

MAA-SE at Belmont University, March 13-14, 2009

Abstracts of Talks

Sequence by Primary Author Last Name

Changing Student Views of Proof Through the Use of Technology, Angel Abney, Georgia College & State University, Janet Shiver, Georgia College & State University

Abstract: According to NCTM, "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (2000, p. 25). As emphasized by NCTM, technology should be used to build on students' current understanding and intuition rather than to replace a basic understanding in mathematics. In mathematics education courses at Georgia College & State University, prospective and current teachers explore mathematical ideas through the use of Geometer's Sketch Pad (GSP) and other mathematics specific software programs. This technology allows them to examine numerous examples or representational forms; far more than could be afforded by hand. This process of exploration helps students more readily make conjectures. GSP not only affords our students powerful visual representations, but also changes their perception of mathematical proof. It is our intention to share some of the ways that technologies, such as GSP, have enhanced the conjecturing process and changed students' views of the nature of proof.

Edgeworth Expansion for Linear Regression Processes with Long-memory Errors, Mosisa Aga, Auburn University Montgomery

Abstract: This paper provides an Edgeworth expansion for the distribution of the maximum likelihood estimators (MLE) of the parameter of a time series generated by a linear regression model with Gaussian, stationary, long-memory errors. Under some sets of conditions on the regression coefficients, the spectral density function, and the parameter values, an Edgeworth expansion of the density as well as the distribution function of a vector of centered and normalized derivatives of the PLL function of arbitrarily large order is established. This is done by extending the results of Andrews D. and Lieberman, O [2002] who provided an Edgeworth expansion for the Gaussian stationary long-memory case to a linear regression processes with stationary Gaussian long-memory errors.

2-dimensional Cohen-Macaulay Complexes with 2-Connected Links, Risto Atanasov, Western Carolina University

Abstract: A 2-dimensional simplicial complex Δ is Cohen-Macaulay if it is connected, the link of each vertex is connected, and the link of each edge is non-empty. The link of each vertex of Δ is a graph. A graph is 2-connected if the smallest number of vertices whose removal disconnects the graph is two. In this presentation we will discuss some properties of 2-dimensional Cohen-Macaulay complexes with 2-connected links as well as the reasons of our interest in studying them.

Tree-Like Spaces with the Fixed-Point Property, Jennifer Aust, University of Tennessee

Abstract: We present a sufficient condition for a tree-like space to have the fixed-point property. The tree-like space is realized as an inverse limit of special finite trees, and is presented in contrast to David Bellamy's 1979 example of a tree-like space that admits a fixed-point-free map. The strategy of the proof is an extension of the crucial idea in the proof that snake-like continua have the fixed-point property. We will describe this idea briefly in the context of the known result before extending it.

Writing Across the Curriculum and Writing in the Disciplines as they Relate to Mathematics, Patrick Bahls, University of North Carolina, Asheville, Nieves McNulty, Columbia College, Madeleine Schep,

Columbia College

Abstract: This short course will introduce participants to the basic ideas behind WAC and its offshoots, Writing to Learn (WTL) and Writing in the Discipline (WID), as they apply to mathematics. Then participants will learn how to incorporate writing in their own mathematics courses. They will learn about some simple WTL exercises suitable for use in math classrooms, and they will learn how to begin creating effective assignments asking students to construct meaningful and authentic written work in mathematics. Instruction will include tips and techniques on how to assess those writing assignments. The course will conclude with some suggestions for initiating department-wide activities related to WAC and WID in math.

Exploring Mathematics from the Khmer Empire, Paul Baker, Catawba College

Abstract: The Khmer Empire flourished in Cambodia for well over one thousand years. The Khmers built the largest temple complex in the world: Angkor Wat. The only surviving written records of the Khmer Empire are approximately 1200 stone inscriptions from the temples. In the summer of 2008 the presenter searched translations of the inscriptions for evidence about the state of Khmer mathematics. Despite Arabian and Hindu claims, there is evidence - etched in stone - that the Khmers were the first to use the number Zero. Other features of ancient Khmer mathematics will also be presented.

Julia Sets as Limits of Surface Projections, Julia Barnes, Western Carolina University,
Beth Schaubroeck, United States Air Force Academy

Abstract: Julia sets for the family of complex functions $f_c(z) = z^2 + c$ have been well-studied for years, and many people are familiar with the images of these Julia sets. However, the graphs of the functions $f_c(z)$ themselves and their iterates are more difficult to visualize because they live in four-space. In this talk, we explore the graphs of these functions by analyzing the graphs of the real and imaginary parts of the iterates of $f_c(z)$. Then we look at the limit of these projections and explore the connections between these graphs and the Filled Julia sets of the corresponding functions.

Differential Equations and the TI-89, Daniel Biles, Belmont University

Abstract: I will overview the use of the TI-89 calculator in teaching the undergraduate ordinary differential equations course. I will supply the necessary steps for using the differential equation functions of the TI-89 - no experience with the TI-89 will be assumed.

MAA Educational Policy, David Bressoud, Macalester College

Abstract: I will talk about the MAA Educational Policy and how to bring this policy to the sections.

Proofs and Confirmations: The Story of the Alternating Sign Matrix Conjecture, David Bressoud, Macalester College

Abstract: What is the role of proof in mathematics? Most of the time, the search for proof is less about establishing truth than it is about exploring unknown territory. In finding a route from what is known to the result one believes is out there, the mathematician often encounters unexpected insights into seemingly unrelated problems. I will illustrate this point with an example of recent research into a generalization of the permutation matrix known as the "alternating sign matrix." This is a story that began with Charles Dodgson (aka Lewis Carroll), matured at the Institute for Defense Analysis, drew in researchers from combinatorics, analysis, and algebra, and ultimately was solved with insights from statistical mechanics. This talk is intended for a general audience and should be accessible to anyone interested in a window into the true nature of research in mathematics.

The Importance of Fuzzy Logic and Its Applications, Melvin Bridges, Alabama State University

Abstract: Fuzzy theory has become a breakthrough of measuring or providing model to subjective ambiguity. Fuzzy theory is a theory that studies ambiguities and can be used for numerical analysis of ambiguities. In this project we will use fuzzy logic to show how ambiguity to useful in mathematics and give several examples.

Topological Invariants of Putative Exotic Complex Projective Spaces, Ryan Brown, Georgia College, Jan Segert, University of Missouri

Abstract: A classical problem in complex geometry is to determine the conditions under which two manifolds with the same differentiable structure admit different complex structures. We will call a complex manifold an exotic complex projective space if it is diffeomorphic, but not biholomorphic, to the complex projective space, with its standard complex structure. It is unknown whether such exotic structures exist, but E. Thomas has previously given necessary and sufficient conditions for an element of the cohomology ring to occur as the total Chern class of an almost-complex structure in low dimensions, establishing the existence of exotic almost-complex structures. In this talk we show that most of these elements cannot occur as the total Chern class of a complex structure with multiplicative group symmetry.

Using Clickers to Teach Statistics, Derek Bruff, Vanderbilt University

Abstract: This talk will describe the use of a classroom response system to engage and assess students in a probability and statistics course for undergraduate engineering students. The system makes it possible to expect all students to think about and answer (using handheld clicker devices) the questions posed to them by instructors, leading to greater participation and engagement. The system also provides immediate feedback on student learning, allowing instructors to tailor class sessions to the learning needs of students. Furthermore, asking multiple-choice questions in this way can help students develop conceptual understanding of important ideas in statistics. Conceptual understanding is the primary learning goal in the course, and it is one that can be difficult to achieve with students who are often focused on procedures and computations. Thus, clickers help to create an active, responsive learning environment during class in which students are engaged with important course content. The talk will feature sample clicker questions from statistics as well as a description of ways to structure class time to take advantage of clickers.

Analysis of Order of Error for Numerical Solution of Multiple Nonlinear Volterra Integral Equations, Yuriy Bulka, Austin Peay State University

Abstract: We look at a class of causal equations with memory that are more general than ordinary nonlinear Volterra integral equations, namely the Multiple Nonlinear Volterra Integral Equations (MNVIE). They are used to model general causal systems with memory, which are physically realizable, and thus important in different fields. We show that the output process in a general system, described by polynomial Volterra operators, is obtained as a solution of such an equation when the system contains a feedback mechanism, like in systems with controls. We assume that the kernels of the equations are Lipschitz. We propose a finite difference scheme for numerical solution of MNVIE, which is a generalization of the second-order composite-trapezoidal scheme, by adopting terminology of ODEs. We show that the global error of this method is of the order of square of the step of partition.

Pólya's Theorem With Zeros, Mari Castle, Kennesaw State University

Abstract: Let $\mathbf{R}[X] = \mathbf{R}[X_1, \dots, X_n]$ and let Δ_n denote the standard n -simplex $\{(x_1, \dots, x_n) \in \mathbf{R}^n \mid x_i \geq 0, \sum_i x_i = 1\}$. Pólya's Theorem says that if a form (homogeneous polynomial) $p \in \mathbf{R}[X]$ is positive on Δ_n , then for sufficiently large $N \in \mathbf{N}$, the coefficients of $(X_1 + \dots + X_n)^N p$ are positive. In this talk, we discuss a generalization of Pólya's Theorem to form which are allowed to have zeros in the simplex. We give a characterization of forms which satisfy the conclusion of Pólya's Theorem (with "positive coefficients").

Using Elasticity To Assess the Effects of Precipitation on Plethodon Salamanders, Mark Cawood, Clemson University

Abstract: Elasticities quantify proportional changes of a population due to small proportional changes in demographic parameters, such as survival rates and reproduction. It is known that precipitation affects the number of eggs laid by female salamanders. In this talk, we use elasticity to quantify the effect of precipitation on Plethodontid salamanders.

Closed Relations and Stability in Dynamical Polysystems, George Cazacu, Georgia College and State University

Abstract: This paper follows the ideas of E. Akin in an attempt to ease the problem of finding strict Lyapunov functions for dynamical polysystems. Results obtained in the context of closed relations are used in conjunction with Chain-recurrence and Lyapunov functions.

Scaling Graphs of Curves to Demonstrate Behavior, Jeffrey Clark, Elon University

Abstract: In his work *Beautiful Evidence*, Edward Tufte refers to studies that show that the behavior of plots of ordered paired data are most easily understood if the scaling for the display is chosen so that the average slope between adjacent points (positive or negative) is 45 degrees. This talk will examine using such a criterion in choosing the scaling for the graphs of curves.

Modeling and Optimizing HIV Treatment, Nicholas Clark, Xavier University

Abstract: Highly active antiretroviral therapy (HAART) is currently the standard treatment for the Human Immunodeficiency Virus (HIV). We modify an existing system of differential equations describing the interaction of the HIV virus with the human immune system. In this model, we incorporate variables representing typical HAART treatment with three drugs: Two Nucleoside Reverse Transcriptase Inhibitors (NRTIs) and one Protease Inhibitor (PI). We form an optimality system which includes the adverse side-effects of these drugs and solve this system numerically using the Runge-Kutta order four algorithm in order to determine the treatment that will maximize the quantity of CD4+ T-cells in a patient (strengthening the immune system) while minimizing hazardous side effects of the drug treatment on a patient's health.

A Motivated Cauchy (Extended) Mean-Value Theorem, Robert Clay, Dalton State College

Abstract: The proof of the Cauchy Mean-Value Theorem in most elementary texts (that still include it) pulls a function out of the air and applies Rolle's Theorem to it. The purpose of this note is to show that this function arises naturally from the geometric interpretation of the function and to give a proof that analogous to the usual proof of the Mean-Value Theorem. The proof allows a weakening of the hypotheses.

BRT Polynomials of a Link Family, Melissa Cook, Berry College

Abstract: We will explore the properties of a specific link family through looking at associated dessins and the BRT (Bollobas, Riordan, Tutte) polynomials. We will first give a brief introduction into knot theory and give necessary definitions. Next, we will discuss the relationships between the links, dessins and BRT polynomials. The final results and future investigations of this topic will conclude the talk.

Physical Numbers and the Return of the Infinitesimal, Brian Crissey, North Greenville University

Abstract: The Reals (\mathbf{R}) traditionally include numbers whose precision might be finite or infinite. \mathbf{R} can be partitioned into Physical numbers (\mathbf{P}) and Unimaginable numbers (\mathbf{U}). \mathbf{P} is the proper subset of \mathbf{R} that includes rationals and all those numbers that Solomon Feferman, in his well regarded 1998 work *In the Light of Logic*, defined as intended for measuring objects in our universe. A repeating decimal,

when converted into the radix of its denominator, becomes a non-repeating rational, and so belongs to \mathbf{P} . Included in \mathbf{U} but excluded from \mathbf{P} are numbers that cannot measure objects in our universe, which include irrationals, all numbers of infinite precision, and all outputs of non-terminating processes. No human lives long enough to sequentially imagine all the digits that belong to any member of \mathbf{U} , hence the designation as Unimaginable numbers. Two numeric expressions whose evaluations cannot be differentiated correspond to the same measurement in the universe and thus map onto the same member of \mathbf{P} . Max Planck established quantum limits on meaningful measurement. Each Planck value is a combination of three fundamental constants: \mathbf{c} (the velocity of light), \mathbf{g} (the gravitational constant), and \mathbf{h} (Planck's constant). Planck values for time, length, area, volume, and mass limit the maximal precision by which meaningful measurements may be taken. Quantum-limited precision in our universe makes it meaningless to try to distinguish two numbers differing only in the digits beyond the quantum limit. Attempts to measure more precisely than the appropriate Planck limit lead into gray, formless probability spaces, where there is nothing "physical" to measure. It is at this point that pure and applied mathematics diverge, where insistence on applicability to the real world requires some pure mathematical results to be discarded. Partitioning \mathbf{R} into \mathbf{P} and \mathbf{U} allows a re-examination of the cardinality of \mathbf{R} and of the usefulness of the subfield of transfinite mathematics. Georg Cantor's famous diagonal proof of the non-denumerability of \mathbf{R} requires the inclusion in \mathbf{R} of infinitely long digit expansions that can only be expressed as the output of denumerable non-terminating procedures. Such expressions are in \mathbf{U} , not \mathbf{P} . Thus it follows that it is only the relatively useless subset \mathbf{U} , and not \mathbf{P} , which is non-denumerable. The cardinality of \mathbf{P} , the useful subset of \mathbf{R} , is \aleph_0 , the cardinality of the integers. To confirm this from another perspective, observe that the existence of Planck limits leads inexorably to the conclusion that in our universe there is a smallest unit of measurement of time, length, area, volume, and mass. Every member of \mathbf{P} therefore maps into an integer whose fundamental unit of measurement is this smallest unit of measurement, the legendary infinitesimal, which we will designate p in honor of Max Planck. Thus, as before, the cardinality of \mathbf{P} must be \aleph_0 , the cardinality of the integers. The quantum divide between pure and applied mathematics has many implications. Here is one small example: In applied mathematics, asymptotes really do touch their limits when the difference between the function and its limit fall below the infinitesimal p . The reason is that measurements below p are indistinguishable from zero in our quantum universe. In the world of meaningful, or applied, mathematics, all useful mathematics can be restricted to the \mathbf{P} subset of \mathbf{R} . David Hilbert's Continuum Hypothesis that \mathbf{c} , the presumed cardinality of \mathbf{R} , is the first cardinal larger than \aleph_0 , is thus rejected for the meaningful subset \mathbf{P} of \mathbf{R} , whose cardinality does not exceed \aleph_0 . The cardinality of \mathbf{U} , on the other hand might indeed be \mathbf{c} , but one must ask who cares any longer? One might as usefully try to estimate the number of angels that can dance on the head of a pin.

The CDSSOLN Software Package: Efficient Software For Solving Large Sparse Linear Systems,
Moses Davis, Alabama State University

Abstract: The CDSSOLN Software package, written using MATLAB code, was designed to find solutions to large sparse linear systems. Such systems often arise from elliptical partial differential equations whose solutions are estimated using finite difference methods. These linear systems may be symmetric or nonsymmetric in nature. The CDSSOLN software package is user-interactive and consists of basically five components: the selection of an acceleration scheme, the selection of a preconditioner, input of initial settings, the performance of computations, and the selection of solution output. The objective of this research project is to revise and update the CDSSOLN software package to include current MATLAB programming code thus making the software more efficient.

Non-intuitive Strategies for Video Poker, Joe DeMaio, Kennesaw State University, Sean Ellermeyer, Kennesaw State University

Abstract: Playing poker against multiple opponents where the best hand takes the pot is quite different than playing video poker against a machine with fixed payouts for different hands. Conventional wisdom argues that one should never discard a made hand in hopes of a better hand. This is true when the best hand wins the pot and elements of betting, bluffing and human psychology come into play. Said elements

do not exist in video poker. In video poker, scenarios occur where one should discard a made hand with a small payout in the quest for a better hand with a larger payout. In this talk we present a sampling of these scenarios and provide the correct long term strategy for playing such a hand.

Two Courses with Different Prerequisites and Expectations Taught Simultaneously, Lothar Dohse, UNC Asheville

Abstract: Two courses with different levels of expectations, Mathematical Modeling (prerequisite: Calculus III) and Environmental Modeling (prerequisite Precalculus) were taught simultaneously. These two courses were populated by students of very different backgrounds and abilities. Although topics of the courses overlapped, one class had a significant mathematical component that required an understanding of calculus while the other did not. To assess students' progress, team projects and exams were used. While the exams for the two sets of students differed, All students worked on the same projects. Mixed groups comprised of Mathematicians and Biologists were required to work as teams on projects that had a mathematical and biological component. This presentation will give examples of the type of assigned problems and exam questions of this class, as well as a critical review of the effort.

Monty's Cognitive Dissonance, Christopher Duncan, Lander University

Abstract: Cognitive Dissonance describes a state in which a person's beliefs are at odds with each other. This talk will discuss the recent work of Yale economist M. Keith Chen in which he identifies a methodological flaw related to the Monty Hall Problem. This flaw may have led researchers in social psychology to incorrectly observe choice-induced dissonance when there is none.

Equiangular Lines and Parseval Frames, David Duncan, Coastal Carolina University

Abstract: The connection between the problem of finding n equiangular lines in k dimensional Euclidean Space, and the question about which Parseval frames are optimal for correcting messages with two erasures will be discussed. Finally, a criterion for the existence of equiangular lines in terms of n and k will be presented.

Using a Numerical Analysis course to revisit Calculus, Sean Eastman, Armstrong Atlantic State University

Abstract: Most of the algorithms in a typical Numerical Analysis course are based on concepts from Calculus that we assume the students are familiar with, but often aren't. This can be frustrating for students, who often wind up spending a lot of time.

Mathematics and Astronomy in Ancient Egypt and Greece, Steve Edwards, Southern Polytechnic State University

Abstract: We trace the historical development of astronomy, geometry, and number theory. We begin with what is known about these subjects in ancient Egypt, and trace the development of ideas through the thinkers in Athens and Alexandria. We will follow the progress of theories of the cosmos and see how they provided the basis for the Ptolemaic system, which was used for more than one thousand years. We will examine how the mathematical ideas of Egypt influenced those of Greece, and we will see how and why these ideas came into being.

All Math Software is Not Created Equal: What's the Difference?, Jordan Enzor, Hawkes Learning Systems

Abstract: The use of technology has become increasingly implemented in Mathematics courses, but what makes one software system different from another? Hawkes Learning Systems (HLS) is a unique program

proven to increase student learning, performance, and retention. Discover what makes HLS different and how those differences can help your students succeed!

Modeling Polar Bear Population in a warming Arctic Climate, Alexander Ford, UNC Asheville, Charles Helms, UNC Asheville

Abstract: Nowhere is global warming more evident than in the Arctic. The ice sheet is now diminishing by 30% per decade. This ice sheet is home to most of the world's polar bears, a species at risk of dying out this century. Using the STELLA (tm) software and current estimates of the polar bear population we developed a discrete time mathematical model to measure the impact that the loss of the Arctic ice sheet has on this population. This model is used to determine if it is possible for the polar bears to survive on the Arctic in the face of global warming.

Symmetric product of AR and Hilbert cube manifolds, Kailash Ghimire, Georgia Southwestern State University

Abstract: Let X be a compact AR which is not a Q- Manifold, and i, j be two + integers with $i < j$. For any positive n , the n^{th} symmetric product $F_n(X)$ of X is defined by $F_n(X) = \{A \subset X : A \text{ has at most } n \text{ points} \}$ with the Hausdorff metric topology. Some relation between $F_i(X)$ and $F_j(X)$ will be discussed in this presentation.

Pythagoras, Russell Glenn, Wofford College

Abstract: This presentation will focus on one of mathematics' first and possibly most mysterious characters; Pythagoras. We will focus briefly on the life of Pythagoras, emphasizing his exceptionally diverse influences, and then we will focus on his broader impact on society philosophically, scientifically, and mathematically. Although many of Pythagoras' ideas were wildly speculative, as we'll see, he made some very fundamental contributions to music, astronomy, number theory, and geometry. His thoughts and teachings have influenced many prominent people throughout history, and in many ways, he serves as an intellectual bridge between ancient mysticism and modern mathematics.

An Anatomy of a Fluid Flow With a Very Low Reynolds Number In a Semi-infinite Circular Tube, Gregory Goeckel, Presbyterian College

Abstract: Imagine that a pipe, blood vessel, or even an air tube gets partially blocked. How far downstream are the effects of the blockage noticeable? What happens to the velocities of the flow as it transitions from the blockage to it's fully developed stage? Are there any lasting residual effects of the blockage downstream? Using animated gif files that were created from data collected from techniques that I developed within my dissertation, this presentation will illustrate and explain the development of the axial, radial, and angular velocities of a fluid with a very low Reynolds number through a cylindrical pipe. The initial condition will simulate a half blocked pipe with a uniform axial velocity. The illustrations will show the developments of the velocities from the entrance condition through the flow's fully developed Poiseuille flow.

Never Give a Non-Mathematician an Even Break, Ron Gould, Emory University

Abstract: In this talk we will consider several situations where being a mathematician definitely gives you the advantage. In each case, applying a little elementary mathematics sways the outcome of the event.

These situations will include a "mind reading" card trick, where knowing the mathematics is critical to the performance of the trick, a simple coin flipping game where we can greatly tip the odds of winning in our favor and a paint-ball shootout, where a simple strategic change helps improve our chance for victory.

A Trait Network Model for Resource Allocation Strategies, Robert Gove, University of North Car-

olina, Greensboro, Rebecca Fogel, University of North Carolina, Greensboro, Jan Rychtar, University of North Carolina, Greensboro, David Remington, University of North Carolina, Greensboro

Abstract: We are developing models using the rock cress plant, *Arabidopsis lyrata*, as a model organism to understand the genetic basis for resource allocation between growth and maintenance vs. current reproductive output. *A. lyrata*, which is a perennial, is well-suited for this task because of its extensive variation in resource allocation strategies. Moreover, it is a sister of the annual model plant *A. thaliana*, and both plants have complete or nearly complete genome sequences. These facts, combined with the contrast between annual vs. perennial life histories, provide excellent conditions to examine resource allocation strategies and trade-offs. We have constructed a trait network to model the hierarchy of growth and reproductive traits in the plant and their influences on each other. From this trait network we derived a system of linear equations to simulate populations in which the phenotypic values for each trait are functions of genetic, environmental and upstream trait effects. The model is flexible in its ability to simulate different populations which have different traits under genetic control. By comparing the correlations of the phenotypic values in the model to field data we are able to test the predictive value of the trait network model as well as predict which traits may be under genetic control in that population.

Some L^p Inequalities for Polynomials, Narendra Govil, Auburn University

Abstract: If $p(z)$ is a polynomial of degree n and $p'(z)$ its derivative, then according to the well-known Bernstein's Inequality

$$\max_{|z|=1} |p'(z)| \leq n \max_{|z|=1} |p(z)|. \quad (1)$$

The above inequality of Bernstein was generalized by Zygmund [Proc. London Math. Soc. 34 (1932), 392-400], who proved that for any polynomial $p(z)$ of degree n , we have for $\delta \geq 1$

$$\left(\frac{1}{2\pi} \int_0^{2\pi} |p'(e^{i\theta})|^\delta d\theta \right)^{1/\delta} \leq n \left(\frac{1}{2\pi} \int_0^{2\pi} |p(e^{i\theta})|^\delta d\theta \right)^{1/\delta}. \quad (2)$$

In case the polynomial $p(z)$ has no zeros in $|z| < 1$ then the above inequality has been sharpened by de Bruijn [Indag. Math. 9 (1947), 591-598] for $\delta \geq 1$, and by Rahman and Schmeisser [Journal Approx. Theory 53 (1988), 26-32] for the case $0 \leq \delta \leq 1$. In this talk we will discuss inequalities analogous to (2) for some other classes of polynomials

Permutations Almost Avoiding Two Patterns of Length 3, William Griffiths IV, Southern Polytechnic State University

Abstract: A permutation is said to avoid a permutation pattern if no subsequence of the permutation matches the pattern. There are many interesting questions which can be asked in this area, and some of them are excellent for research involving undergraduates. In this talk, we shall present a brief overview of pattern avoidance, as well as a generalization called almost avoidance, where we are allowed to delete an element of the permutation before checking for the pattern. New results on the enumeration of permutations almost avoiding two patterns of length 3 will be shown.

Sudoku Calculus, Queen Harris, Georgia Perimeter College

Abstract: Many people enjoy working Sudoku Puzzles, especially students. Participants will be given original Sudoku Limits, Sudoku Derivatives and Sudoku Integrals. All participants will create a Sudoku Calculus Review to take home. Bring your calculators!

Centrality Measures in Social Network Analysis, Corley Henderson, Samford University

Abstract: Social network analysis uses graph theory and other mathematical tools to analyze relationships (e.g. friendships, financial transactions, etc.) between actors in a given system. How do we know who is

at the center of these networks? In this talk, I will describe three common measures used to determine the most central actor in a network: centrality, betweenness, and closeness. I will then discuss some general guidelines on how to use a network's structural properties to aid in determining which measure would be most suitable to use. If time permits, I will also touch on how to approach the concept of centrality in a network with weighted edges.

On the Alternating Sums $\sum_{k=0}^n (-1)^k \binom{n}{k} \binom{k}{a}$, Curtis Herink, Mercer University

Abstract: We use combinatorial methods to establish the values of these sums. The results are then applied to show how to express polynomials as linear combinations of a nonstandard basis. For the special case when the polynomial is a power of x , we give a combinatorial interpretation of the coefficients of the linear combination.

On the Numerical Solution of Stiff Ordinary Differential Equations Using Exponential Basis, Zachary Hodge, Austin Peay State University

Abstract: A numerical method for solving stiff ordinary differential equations is presented. Stiff systems are defined as having eigenvalues of significantly different magnitudes, and exhibit rapid transient portions on certain intervals. The method is constructed using exponential basis functions. Numerical examples of linear and nonlinear systems of equations are presented using the method.

Modeling Animal Mother-Infant Distance Proximity Over Time to Determine a Change Point in Behavior, Lorrie Hoffman, Armstrong Atlantic State University, Greg Knofczynski, Armstrong Atlantic State University, Steve Clark, SeaWorld

Abstract: Biologists frequently use a statistic referred to as the Hinde index (first appearing in the literature in 1970) in order to explain physical closeness of mother animals to their new-borns. The Hinde index is a proximity affinity index calculated from dynamic data that includes the number of approaches (an action that reduces the distance between the pair) and leaves (one that separates them) initiated by each animal in the pair. The Hinde index is often collected over long time spans (many months, in some cases) and at various intervals (minutes or even weeks). The underlying natural model is assumed to be that of a decreasing Hinde index (showing less mother-infant dependency) that stabilizes at some point, i.e. reaches a steady state that may represent maturation between the animal pair. Under this assumption, a two-regime regression statistical model would be a feasible choice to uncover the parameters associated with these proximity-pairing events. Those parameters are: 1) an original proximity propensity, 2) the rate of decrease to steady state, 3) the level of affinity at steady state, 4) the time when steady state is reached, and 5) the variability exhibited by the index. Exploring a particular set of data from whales using a method developed in 1958 by Quandt reveals short-comings of the Quandt approach, leading to a discussion of more recent methods along with a moment-matching/non-parametric algorithm developed by the authors.

A villainous application of edge-colouring on graphs, Sarah Holliday, Southern Polytechnic State University, Atif Abuieda, University of Dayton, David Leach, University of West Georgia

Abstract: A simple graph G is properly edge coloured. An enemy permutes the labels on the edges so that the graph has the same label set, but is no longer properly edge coloured. The Edge Chromatic Villainy is the minimum number of swaps that need to be made to the permuted labels so that the graph is restored to a proper edge colouring. Some results will be given, and extensions to the vertex villainy will be shown.

What is a P-value?, Patricia Humphrey, Georgia Southern University

Abstract: Many students have a difficult time understanding p-values. This paper presents a simple

demonstration that has been used in class many times to illustrate the concept when testing a proportion. It is an active learning exercise that uses only a (possibly) altered deck of cards, and either graphing calculators (TI 80 series) or a computer package to simulate the p-value for the test. It can be expanded (if desired) to also demonstrate the power of a test.

Perspectives on Academia as a Second Career in Mathematics, Mike Johnson, Meredith College

Abstract: As faculty, many of us are educators of older students returning to college for a "fresh start" in new careers and in life. Yet, the occasion of welcoming middle-age and older individuals into new careers in academia itself is downright uncommon, and particularly so in mathematics. After 30 years in industry, 17 years after my doctorate, and after 4 years of part-time adjunct teaching, I am in my first full-time year as a new assistant professor of mathematics. In this brief presentation I will share some first-hand observations on career change in general, and on later-in-life entry into an academic career in particular. I will offer a few reciprocal observations based on colleagues who entered industry from academia, and suggest how all these observations might be applied to the benefit of older students seeking new career directions.

Getting Involved in the MAA, Ellen Kirkman, Wake Forest University, David Stone, Georgia Southern, Ray Collings, Georgia Perimeter College

Abstract: MAA officers will talk about opportunities to be involved in MAA sectional and national committees, and solicit names of members interested in becoming more involved in these activities.

Promoting the MAA's Science Policy, Ellen Kirkman, Wake Forest University

Abstract: A brief introduction to the MAA's Science Policy and how MAA members can work to promote that agenda.

Cognitive Ecology: Opportunities and Challenges, Jeff Knisley, East Tennessee State University

Abstract: Mathematical models are frequently used in ecology to describe changes in population size and interactions of different populations. Agent-based simulations are often used to illustrate these models and the ecology associated with them. However, the individual agents in a typical agent-based model tend to behave randomly unless interacting with other agents. Cognitive ecology, on the other hand, suggests that individual agents should behave with some level of cognition (e.g., learning). In this talk, we discuss via examples how mathematical models and the corresponding agent-based simulations are altered when the agents are given cognitive abilities.

Calculus, Statistics, and Biology: Integration through Symbiosis, Jeff Knisley, East Tennessee State University

Abstract: It is possible to teach calculus, statistics, and biology in an integrated context that is mutually beneficial to all three areas, and this integration is possible without compromising the integrity or rigor of any of the three. This short course introduces the contexts, the active learning tools, the laboratory experiences, and the assessment methods for an introductory lab science sequence that not only features such a symbiosis of the three areas, but also serves as an early introduction to computational science and algorithms.

Math, Murder, and Mystery: Mathematics and Detective Fiction, Charlotte Knotts-Zides, Wofford College

Abstract: This spring, a colleague in the English department and I are teaching linked courses around the theme of mathematical logic and detective fiction. This presentation will explain the logistics of the class, its common goals, and some of the surprises along the way!

UBM: Interdisciplinary Training of Undergraduates in Biological and Mathematical Sciences, Tor A. Kwembe, Jackson State University, Hyun J. Cho, Jackson State University, Zhenbu Zhang, Jackson State University

Abstract: This project is designed for mathematics and biology students or other science students with interest in mathematics or biology who are interested in the application of mathematics to biology. Participating students take courses designed to strengthen the mathematical knowledge and skills of biology majors, and increase the ability of mathematics majors to use their quantitative skills to solve biological problems. They participate in a five-week summer intensive course at a National Laboratory where they collaborate on fisheries science projects and also take courses in marine and coastal science. Finally, students take part in collaborative research work at JSU during the academic year for a minimum of two years under the supervision of faculty teams from biology and mathematics departments. This interdisciplinary training of students focuses on population biology with emphasis on marine/coastal science. However, students also have opportunities to conduct research in other areas of biology and biomathematics. We will do both a poster and a talk on the successes of the program in its four years of operation.

Opportunities at the new National Institute for Mathematical and Biological Synthesis, Suzanne Lenhart, University of Tennessee

Abstract: The new National Institute for Mathematical and Biological Synthesis at the University of Tennessee arises from a new collaboration between the National Science Foundation and the other agency sponsors, the U.S. Department of Homeland Security and the U.S. Department of Agriculture. Opportunities for researchers, students and educators to collaborate across disciplinary boundaries and to take an integrative approach to challenges in natural and human systems will be discussed.

Poisson-Voronoi Tessellations, Limacons, and Buffon Disks, Thomas Lewis, Furman University

Abstract: We consider the following problem in stochastic geometry. Let a tessellation of the plane be induced by a homogeneous Poisson process. What is the probability that a disk thrown onto the plane will land safely within a tile?

Some Polynomial Identities and Commutative Rings, Michael Lomuscio III, Western Carolina University

Abstract: There are certain polynomial identities that imply that a ring is commutative if they hold for all elements in the ring. We will discuss several such identities. We will provide an elementary proof that if the identity $a^3 = a$ holds for all elements a in the ring, then the ring is commutative. We will also discuss the relation of this result with Jacobson's theorem about polynomial identities and commutative rings.

Can You Hear Me Now?, Jaleesa Longmire, Alabama State University

Abstract: The purpose of this research is to investigate the possibility that cellular phones and other audible electronic devices have an effect of causing hearing loss. In particular, there is an increase in the number of hearing loss cases among youths and young adults. In doing this project, the process requires a great deal of research in the areas of medical statistics. This research is dated from the year 2000 to present day and sheds light on the reason there is a need to ask the question: 'Can you hear me now?'

Analyzing Breast Cancer Data Using Genetic Algorithms and Logistic Regression, James Lucy, Alabama State University

Abstract: In this paper, we explore genetic algorithms to classify different breast cancer data sets. In order to compare the performance of the genetic algorithms, we also use other classification rules such as logistic

regression. We use computer software called Weka (ver 3.5.2) to study genetic algorithms, logistic regression, and other classification rules. Feature selections are made by maximizing accuracy rates of classification.

On Two Different Published Algebraic Representations of Napier's Logarithm, Dr. Andy Martin, Kentucky State University

Abstract: Two popular History of Mathematics ([2],[3]) texts agree on what algebraic form represents the logarithm as defined by Napier, but a third ([1]) has something different. Why don't they agree? Which is correct? Are the representations equivalent? If not, how are they related? Does either exhibit the "logarithmic" properties of turning products into sums and quotients into differences? After describing Napier's definition, this talk will address these and related questions, which the speaker has assigned students (and will again) as a nonstandard way to review properties of logarithms. [1] Boyer, Carl A History of Mathematics, Wiley and Sons, 1968. [2] Eves, Howard An Introduction to the History of Mathematics, 5th ed, Saunders College Publishing 1983. [3] Katz, Victor A History of Mathematics: An Introduction, HarperCollins 1993.

Jeu de taquin: the 15-puzzle, Sarah Mason, Davidson College

Abstract: The 'jeu de taquin' puzzle (commonly known as the 15-puzzle) consists of 15 numbered squares on a 4x4 grid. The object of this puzzle is to slide the squares around the grid until they are arranged in increasing order. We discuss several ways in which this simple sliding procedure governs the behavior of certain classes of polynomials.

Team Teaching Geometry using Interactive Video Technology, Tania McDuffie, Converse College, Myrtle Lewin, Agnes Scott College

Abstract: The two authors collaborated to teach a graduate level Geometry with Technology course to students in the M.A.T. in Secondary Mathematics programs on our two campuses. We will discuss our expectations for team teaching, the issues we faced finding suitable technology that could support both planning and delivery, and the successes experienced.

The Equation $x^n = e$ and Cyclic Groups, Katie Melhuish, Western Carolina University

Abstract: In this presentation we will show that an Abelian group of order p^k (p -prime number) is cyclic only if the equation $x^n = e$ has at most n solutions in G for each positive integer n . Using this result, we will show a more general one: If G is a finite Abelian group and for each positive integer n the equation $x^n = e$ has at most n solutions in G , then G is cyclic.

How to Draw a Straight Line and Other Linked Problems, Tonja Miick, Western Kentucky University, Tom Richmond, Western Kentucky University

Abstract: There are two commonly used techniques for drawing circles: tracing a circular object, or constructing a circle using a compass or string. There is only one commonly used technique for drawing a line: tracing a straightedge. In his 1877 treatise 'How to Draw a Straight Line,' A.B. Kempe gives several methods for constructing a line using mechanical linkages. A mechanical linkage is an arrangement of rigid rods connected at pivoting joints. After describing one method to construct a line, we discuss Kempe's later claim that a linkage can be made to sign your name.

Fibonacci, Heather Morgan, Georgia College and State University

Abstract: Fibonacci sequence has rich history. We will define the Lucas sequence and establish different relationship between the Fibonacci and Lucas sequences. We will show a more general recurrence construction between the Fibonacci and Lucas sequence, and from this general recurrence construction we will make our

own sequences. We will show how some of the Fibonacci and Lucas sequences relationship can be used in our sequence, and to find special relationship that only work in our own sequences.

A Comparison of Two Modes of Delivery for College Algebra, Jack Morrell, Atlanta Metropolitan College, Gyuheui Choi, Atlanta Metropolitan College

Abstract: Atlanta Metropolitan College is a minority two-year, commuter institution within the University System of Georgia. Faced with high non-success rates in College Algebra, Atlanta Metropolitan College has tried a variety of initiatives to ameliorate the situation. There are system-wide mandates concerning the course content and the number of contact hours. This has led to an evolutionary path of restructuring the course in attempts to open new possible avenues for success and to combat the new obstacles that appear in each restructuring. This presentation will examine the results of a trial use of publisher's computer-presented (provided) homework and quizzes in a number of sections of College Algebra and compare/contrast these results with those from sections that utilized instructor-enabled recitation sections for the same purpose. All sections used departmental hourly exams and final exam. A comparison of the difficulties encountered in each mode will also be examined.

The Impact of Inquiry-Based Instruction on Student Achievement, Bernadette Mullins, Birmingham-Southern College, John Mayer, University of Alabama at Birmingham, Rachel Cochran, Center for Educational Accountability, Jason Fulmore, Center for Educational Accountability

Abstract: The Greater Birmingham Mathematics Partnership has been investigating the relationship between inquiry-based classroom instruction and student achievement in the middle grades. Using classroom observations, we identified the level of implementation of inquiry-based instruction in grades 5-8 in partnership schools. The results showed that students in high implementing classrooms showed more growth in scores on the SAT-10 than students in moderate or low implementing classrooms.

Evaluating Derivatives with MATLAB, Richard Neidinger, Davidson College

Abstract: An introduction to both automatic differentiation and object-oriented programming can enrich a numerical analysis course that typically incorporates numerical differentiation and basic MATLAB computation. Automatic Differentiation consists of exact algorithms on floating-point arguments, implemented by overloading standard elementary operators and functions in MATLAB with a derivative rule in addition to the function value. These operate on a class of value-and-derivative objects or a class of series coefficient objects, which provide simple examples of the new (as of release 2008a) class definition structure in MATLAB. Most methods are simply one-line programs, corresponding to Calculus I derivative rules. The resulting powerful tool computes derivative values and is applied to Newton's method for root-finding. Automatic multivariable partials give the Jacobian to enable a convenient implementation of Newton's method for nonlinear systems of equations. A series class can compute Taylor coefficients, equivalent to higher-order derivatives.

Isomorphic classes of Linking Pairings on 2-groups, B. Ntatin, Austin Peay State University

Abstract: The main aim of this talk is to show that all isomorphism classes of linking pairings of a finite abelian group can be realized as the linking form of a Seifert manifold which is a rational homology sphere. In order to determine if two linking forms are in the same isomorphism class, we use a combinatorial device referred to as an admissible table to deal with the fact that the decomposition of a linking pairing on a 2-group in to direct summands is not unique. We actually produce Seifert manifolds with specific Seifert presentations on which the linking forms have specified decompositions and for which a certain system of invariants are then used to determine if two linking forms actually have the same orthogonal sum decomposition and hence isomorphic.

Non-STEM Major Students' Challenge to Precalculus, Hyounkyun Oh, Savannah State University, Sujin Kim, Savannah State University

Abstract: The College Algebra pilot class used in this study takes the mutual teaching and learning through inner group discussion, under the instructor's guideline, as the principal learning methodology. This class is designed for non-STEM major students who take College Algebra as their last mathematics course for their degrees. Due to non-declaration of the course title, each class contains non-STEM major students (as well as STEM major students) who have to complete the additional mathematics course, 'Precalculus.' In this study, we analyze the academic performance of non-STEM majoring students having participated in the pilot program, compared to the results of STEM majors or non STEM majors who took the University's traditional College Algebra course. Finally, we look for a way to successfully lead students through this type of pilot program.

Mathematical Modeling of a Low-temperature-differential Stirling Engine, Jack Pace, Southern Polytechnic State University

Abstract: A Stirling engine is an external-combustion, closed-cycle heat engine in which air is the working fluid. Stirling engines are capable of high theoretical efficiency, and so have long been considered as replacements for the common petroleum-based engine. This paper presents a mathematical model of a gamma-configuration Stirling engine, incorporating the dynamics of its flywheel and two pistons, and also some of its thermodynamics. The resulting D.E. is solved numerically, and the computer program draws a moving diagram of the engine running, and also graphs the fundamental variables of the motion as they change with time. An actual small model of this type of engine will also be shown.

Bayes' Theorem Alternatives, John Paulling, Tusculum College

Abstract: Abstract: Bayes' Theorem Alternatives Probability trees can be used to better understand how Bayes' theorem relates a priori and a posterior probabilities to calculate either. Trees, conditional probabilities, and observations using the most basic probability formulas can together lead to better understanding of probabilities found using Bayes' formula and sometimes far simpler calculations.

Using Mathematical Uncertainties to Encourage Critical Thinking, Mike Pinter, Belmont University

Abstract: Some models of adult development associate exposure to uncertainties of knowledge with the enhancement of critical thinking skills. In this presentation, we'll consider ways to help our students explore some of the uncertainty and the unknown in mathematics in order to enhance their critical thinking. We'll primarily explore examples for general education mathematics and quantitative reasoning courses, with some mention of opportunities for majors courses as well.

Statistical Analysis in the NFL, Kyle Prince, Maryville College

Abstract: Statistical analysis has been used in the NFL (National Football League) since its beginning to attempt to predict this often unpredictable game. Ranking players and estimating current win probabilities are just a few of the problems currently facing NFL teams. In this paper, a multiple regression approach is used to rank players based on their average change in expected eventual points and a logistic regression model is used to estimate in-game win probabilities. Both regression models are based on data from the 2006 and 2007 regular seasons. Using the eventual points model to rank quarterbacks based on their average change in predicted eventual points better approximates a quarterback's worth than the current flawed quarterback rating system because it does not count all interceptions and incompletions the same and accounts for both sacks and fumbles. Whereas, the win probability model is used to both aid in decision making and in the creation of win probability graphs.

Calculus for Lunch: It's All on the Table, Marshall Ransom, Georgia Southern University

Abstract: Most of elementary calculus can be examined using only a few discrete values of two twice differentiable functions and their derivatives. This is a quick insight to an interesting way to ask questions about fundamental theorems and applications.

Classic Calculus Labs, Nell Rayburn, Austin Peay State University

Abstract: This workshop will focus on hands-on activities which can be used in calculus classes to motivate and reinforce key concepts. Although there are lots of great computer labs in use, the labs that we will explore require no more technology than a scientific calculator and can be done in a standard classroom. These activities, which come from a variety of sources and authors, are classics which have withstood the test of time! Lessons will include modeling the motion of Muybridge's cat, making a physical model to illustrate the rectangle approximation of the centroid of a planar lamina and approximating volumes by slicing cucumbers. Participants will be invited to share ideas for labs of this type which they have used successfully.

Calculus: The Kissing Curves Connection, Natalie Rich, University of North Carolina - Asheville

Abstract: In this talk, the Kissing Curves Theorem is introduced. Once established, this theorem can be used to prove the familiar differentiation shortcuts using only algebra and geometry. This approach may be more appropriate to a Calculus I audience than the traditional limit approach.

Stability Analysis of a Model of Atherogenesis, Laura Ritter, Southern Polytechnic State University, Akif Ibragimov, Texas Tech, Jay Walton, Texas A & M

Abstract: Atherosclerosis is an immune mediated disease of the vascular system resulting in the deposition of lipid laden cells in the walls of large muscular arteries. We present a model of some bio-chemical processes involved in the early stages of the disease—atherogenesis. In particular, we consider the role of immune cells in the presence of chemical stimuli and low density lipoproteins. The model is a system of nonlinear primarily parabolic reaction-diffusion equations. A linear stability analysis using an energy estimate approach is presented with an analysis of the stability criteria with respect to the bio-medical implications.

MyMathLab, Laura Roberts, Pearson

Abstract: MyMathLab-Pearson Education's most robust technology solution-is a series of text-specific, easily customizable online courses for Pearson Addison-Wesley and Pearson Prentice Hall textbooks in Mathematics. Powered by CourseCompass(tm) (Pearson Education's online teaching and learning environment) and by MathXL (our online homework, tutorial, and assessment system), MyMathLab gives you the tools you need to deliver all or a portion of your course online, whether your students are in a lab setting or working from home.

How to master scheduling a series of dinner parties, Chris Rodger, Auburn University

Abstract: In this talk I will give descriptions, along with some solutions, of the problem of seating people at dinner tables so that each person gets to meet as many other people as possible. Techniques used involve both graph theory and combinatorial design theory, with plenty of pictures to make them all clear!

Latin Squares and Quasigroups in Cryptography, Michael Russell, Western Carolina University

Abstract: A latin square is an $n \times n$ table filled with n different symbols in such a way that each symbol occurs exactly once in each row and exactly once in each column. A quasigroup $(Q, *)$ is a set Q with a binary operation $*$, such that for each a and b in Q , there exist unique elements x and y in Q such that $a * x = b$ and $y * a = b$. Since the number of quasigroups and latin squares gets larger as n increases,

their application in cryptography is very interesting and intriguing. In this presentation, we will discuss the connection between quasigroups and latin squares. This connection helps to make algorithms for generating quasigroups. There are several quasigroup transformations that can be used in order to encrypt and decrypt messages using quasigroups. We will discuss two of these quasigroup transformations and, using them, we will define encoding and decoding functions. We will provide algorithms for encryption and decryption using a fixed quasigroup. Finally, we will use the mathematical application MATHLAB to generate code for generating quasigroups and for running encryption and decryption algorithms.

Mathematical Models of Kleptoparasiting Behavior in Sea Gulls, Jan Rychtar, University of North Carolina Greensboro

Abstract: Kleptoparasitism is the stealing of food by one animal from another. This has been modeled in various ways before, but all previous models have only allowed contests between two individuals. We design and analyze a model of kleptoparasitism where individuals are allowed to fight in groups of more than two, as often occurs in population of sea gulls . We find the equilibrium distribution of the population amongst various behavioral states, conditional upon the strategies played and environmental parameters, and then find evolutionarily stable challenging strategies. We find that there is always at least one evolutionary stable strategy, but sometimes there are two or more, and discuss the circumstances when particular ESSs occur, and when there are likely to be multiple ESSs.

Comparing Numerical Methods for solving Lotka-Volterra equations, Ramanjit Sahi, Austin Peay State University

Abstract: Lotka-Volterra is a system of differential equations used in characterization of interaction between two or more species in an ecosystem. It is the simplest model of predator-prey interactions. Various numerical techniques have been applied to solve the Lotka-Volterra equations. The least accurate and the easiest is the Euler method. Numerical methods for solving Lotka-Volterra equations are reviewed and an alternative approach is proposed.

Even, Odd, and 'Other' Functions, Shiva Saksena, University of North Carolina Wilmington

Abstract: Replacing 'x' by its additive inverse '-x', in any function $y=f(x)$, is used to define even and odd functions according as $f(-x)=f(x)$ or $f(-x)=-f(x)$ respectively. We consider another possibility, namely, $f(-x)=1/f(x)$ to define functions that are reciprocally symmetric to a point. Furthermore replacing 'x' by its multiplicative inverse '1/x', in any function $y=f(x)$, will be used to classify functions in a similar manner. We will provide examples in each case and show that this classification of functions is independent of the evn/odd/neither classification.

Rational Residuacity of Primes, Stephen Savioli, Armstrong Atlantic State University

Abstract: With over 200 proofs of the law of Quadratic Reciprocity most undergraduates have encountered it in one class or another. But what about higher power residuacity? This is the question that rational reciprocity laws investigate, the relationship between reciprocals of rational residue symbols. We will begin with a brief introduction to residuacity, touch on quadratic reciprocity and finish with a new law.

An Algorithm for Generating Graceful Labels when Combining Caterpillars, Theodore Schoen, UNC Asheville

Abstract: A caterpillar is a type of tree, and a graceful label is a numbering of the vertices in a graph such that the label of any edge is equal to the difference of its incident vertices. Let P1 and P2 be gracefully labeled caterpillars. This paper explains and demonstrates an original algorithm designed to combine P1 and P2 into a third caterpillar P3 such that P3 is also graceful.

Combinatorial Identities through Graphical Representations, Kyle Schutt, Elon University

Abstract: Combinatorics is simply the study of finite sets of objects. It is described here visually and arithmetically through flagpole arrangements and identities, respectively. The flagpole arrangements are composed of a flagpole, guy wires, and blocks. Particular arrangements can be utilized to visually represent well known combinatorial identities. Moreover, flagpole arrangements can, theoretically, prove any type of combinatorial identity, including complex and recursive identities.

Analysis-and-Synthesis: Reviving the Ancient Method of Mathematical Discovery, Damon Scott, Francis Marion University

Abstract: The original meaning of the word analysis has so far fallen from use that many mathematicians do not even know it: working backward from a result. Synthesis is going the other way: providing a "straight shot" proof from hypotheses to conclusions. The whole combination, analysis-and-synthesis, was a standard fixture in a mathematician's education in the days of Archimedes, but the current environment supports only synthesis with formal training. The method of analysis-and-synthesis will be shown in stages, from very elementary applications, to how it can be applied in classroom situations, and from there to its most impressive use, as a structure to use not just for finding research-level proofs but for discovering the mathematical results in the first place.

Maximizing the Spectacle of Water Fountains, Andrew Simoson, King College

Abstract: For a given initial speed of water from a spigot or jet, what angle of the jet will maximize the visual impact of the water spray in the fountain? We focus on fountains whose spigots are arranged in circular fashion, and couch the measurement of the visual impact in terms of the surface area and the volume under the fountain's natural suggested surface (of the object of revolution of any of the streams of water about the center of the fountain). Pappus' two theorems involving the centroid of an arc and of an area are used as keys to answer the question. The critical angle is in general not 60 degrees.

Calculus II for Students with an AP Background, Joseph Spivey, Wofford College

Abstract: Duke's Department of Mathematics recently adopted a new Calculus II course for students with AP credit for Calculus I. Calculus II is composed of two very different groups of students—those with AP credit for Calculus I, and those without. More and more students are entering college with AP credit for Calculus I, and as a result, Calculus II is becoming increasingly divided. The new Calculus II course for students with AP credit was designed by a self-selected committee of graduate students who felt that the current Calculus II course was not adequately serving either group of students. Separating the two groups of students into two classes allows the needs of each group of students to be more directly addressed. The new Calculus II course is unique in many ways, not the least of which is that it contains elements of both reform calculus and traditional calculus. This talk will focus on the curricular problems that the graduate student committee found and how the new course is designed to solve these problems.

A Roadblock in Understanding Math Induction Proofs, David Steele, Univ of No Carolina at Asheville

Abstract: In their early attempts to understand proofs by mathematical induction, students often struggle with the perception that the proofs are somehow using what they are trying to prove. The root of this confusion seems to be a faulty understanding of the proof of the universal conditional that occurs within each math induction proof. Giving special attention to this may improve overall understanding of mathematical induction.

Traditional and Digraph Iterated Function Systems for Variations of Peano's Space-filling Curves, Jessica Stewart, Elon University

Abstract: This research takes two seemingly separate areas of mathematics-space-filling curves and digraph iterated function systems-and relates them to one another. Despite appearing very complex with their non-integer dimension, many fractals can easily be described using an iterated function system. Iterated function systems can also be used to describe the approximations of space-filling curves, whose limiting set is a given area in space. The path of many space-filling curves can also be described using a digraph iterated function system. The digraph iterated function system for a space-filling curve is found by mapping the individual coordinates against an independent variable, time. The digraph is formed by showing how the individual coordinate graphs against time are independent upon one another in higher approximations. The technique of finding the traditional and digraph iterated function systems for a space-filling curve was generalized for all space-filling curves, regardless of their dimension, from the example of Hilbert's two-dimensional space-filling curve. This generalized technique for finding the traditional and digraph iterated function system is applied to two-dimensional switchback and meandering Peano curves, two variations of the three-dimensional Hilbert curve, and a three-dimensional Peano switchback curve. The digraph iterated function system provided the foundation to create the parametric functions that produce the full Peano and Hilbert curves in Mathematica.

Reality Math, Dorothy Sulock, University of North Carolina Asheville

Abstract: Reality Math is an innovative approach for the generally required math-for-liberal-arts-majors at the university level. Units embedding mathematics learning and practice within case studies from the real world can be done independently outside the classroom by students or instructors may want to utilize a small group approach within the classroom. The units are on topics relevant to the students and thus provide motivation for learning functional numeracy, analyzing information from tables and graphs, and grappling with the very large and very small numbers of the social sciences and sciences. Students are required to figure out how to answer complex questions not spoon-fed by a teacher. Students are responsible for their own learning. Examples of existing units: Ecological Footprint; False Positives; Life Expectancy; Personal Investing; March Madness; UN Millennium Development Goals for Foreign Aid; Nile Perch; Nuclear Forces of China, US, and Russia; World Oil; Orbital Speed of Planets; CO2 and MPG; the Education Lottery; Solar Energy; Detecting Gender Differences; and many more.

A Self-Starting Trigonometrically Fitted Method for Second Order Oscillatory Differential Equations, Scott Swindell, Austin Peay State University

Abstract: In this paper, we propose a trigonometrically fitted method of step four that is self starting for the direct solution of highly oscillatory second order differential equations of both linear, and non-linear orientation. The method is compared with both Adams and Numerov's methods, which are traditionally applied in a predictor-corrector fashion. In particular, trigonometric basis functions are used to improve the accuracy of the method. Numerical examples are given to illustrate the reliability of the method.

Construction of Two-dimensional Block Design for Correlated Errors, Mohammed Talukder, Albany State University, Seyed Roosta, Albany State University

Abstract: This paper deals with the construction of a neighbor balanced incomplete two-dimensional block designs. The method of differences is used to construct the proposed designs. These designs are highly efficient for generalized least squares estimation for generalized least squares estimation of treatment contrasts when the errors are correlated. The relative efficiency of each of these designs is computed with with a hypothetical universally optimal design.

Mathematical Modeling in AP Calculus, Daniel Teague, NC School of Science and Mathematics

Abstract: Participants will work through several mathematical models that can enhance both AB and BC

calculus courses. Other models will be discussed that can be used as projects that pull together many topics from the course for use after the exam. Models include real-world max-min problems, applications of area, and modeling with simple differential equations.

Regression Analysis in AP Statistics, Daniel Teague, NC School of Science and Mathematics

Abstract: This workshop will present the important aspects of regression analysis in the introductory statistics course. Re-expression and residual analysis, as well as inference for regression will be illustrated by examples. Important features of the mathematical underpinnings will also be considered. The workshop presenter was on the committee that wrote the AP curriculum and served on the Test Development Committee for 5 years.

A Hybrid Method for Ordinary Differential Equations, Douglas Tramill, Austin Peay State University

Abstract: A two-step hybrid method with two-nonstep points is developed for solving ordinary differential equations. The performance of the method is compared with conventional techniques such as the Adams and Runge-Kutta methods. Numerical examples are given to show the accuracy of the method.

Ugly Curves and the Loewner Equation, Amy Valentine, Belmont University, Catherine Simpson, Belmont University, Sarah Claiborne, Belmont University

Abstract: The Belmont Undergraduate Research Student Team (BURST) is a group of undergraduate students who are studying the Loewner differential equation, which can be symbolized as a black box with functions as input and different curves as the output. One focus of the study has been to input both random and deterministic functions to see what the output may look like through computer generated pictures. One of our challenges has been to find input functions that give 'ugly' output curves. In particular, we would like to find input functions that will output a spiral or a space-filling curve. Another focus has been putting fractal functions, such as the blancmange, into the black box. The team is working on predicting and proving results about the geometry of output curves.

Students' Reaction Towards Cooperative Group Learning in Reform College Algebra, Karen Watson, Fort Valley State University, Samuel Cartwright, Fort Valley State University

Abstract: Cooperative group learning involves the collective cooperation of members in a group to complete a shared task. We used this type of learning as an instructional tool to maximize the learning for each member of the group. The idea was for each to see how the success of each member of the group benefits the other. During this presentation we will share how we structured our cooperative learning experience. We will also share what worked and what aspects needed revisions. The presentation will also include quotes from students concerning their experiences.

Activities for a Geometry Classroom, Carroll Wells, Lipscomb University

Abstract: According to research done by Robert Marzano and Debra Pickering (BUILDING ACADEMIC VOCABULARY, 2005, Association for Supervision and Curriculum Development) one of the best ways to teach academic vocabulary from content areas is to ask students to construct a picture, model, or graphic representing the term or phrase. During this presentation, three boxes will be constructed and used to illustrate various geometric concepts or terms. These activities are appropriate for geometry classes at all levels. College students preparing to teach mathematics will also benefit from these activities.

Two-Dimensional Continuous Space in a Bioeconomic Harvesting Model, William Youree, Kennesaw State University

Abstract: Integro-Difference equations are used to produce a two-dimensional model of a plant population.

It is assumed that this plant species is invading an area and has a negative effect on the native plant and/or wildlife population. Therefore, we want to determine how to optimally harvest the invasive plant in order to minimize the spread and minimize the cost of harvesting. Optimal Control Theory is used to create a Bioeconomic model. Several parameters are varied to show how they affect the outcome. The model is implemented in MATLAB and the results are displayed as movies.

The Theta Complex of Certain Families of Hypergraphs, Tony Zamberlan, Augusta State University

Abstract: This talk will focus on the results stemming from the REU I participated in last summer at the University of Tennessee in Knoxville. When necessary, requisite definitions and examples are provided for those whom this subject is completely foreign. Ideas from graph theory, combinatorics, algebra, and topology are discussed, as well as an interesting connection to a famous problem in computer science.

A Derivative-free Iterative Method for Nonlinear Equations, Yilian Zhang, University of South Carolina Aiken

Abstract: A new iterative method based on modified Chebyshev's method is developed. This new scheme does not involve with derivatives, and it is more effective than Steffensen's method. Numerical results are presented.

Analytic Analysis and Computer Simulation for the Distribution of Genes in a Large Population, Zhenbu Zhang, Jackson State University

Abstract: In this talk, we consider gene locus having two alleles and use Mendel's Laws to construct a model for how the distribution of genes in a large population can evolve. We investigate the fate of genes in the population by doing theoretical and numerical analysis.

Optimal Control of 'Harvesting after Growth' in an Integrodifference Population Model, Peng Zhong, University of Tennessee, Suzanne Lenhart, University of Tennessee

Abstract: An optimal control harvesting problem for a population modeled by an integrodifference equation model is considered. The proportion to be harvested is taken to be control. The harvesting occurs after the growth of the population but before the dispersal. The goal is to find the optimal harvesting control to maximize the profit. Existence and characterization of the optimal control are established.

Compactly Supported Wavelets With Dilation Factor 3 and Application in Image Compression, Jie Zhou, Coastal Carolina University

Abstract: In this paper, we give the parameterized filters which satisfy the necessary and sufficient conditions for orthonormality. The parameterization includes all compactly supported univariate scaling functions contained within the interval $[0, 9/2]$ using dilation factor 3. Finally, we compare the parameterized wavelets of length six with biorthogonal Daubechies 9/7 wavelets in an image compression scheme.

A Linear System of Strip-Based Projection Model in Discrete Tomography, Jiehua Zhu, Georgia Southern University, Xiezhong Li, Georgia Southern University, Yangbo Ye, University of Iowa, Ge Wang, Virginia Tech

Abstract: Discrete tomography deals with image reconstruction of an object with a finitely many gray levels (such as two). The strip-based projection model is more realistic to model the raw detector reading in some applications than the line-based projection models. In this talk we will analyze the linear system generated by strip-based projection model and establish equivalence between the system matrices generated by the strip-based and line-based projection models.