may be described in terms of mathematical objects called designs. In this talk I will describe these objects and introduce a natural generalization involving multisets, called k-coloured constant composition designs. Interesting connections to geometry and coding theory will be presented, for both traditional designs and in the newer multiset setting.

Emma Vaughn (g), Murray State University
Choose Your Best Strategy…and Lose: The Symmetric n-Person Prisoner's Dilemma
The Symmetric n-Person Prisoner's Dilemma is a game played between n players in which players benefit from forming coalitions where each member cooperates while individuals are rewarded for defecting. In the world of business, players try to maximize their profits by beating the other players, but with the risk that they will lose big. From the 3-person game, conditions are developed for the Symmetric n-Person Prisoner's Dilemma.

Brandon Wayt (g), Murray State University
Finding tori in reflection group actions
Associated to any Coxeter system (W,S) is a labeled simplicial complex L, called the nerve of (W,S), and a complex Sigma, called the Davis complex, on which W acts properly and co-compactly. When $L=S^2$, K is a 3-dimensional orbifold and Sigma splits into Euclidean and non-Euclidean pieces. We examine the Euclidean cases and show that these pieces have a torus as an intermediate cover.

Amanda Welch (u), Northern Kentucky University
Combinatorial Game Theory
Combinatorial games are two player games lacking chance. Mathematicians study these games in order to develop winning strategies. I will begin by giving a brief introduction to combinatorial games. Then I will discuss Greedy Cannibals, the game I studied.

Susan White (f), Bellarmine University
A topological proof of the infinity of primes
In 1955, Harry Furstenberg provided a topological proof of the infinitude of the prime numbers. In this talk, we will discuss the proof, and we will look at other classical results that may be proven using topological techniques.

D. Jacob Wildstrom (f), University of Louisville
Multiclaimant Generalizations of Asset-Division Functions
When the claims on an asset exceed its total value (as, for instance, when an estate has a negative net value), there are several ways to partially satisfy each claimant. This talk will use an unusual asset-distribution algorithm mentioned in the Babylonian Talmud and illuminated by Aumann as a jumping-off point for an investigation into the circumstances under which asset distribution schemes

designed for two claimants can be extended to be applicable to distribution of an asset to more than two participants.

Aaron Young (u), Western Kentucky University
Instant Insanity II
Instant Insanity 2 is a variation of the poplar, classic 1967 puzzle, Instant Insanity, in which there are five different colors instead of four and the tiles are on a cylinder. A graph theoretical approach is used to find the number of solutions to the Ultimate level of Instant Insanity 2

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Film Screening
In the Footsteps of Newton
In the Footsteps of Newton follows the inspirational journey of seven Hanover College math majors as they go on a quest to learn about Isaac Newton in a History of Math class. The students follow in the footsteps of Newton, from his early life on the farm at Woolsthorpe Manor, to his student days in Grantham and academic life in Cambridge, to his final years in London. The film received rave reviews at MathFest last August and the Utopia Film Festival in Greenbelt, MD, and is currently entered in other national film festivals. Wesley Hough, a UK graduate student who is featured in the film, and Nancy Rodgers, who taught the class and produced the film, will be available to answer questions. A limited supply of free DVDs will be distributed for campus screenings. For more information, reviews, and a trailer: *math.hanover.edu/newton*