Invited Talks: Abstracts and Biographical Information

Erik Demaine, "*Algorithms meet Art, Puzzle, and Magic*"

Erik Demaine is a Professor in computer science at the Massachusetts Institute of Technology. Demaine's research interests range throughout algorithms, from data structures for improving web searches to the geometry of understanding how proteins fold to the computational difficulty of playing games. He received a MacArthur Fellowship as a "computational geometer tackling and solving difficult problems related to folding and bending--moving readily between the theoretical and the playful, with a keen eye to revealing the former in the latter". He appears in the recent origami documentary Between the Folds, cowrote a book about the theory of folding (Geometric Folding Algorithms), and a book about the computational complexity of games (Games, Puzzles, and Computation). His interests span the connections between mathematics and art, particularly sculpture and performance, including curved origami sculptures in the permanent collection of Museum of Modern Art (MoMA), New York.

Abstract: When I was six years old, my father Martin Demaine and I designed and made puzzles as the Erik and Dad Puzzle Company, which distributed to toy stores across Canada. So began our journey into the interactions between algorithms and the arts (here, puzzle design). More and more, we find that our mathematical research and artistic projects converge, with the artistic side inspiring the mathematical side and vice versa. Mathematics itself is an art form, and through other media such as sculpture, puzzles, and magic, the beauty of mathematics can be brought to a wider audience. These artistic endeavors also provide us with deeper insights into the underlying mathematics, by providing physical realizations of objects under consideration, by pointing to interesting special cases and directions to explore, and by suggesting new problems to solve (such as the metapuzzle of how to solve a puzzle). This talk will give several examples in each category, from how our first font design led to building transforming robots, to how studying curved creases in origami led to sculptures at MoMA. The audience will be expected to participate in some live magic demonstrations.

Bob Devaney, "Fractal Geometry of the Mendelbrot Sets"

A native of Methuen, Massachusetts, Robert L. Devaney is currently Professor of Mathematics at Boston University. He received his undergraduate degree from the College of the Holy Cross in 1969 and his PhD from the University of California at Berkeley in 1973 under the direction of Stephen Smale. His main area of research is dynamical systems, primarily complex analytic dynamics, but also including more general ideas about chaotic dynamical systems. Lately, he has become intrigued with the incredibly rich topological aspects of dynamics, including such things as indecomposable continua, Sierpinski curves, and Cantor bouquets. He is the author of over one hundred research papers and of fourteen books in the field of dynamical systems as well as a dozen pedagogical papers in this field. He has also been the "Chaos Consultant" for

several theaters' presentations of Tom Stoppard's play Arcadia. In 2007, he was the mathematical consultant for the Kevin Spacey movie called Twenty One.
His hobbies include cruising the waters in his sail boat Cygnet, watching Opera, and collecting coffee mugs from Colleges/Universities he speaks at. In 2012 he will become President-elect of the Mathematical Association of America. Then, in 2013-14, he will serve as the President of the MAA.

Abstract: In this lecture we describe several folk theorems concerning the Mandelbrot set. While this set is extremely complicated from a geometric point of view, we will show that, as long as you know how to add and how to count, you can understand this geometry completely. We will encounter many famous mathematical objects in the Mandelbrot set, like the Farey tree and the Fibonacci sequence. And we will find many soon-to-be-famous objects as well, like the "Devaney" sequence. There might even be a joke or two in the talk.

Christie Perry

"*The Kentucky Core Academic Standards: Opportunity and Challenge*"

Christie Perry is an assistant professor in the Department of Mathematics, Computer Science, & Physics at Morehead State University in Morehead, KY, where she teaches mathematics content courses for preservice elementary and middle school teachers, secondary methods courses, and supervises secondary student teachers. She was a member of the first doctoral cohort of the ACCLAIM project (Appalachian Collaborative Center for Learning, Instruction, and Assessment in Mathematics), and completed her Ph. D. in mathematics education from the University of Louisville in 2007. Prior to joining MSU, Christie worked for the Bath County School system in Kentucky. During this tenure she spent 16 years as a middle school mathematics teacher and 6 years teaching mathematics at the high school level. She also served as a teacher partner with the Appalachian Rural Systemic Initiative (ARSI). She retired from the public school system in 2006 with 28 years of service. Christie lives in Salt Lick. She has two grown children, Leslie Collins and Allison Perry, and one granddaughter, Ruth Collins.

Abstract: This talk will be an overview of the Kentucky Core Academic Standards and the Common Core State Standards. Implications for higher education and teacher education will be discussed and examples of how the Standards have affected my work will be demonstrated.

Abstracts of Contributed Talks

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

Mike Ackerman (f), Bill Fenton (f), and Anne Raymond (f), Bellarmine University
A Mathematics Capstone Course
In the early 1990s, the Mathematics Department at Bellarmine University underwent a review of our curriculum for the mathematics and actuarial science majors. Consequently, we developed a capstone course, entitled *Readings in Mathematics*, required of all seniors in the spring of their graduation year. In our talk, we present the current design of our capstone course: the preliminary assignments, the major project, the role of the department advisors, and the assessment challenges. As a capstone experience, we hope that students begin to see the interconnectedness and interplay of their various mathematics courses and that they find mathematical topics to excite their curiosity beyond the classroom.

Amir Ahmadi (u), Morehead State University
Kentucky's Potential for Wood Biofuel Production*: *An Economic Feasibility Analysis
Yellow poplar is used to estimate the cost and revenue of a fast pyrolysis system. Bio-oil from the reactor is estimated via chemical and kinetic equations. Costs and revenues are then represented by the direct costing method. Current market conditions make it infeasible for using wood for bio-oil production.

Dora Ahmadi (f) & Julie Lang (u), Morehead State University
Mathematics College Readiness
The presenters will discuss results from a project aiming at preparing high school seniors for college level mathematics. The program used the Hawkes Learning System to increase the interest and active participation of high school students during a three year project that has shown its sustainability. Follow-up results of the 2008 cohort of high school students who attended Morehead State University will be shared.

Tony Bankemper (u), Northern Kentucky University
Binary Disruption in Embedded Clusters
The purpose of this talk is to explore via numerical simulations the possible disruption of binary stars by the most massive stellar member of an embedded cluster. It appears that most stars within our galaxy are born in dense clusters, but over time, a significant fraction leave these environments to become field stars. In addition, about 70% of stars within our galaxy are in binary systems, but it is still unknown whether or not all stars are born in binaries. If so, then a significant fraction of young binary systems must be disrupted within the cluster environment before escaping.

Virgil Barnard (u), University of Kentucky
Independent Proof of Quadratic Reciprocity
In the pursuit of proving quadratic reciprocity (what Gauss referred to as a golden law), my goal was to do so “without words”. This presentation will show sequences of “flip book” images that where most critical in constructing this proof and their surprising connections to geometry.

Zac Bettersworth (u), Khant Minn (u), Steffen Krebs (u), Georgetown College
Space Time Approach to Rafting Trip
This presentation is about a mathematical model that is designed to help a rafting tour agency plan out a schedule for an annual season. The goal is to maximize the number of trips per half year while minimizing the contacts of individuals with other customers on the river. The model generates a pattern in the ways one trip comes across others, from which we can make calculations about total number of trips and quantify the amount of campers' interactions. We model the problem as a combination of a series of piecewise position functions of time that allows us to keep track of where each set of boats are at any given time. We chose this model because our interest is to quantify the amount of disturbance to the wilderness experience felt by each group of campers. We achieve this goal by identifying the intersections of the position functions since our model predicts quite accurately the relative amount of interactions among groups of campers.

Ghan S Bhatt (f), Tennessee State University, Nashville TN
Finite Frames in Application
For a signal to be analyzed or to be transmitted, we need to have a nice basis for the space in which the signal belongs. The construction of a nice basis is too restrictive. Frames have been introduced recently to signal processing/data compression as they are less restrictive, being linearly dependent spanning set. Some properties of finite frames and current trend finite frames will be discussed in this talk.

Robin Blankenship (f), Morehead State University
Understanding ≠ Remembering
Preparing for class and working to understand mathematical content is a very different process than preparing for recall during a testing situation. The class preparations I emphasize are called "the three reading habits", and I use quoting them in the first week of school to demonstrate the reality that clear lecture is not enough to put information in verbatim recall ability. How does one study for recall?

Scott Brabon (u), Rebecca Gaul (u), Laura Hochstetler (u). Asbury University
Whatever Floats Your Boat
How might one schedule an optimal mix of river rafting trips, of varying duration (within the range of 6 through 18 nights on the river) and propulsion (motor or oar) that will utilize campsites in the best way possible while minimizing contact between camping groups? Our solution to this problem from the 2012 Mathematical Contest in Modeling highlights a relationship between the greatest common divisors of trip durations, leading to construction of an optimal schedule.

Beth Bradley (f), University of Louisville
Using a 3D finite volume for the pressure gradient force in atmospheric models
We present a finite volume algorithm for approximating the pressure gradient force (PGF) in atmospheric models. Typically, meteorological models discretize equations generated from a PDE model. In the present work, we examine the use of a finite volume approach, which relieves difficulties encountered in earlier algorithms: It allows for a terrain-following vertical coordinate while significantly reducing truncation errors generated by the approximation. We compare the current model to a 2D finite volume model produced by Lin in 1997.

Joshua Bradley (u), Morehead State University
HyperNEAT Chess
In this presentation, we discuss the application of a relatively new neuroevolution algorithm, called Neuroevolution of Augmenting Topologies (NEAT), to the game of chess. We will explain the benefits of using a Hypercube-based encoding scheme and how it can improve performance. Current work and results toward the creation and implementation of a distributed version of this algorithm will be presented as well.

Kaity Bradley (u), Aaron Hill (u), and George Lytle (u), Asbury University
Embezzlement: the Katz out of the Bag
As part of the Consortium on Mathematics and its Applications Interdisciplinary Contest in Modeling, this presentation implements a modified version of the Katz Centrality from graph theory to analyze a message network in an embezzlement case.

Russell Brown (f), University of Kentucky
Central Kentucky Mathematics Circles
A mathematics circle is an informal educational activity where professional mathematicians work with students or school teachers to explore new mathematical ideas through problems and hands-on activities. I will describe several mathematics circles operating in central Kentucky and list sources of funding and support for those who are interested in starting a mathematics circle.

Daniel W. Burton (u), Jennifer J. Birriel (f), Ignacio Birriel (f), Morehead State University
VLF Observations of Meteor Showers Using the INSPIRE VLF-3
The INSPIRE (an acronym for "Interactive NASA Space Physics Ionosphere Radio Experiments") Project has been providing simple, low-cost use receivers for high school and college students to observe very low frequency (VLF) radio waves from Earth's ionosphere. It can detect VLF signals from natural and man-made sources in the frequency range of 0-22 kHz. INSPIRE was originally designed for the study of VLF waves generated in lightning strikes to study Earth's magnetosphere and ionosphere; however, the investigators have utilized the device to study the VLF emissions associated with meteor showers. The presenter will discuss some preliminary results.

Zachariah Casey (u), Northern Kentucky University
Darboux Springs
Darboux Helices are space curves that have constant non-zero Darboux curvature and torsion. We found that the curves are always bounded and lie on a hyperboloid but is only closed when the constant non-zero Darboux curvature and torsion are two of a Pythagorean triple. This presentation shows various examples of what Darboux Helices would look like.

Jorge Chang (u), Morehead State University
Kentucky Rook: How to Win
Rook is a card game in which two teams of two layers aim to reach a certain amount of points by taking specific cards in a series of tricks. The tricks consist on each player playing a card; the player who played the card with highest value takes the trick. This project aims to uncover the nature of the game and develop an algorithm to increase the chances of winning the game. The approach taken was to program an artificial intelligence for the game capable of following an algorithm to win the game every time chances allow it and relying as little as possible on luck.

Chris Christensen (f), Northern Kentucky University
Fruit Attack
JN-25, the primary Japanese naval code of World War II, used additives. British and American codebreakers tried to separate the additives from the code groups first by hand and then by machine (and then went back to "by hand"). One of the machines used to attack JN-25 was built at National Cash Register in Dayton, Ohio. Because of its appearance, the British called the machine "Fruit." We will consider how Fruit operated and how it was used to attack JN-25.

Tyler Clark (g), Western Kentucky University
Continued Radicals and Cantor Sets
We will construct several continued radicals and look at their convergence properties. Furthermore, we will look at some conditions in which a continued radical creates a set homeomorphic to the cantor set. Finally, we will examine the measure of the generated Cantor sets.

Tarah Cole (u), Northern Kentucky University
Assessment of Risk Factors for Truancy of Children in Grades K-12 Using Survival Analysis
Survival Analysis is a time-to-event statistical analysis commonly used to assess risk of particular events based on available predictors. This presentation provides a brief overview of survival analysis, primarily focusing on the methodologies and results from a study conducted to evaluate risk factors pertaining to truancy using data obtained from a large Kentucky school district.

D. Coulliette (f), K. Rietz (f), and N. Brabon (u), Asbury University
Rate-Limited Sorption Modeling in Contaminant Transport
Computational models of contaminant transport are used regularly for designing subsurface environmental remediation systems. These models predict the movement of the contaminant 'plume' through a porous media containing groundwater. In many soils, the contaminant sorbs to the solid matrix in the porous media. As a result, the rate at which this contaminant may be removed by traditional pump-and-treat flushing is much slower than that of the contaminant in the fluid portion of the media. This phenomenon is called rate-limited sorption (RLS) and it is particularly problematic in cases where the contaminant has been in place for a long period of time. Although RLS has been noted in the academic literature for years, production models used for field work have failed to incorporate the issue. This work presents preliminary results of an attempt to model RLS in a production contaminant transport code.

Daniel J. Curtin (f), Northern Kentucky University
The History of the KYMAA
The national MAA was founded in 1915. In 1916 the Mathematics Section of the Association of Kentucky Colleges and Universities, founded in 1909, applied for membership. In 1917 it became the Kentucky Section of the MAA. In 2015 the MAA celebrates its centennial, and in 2017 we celebrate ours. A history of the MAA, including histories of the sections is in the works. This talk is a preliminary report in which I will discuss the founding of KYMAA, the role of private and public institutions and the early role of women in both leadership and the scholarly program. I will also touch on Dick Davitt's work on Jewish mathematicians fleeing the Nazi regime who were welcomed into Kentucky.

Daniel Dilger*‡, Samantha McKean*, Luke Yap* Bruce Kessler (f), WKU
(* undergraduate student (Gatton Academy), ‡ presenter)
The Ricky McCormick Murder Notes III: Background and Initial Attempts at Decoding the Notes
St. Louis resident Ricky McCormick was found dead in 1999, with no clues as to who killed him except notes found in his pocket written in some type of code used by McCormick. FBI cryptologists worked for 12 years trying to decode the notes, eventually releasing the notes to the general public. This talk will provide the results of our efforts to decode the notes, using the notion that the "words" in the note represent a unique language that McCormick used to avoid incriminating himself. We will show how we used computational methods on WKU high-performance computer to reach these results.

Josh Edge (u), Transylvania University
A Tail of Two Palindromes
The idea of a palindrome, a word or expression that is read the same forward as backward, has been discussed in great detail across a variety of disciplines. The Chinese have even developed a poetic form centered around the palindrome. As such, it seems that the palindrome even reaches into the field of mathematics. This talk will explore the continued fraction representation of numbers and discuss the relation between a number that has a palindromic continued fraction representation and its conjugate.

Claus Ernst (f), Western Kentucky University
Mathematica project of students of the Gatton Academy of Mathematics and Science
Since 2007 WKU houses the Gatton Academy of Mathematics and Science in Kentucky. The Gatton academy is a residential high school for Kentucky juniors and seniors interested in advanced careers in science, technology, engineering, and mathematics. In this talk we will demonstrate examples of mathematica projects developed by Gatton students in a course called Advanced Computational Problem Solving. This projects range from games and puzzles to projects supporting student research.

Leanne Faulkner (f), Kentucky Wesleyan College
What I have learned in two years of Common Core State Standards
The Common Core State Standards for Mathematics are being used in Kentucky this year. This presentation will discuss changes to the courses math for elementary teachers, a new verticality course, and changes to the mathematics major at KWC.

Finley Freibert (g) and Jon-Lark Kim (f), University of Louisville
Classification of CIS Codes of Length 14
In the paper A new class of codes for Boolean masking of cryptographic computations, Carlet, Gaborit, Kim, and Sole defined a new class of rate one-half binary codes called Complementary Information Set (CIS) codes. CIS codes have relations to classical Coding Theory as they are a generalization of Self-Dual codes. CIS codes also have important practical applications as they may improve the cost of masking cryptographic algorithms against side channel attacks. In the paper the authors classified all CIS codes of length less than or equal to 12. In this talk we summarize a result for the classification of length 14 CIS codes.

Nathan Gambrell (u), Northern Kentucky University
Construction of a Kid Krypto Algorithm
Neal Koblitz, one of the developers of elliptic curve cryptography, claims that cryptography "has a tremendous potential to enrich math education" because it puts mathematics in a dramatic setting (spies, intrigue, adventure, etc.) and because cryptography is a counter balance to the impression that students often have that any mathematical problem can be solved quickly. As a way to take advantage of the interest that students might have in cryptology, Koblitz proposed the concept of *Kid Krypto*: *Kid Krypto* is the development of cryptographic ideas that are accessible and appealing (and moderately secure) to those who do not have university-level mathematical training. In this presentation we will construct an encryption algorithm based upon modular multiplication that implements the goals of Koblitz's *Kid Krypto*.

Ryan Gill (f), University of Louisville
Regression Methods with High Dimensional Inputs
In regression problems with high dimensional inputs, least squares estimates are often not possible or not adequate and modifications must be considered. This presentation compares several methods for variable selection and coefficient shrinkage for fitting regression models with high dimensional data and these methods are illustrated with real data.

Isaiah Harney (u), Transylvania University
A Rational Approach to Irrationality
Ivan Niven provided a canonical proof of the irrationality of pi. This presentation will give a detailed explanation of his proof targeted for an undergraduate audience. To this end, the key steps of the proof use basic results from calculus and algebra but combine to form a powerful result.

Betsy Heines (u), Transylvania University
The King's Roundtable: Couples Only
The King is having a party and is inviting couples to dine with him. Will he be able to seat everyone around his table according to the royal protocol which places spouses based on how long they have been married? The result gives us a new characterization of prime numbers.

Cyrus Hettle (u) and Robert Schneider (u), University of Kentucky
Al-Jabar: A Mathematical Game of Strategy *I and II*
We present the basic structure and rules of the game *Al-Jabar*, based on intuitive concepts of color-mixing and ideas from abstract algebra. Game-play consists of manipulating colored game pieces; we discuss how these pieces form a group structure and how this structure, along with an operation used to combine the pieces, is used to create a game of strategy. Moving beyond the initial structure of the game, we then consider other group structures and arrays resembling vectors and matrices. These different structures necessitate changes to certain rules of play; however, those rules were initially determined using general formulas that can be easily extended.

Logan Higginbotham (u), Morehead State University
***Of Fish and Bus Routes*: Finding more efficient bus routes for Rowan Schools**
I intend to find a more cost effective system of bus routes by first using the Capacitated Arc Routing Problem (CARP) model. From there, I will use a transformation described in the paper "Exact Methods Based on Node-Routing Formulations for Undirected Arc-Routing Problems" so that the CARP will be a Capacitated Vehicle Routing Problem (CVRP). I will then solve the CVRP and reverse the transform back into a CARP.

William M. Holbrook II (u), Morehead State University
Approaching the n+k-Queens Problem Through Composition of Solutions
The $n+k$ Queens Problem asks for placing $n+k$ Queens and k Pawns on an nxn chessboard so that no two Queens attack each other. It has been proven that the problem has a solution when $n > \max\{87+k, 25k\}$. In an attempt to obtain nice patterns and lower this bound on n, we have looked at composing solutions and partial solutions for smaller values of n to obtain solutions for larger values of n.

Ronnie Howard (u), Morehead State University
Statistical Mechanics and Knot Mosaics
Mathematicians have often used techniques from physics to solve combinatorial problems. A famous example of this is the solution of the alternating sign matrix conjecture, which relied heavily on methods from statistical and quantum mechanics. Here we discuss the problem of enumerating knot mosaics and make comparisons with solving the Ising model of planar crystals in statistical mechanics.

Rasitha Jayasekare (g), University of Louisville
Multiple Change Point Estimation in a Liquidity Effect Model.
This presentation proposes a method of estimating unknown model parameters in a liquidity effect model with change points in finance. The unknown parameters in this model include the number and location of the change points as well as other regression parameters present in the liquidity effect model. Stock price data from Federal Express (FDX) is used to illustrate the method.

Elizabeth Krantz (g), Western Kentucky University
Sharpening The Boundaries Of The Sequential Probability Ratio Test
In this talk, we present an introduction to Wald's Sequential Probability Ratio Test (SPRT) for binary outcomes. Previous researchers have investigated ways to modify the stopping boundaries that reduce the expected sample size for the test. In this research, we investigate ways to further improve these boundaries. For a given truncation point, we consider all possible boundaries. We then find the one set of boundaries that minimizes the maximum expected sample size while still preserving the error rates.

Maxfield Leidner (g), University of Louisville
The Total Chromatic Sum and Untemperable Graphs
A total coloring of a graph is a coloring of its vertices and edges so that no two adjacent or incident elements have the same color. Its total chromatic number X" is the least number of colors necessary to total-color it. Its total chromatic sum is the smallest sum that can be obtained by total-coloring it with natural numbers and adding those numbers together, and an optimal total coloring is one that achieves this sum. In this presentation, it will be shown that, for some graphs, it is impossible to get an optimal total coloring without using more than X" colors.

James Little (u) and Jennifer Birriel (f), Morehead State University
Long-term Monitoring of Night-Time Sky Brightness in Morehead KY
Light pollution is a pervasive form of environmental pollution that affects humans, animals, and the entire world. We use a Sky Quality Meter with Lens and Ethernet (SQM-LE) permanently installed on the roof of Lappin Hall on the campus of Morehead State University to obtain a quantitative measurements of night sky brightness. We perform fairly simple analyses of our data such as cataloging the number of dark, clear nights versus cloudy nights and determining the darkest and brightest recorded magnitudes. We will be using our data to help test a empirical relationship relating sky luminence as recorded by Unihedron SQM-LE devices and degree of cloudiness recently developed by Christopher Kyba of Institute for Space Sciences, Freie Universität Berlin.

Bryiah Loper (homeschool student), Wilmore
The Art of Math
In western civilization, origami has been viewed as nothing more than a child's pastime consisting of paper planes and waterbombs. However, over the past 50 years, origami has evolved into a incredible, sophisticated form of art with a high degree of order. As a result of this, origami is deeply interwoven into mathematics, and most especially, geometry. Careful examination will reveal the geometry in any origami construction, but with the more modern developments in modular origami, tessellations, and even representational works, mathematical links have become even more obvious. Origami represents the artistic side of mathematics, which can be appreciated by beginners and masters, alike. In this presentation, I hope to explain origami's connectivity between math and art.

Andy Martin (f), Kentucky State University
Should it be called the "Dirichlet Rearrangement Theorem"?
One of my all-time favorite results is that usually referred to as the "Riemann Rearrangement Theorem." This talk will discuss that result as well as address the question of whether the right mathematician is receiving credit for it.

Andy Martin (f), Kentucky State University
Inconsummate Numbers
John Conway defined a positive integer n to be an Inconsummate Number provided no positive integer is equal to the product of its own digit sum and n. (For example, 8 is not such as $72 = (7+2) \times 8$.) Do any Inconsummate Numbers exist? If so, how many are there?

Rus May (f), Morehead State University
How Hard Can the First Problem in Graph Theory Be?
With the Konigsberg bridge problem, Euler famously showed that his namesake circuits exist in a connected graph exactly when the degrees of the graph's vertices are all even. More generally, one could hope to count the number of Euler circuits in such graphs. Oddly enough, this is a formidable problem, even in complete graphs. We discuss algorithmic and asymptotic attempts to enumerate these circuits in complete graphs and hope to gain an appreciation of the depth of the problem.

Alex M. McAllister (f), Centre College
Mathematics and Drama in Ancient Greece
Over the last two years, a drama professor and I developed an inter-disciplinary course entitled *Mathematics and Drama in Ancient Greece*. During January 2012, we team taught this course in Greece. This presentation will share the syllabus, the structure, and some of the content of this course. Particular emphasis will be placed on teaching the Pythagorean Theorem and the insolvability of doubling the cube with an unmarked straightedge and compass to a diverse audience of students.

Michael McCord (u), Morehead State University
Upper Bounds on Crossing Numbers of Knots in Radius 2 Hextile Knot Mosaics
Lomonaco and Kauffman's investigation of characteristics and classifications of knots developed in square tile mosaics inspired the study of hexagon tile mosaics. This project investigates the maximum number of crossings that a number of various families of knots can have and still fit in a radius 2 hexagon knot mosaic.

Samantha McKean*‡, Luke Yap*, Daniel Dilger*, Bruce Kessler (f), WKU
(*undergraduate student (Gatton Academy), ‡ presenter)
The Ricky McCormick Murder Notes I: Background and Initial Attempts at Decoding the Notes
St. Louis resident Ricky McCormick was found dead in 1999, with no clues as to who killed him except notes found in his pocket written in some type of code used by McCormick. FBI cryptologists worked for 12 years trying to decode the notes, eventually releasing the notes to the general public. This talk will provide a background into the problem and our initial research efforts to decode the notes.

Anthony Montemayor (g), Western Kentucky University
Generating Random Polygons in Spherical Confinement
To test biological models of DNA packing such as in the capsid of a bacteriophage, it is important to have a fast algorithm to generate random polygons in confined spaces. This talk will discuss the development of such an algorithm in the case of spherical confinement using elementary results in statistics.

Lan Nguyen (f), Western Kentucky University
Taylor series of solutions of differential equations
Is there any relation between a Taylor series $f(x) = \sum_{k=0}^{\infty} f^{(k)}(a)\frac{(x-a)^k}{k!}$ and a solution of the differential equation $X'(t) = AX(t)$? Yes, this presentation will derive (almost) all Taylor series of functions from the properties of solutions of (linear) differential equations.

Robert C. Powers (f), University of Louisville
A Celebration of May's Theorem
In 1952, Kenneth May gave an elegant characterization of the simple-majority voting rule. May's Theorem is a fundamental result in the area of mathematical social choice. In this talk, we will look at some generalizations of May's Theorem.

Frank Raymond (f), Bellarmine University
A Characterization of the Solution to the Stochastic Multi-dimensional Bellman Equation with an Application to Resource Management
Although existence of a multidimensional closed form solution to the multi-sector Bellman model remains an open mathematical question, this analysis offers a characterization which may be applied to various scenarios. The application herein involves the optimal management of renewable and nonrenewable resources within the context of a stochastic model of optimal control. By characterizing the two dimensional Bellman solution, three rules with respect to resource management are established. Within the context of coastal development, this analysis may help to explain why renewable resources may become increasingly vulnerable to random external shocks as nonrenewable resources are depleted.

Tom Richmond (f), Western Kentucky University
Counting Convex Topologies on a Finite Totally Ordered Set
It is an old problem to find the number T(n) of topologies on an n-point set. For example, T(1) = 1, T(2) = 4, and T(3) = 29. With the aid of large scale computing, the values of T(n) are now known for all values of n up to 18. We focus on finding the number $T_{con}(n)$ of topologies on a finite totally ordered set of n elements which have a base of convex sets, that is, of intervals. We present a recursive algorithm for finding $T_{con}(n)$.

Rebekah Robinson (u), University of Louisville
Confidence Estimation in Segmented Regression
Standard regularity assumptions for regression models are not satisfied in segmented regression models with an unknown change point, and consequently standard inferential methods for confidence estimation are not applicable. This presentation discusses these issues for a segmented regression model with a continuity constraint and proposes a new method of obtaining confidence intervals for the change point parameter in this new setting.

Ryan Stuffelbeam (f), Transylvania University
How Weird are Weird Fractions?
A common mistake made by students is cancelling like digits in the numerator and denominator of a fraction. A weird fraction is a fraction that remains correct after such an invalid reduction. In this presentation, we will discuss a recipe for creating weird fractions and attempt to quantify the prevalence of weird fractions.

Ryan Therkelsen (f), Bellarmine University
Some Properties of Generalized Partitions
A partition of an integer n is a way of writing n as a sum of positive integers, usually described as a sequence of these summands recorded in non-increasing order. In this talk, I will describe what happens when the "non-increasing" convention is relaxed (in a specific way). Under the dominance order, the resulting poset has some nice properties and arises naturally in the study of a certain decomposition of n-by-n matrices.

Matias von Bell (u), David Musser (u), Laura Smith (u), Asbury University
Leaf it to Math
This is a presentation of our team results for the COMAP mathematics contest in modeling. Our task included classifying leaves mathematically, providing a method for numbering and weighing the leaves on a tree, and finding correlations between leaf shape and branching structure.

Ryan Walls (g), Murray State University
A Binary Integer Programming Model for the Optimal Location of Fire Stations: A Case Study of Murray, KY
Where should a city build fire stations to ensure uniform coverage for the entire city? This presentation offers an operations research solution via an integer programming model. The model is demonstrated for the City of Murray, KY.

Devrion Wells (u), Kentucky State University
Graph Theory and its Connection to Today's World
Graphs are mathematical structures that are created using collections of vertices and edges. (Not to be confused with a graph of some function) They are generally used for showing some types of relation between multiple locations, objects, or entities. Graph Theory has been associated with many different subjects and I would like to touch upon some of its applications, and how this growing area of mathematics came about.

Susan C. White (f), Bellarmine University
Ramsey Functions for Quasi-Progressions with Large Diameter
A -term quasi-progression of diameter is a sequence of positive integers in which the distance between any two consecutive terms is at least and at most for some positive integer . Arithmetic progressions are quasi-progressions with diameter . Let denote the least positive integer such that every two-coloring of contains a monochromatic -term quasi-progression of diameter . We find values of for some quasi-progressions of large diameter; that is, . The results partially settle several conjectures due to Landman [Ramsey Functions for Quasi-Progressions, Graphs and Combinatorics 14 (1998) 131-142]. This is joint work with Adam Jobson, André Kézdy, and Hunter Snevily.

D. Jacob Wildstrom (f), University of Louisville
Domination density in stacks of graphs
The Cartesian product of a graph G and a large path P_n can be thought of as a *stack* of copies of G. The domination numbers of such stacks are asymptotically linear in n, and the coefficient of linearity can be thought of as the *density* of the domination. This presentation will establish that the stack domination density is well-defined, discuss bounds and computational techniques for the stack domination density, and exhibit the specific stack domination density both of specific graphs and of certain graph families.

Kara Wiltrout (u), Carl Durcholz (u), Cali Thomas (u), Asbury University
ρ, ρ, ρ Your Boat
Our presentation is on a solution to one of the annual COMAP problems. The problem was to optimize the number of boating and rafting trips a company can offer based on number of available campsites. Our model allows for the user to manipulate the majority of the dependent variables, creating a more functional model.

Luke Yap*‡, Daniel Dilger*, Samantha McKean*, Bruce Kessler (f), WKU
(* undergraduate student (Gatton Academy), ‡ presenter)

The Ricky McCormick Murder Notes II: Background and Initial Attempts at Decoding the Notes

St. Louis resident Ricky McCormick was found dead in 1999, with no clues as to who killed him except notes found in his pocket written in some type of code used by McCormick. FBI cryptologists worked for 12 years trying to decode the notes, eventually releasing the notes to the general public. This talk will provide the theoretical background for our current efforts to decode the notes, using the hypothesis that the notes are not truly a code at all, but a unique language that McCormick used to avoid incriminating himself. We are using linguistics, probabilistic phrase-structure grammars, and basic probability to try to determine the parts of speech of certain "words" that are used repeatedly in the notes, in the hopes of being able to understand this language.

April York (u), Transylvania University

Digit After Digit of Divisibility?: Generating Sequences of Composite Numbers

What happens when a digit is repeatedly appended to the right end of an integer? Are prime or composite numbers created? This presentation will answer these questions, drawing primarily on work of Lenny Jones using covering sets and the Chinese remainder theorem.