MAA-SE Presentation Abstracts
Ninety-first Annual Meeting
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Clayton State University

UGD.1 Kevin Adams — Furman University
Nick Foil, Alexander rice, Furman University

A Discrete Fractal in Z Related to Pascal's Triangle

For each integer $d \geq 1$, let

$$\Im_d = \left\{ k \in \mathbb{Z} : \binom{(2^d+1)k}{k} = 1 \pmod 2 \right\}$$

We examine the self-similarity and dimension of each set $\Im_d$. In particular, we show that both the Hausdorff dimension and the packing dimension of $\Im_d$ are

$$\frac{\log(\phi)}{\log(2)}$$

where ϕ is the golden ratio, demonstrating $\Im_d$ is a discrete fractal in the sense of Barlow and Taylor (Proc. Lond. Math. Soc. 64:125-152, 1992).

❁ TID.5 Tonya Adkins — Johnson & Wales University – Charlotte

Transforming the Hidden Curriculum to Promote Mathematical Success

Teaching and motivating learners is a continual challenge. Have you ever wondered how to integrate "real world" skills into the classroom, while trying to maintain clarity of discipline? Strategies to engage and motivate learners to develop critical thinking skills and growing through the "hidden curriculum," while maintaining subject focus is what you will get in this workshop. Share your strategies with your peers and learn others which you can use right away.

❁ BF.3 F.B. Agusto — Austin Peay State University
A. Adeshina, Austin Peay State University

Optimal Control of Treatments in a Two-Strain

Tuberculosis is a bacterial disease caused by Mycobacterium tuberculosis (TB). The risk for TB infection greatly increases with HIV infection; TB disease occurs in 7%-10% of patients with HIV infection each year. The increase in numbers of patients with both HIV infection and TB has raised the potential for increasing transmission of drug-resistant Mycobacterium tuberculosis strains. In this paper a deterministic model is presented and studied for the transmission of TB-HIV/AIDS co-infection. Optimal control theory is then applied to investigate optimal strategies for controlling the spread of the disease using treatment as the system control variable. Various possible senarios are examined so as to investigate the impact of the controls on the spread of the disease.

❁ MLU.5 Shemsi Alhaddad — University of South Carolina Lancaster

But I'm an English major!

Do you suffer from the when-will-I-ever-use-this blues? In this talk I'll describe my use of mathematical modeling in freshman level mathematics classes. My primary focus will be on the use of modeling to give non-STEM majors an appreciation of the usefulness of mathematics, as well as the confidence to use mathematics as it relate to their field.

UGE.2 Samantha Allen High Point University

Real Data Fitting with Complex Analysis

Given a sample of data coming from an unknown function, we wish to construct a function, called an interpolant, that fits this data and approximates the unknown function as well as possible. Linear combinations of radial basis functions offer a way to compute interpolants extremely well. Unfortunately, in some interesting cases, it is impossible for a computer to accurately recover the interpolant using traditional means. Because we know the interpolant exists, it is natural to consider different strategies. In this talk, we will explore one alternative method for finding this interpolant, which involves moving the problem into the complex plane. This method yields results that are surprisingly accurate when the traditional technique fails miserably.

UGG.2 Liliana Alvarez Austin Peay State University
Anne French, Austin Peay State University

Markov's Wonderland

This project report introduces the theory of stochastic matrices and their significant applications. By using stochastic modeling, we will demonstrate nonsense or parody texts with Markov chains. Initially, Lewis Carroll, also known as mathematician Charles Dodgson, was the first to introduce nonsense texts in children's literature, which are prime examples of Markov chains. Furthermore, we will present realistic applications of Markov chains.

UGC.2 Shannon Michaels Areford University of South Carolina Sumter

A Connection Between Fibonacci Numbers and Lucas Numbers

In this talk I discuss some elementary properties of Fibonacci numbers. I will prove an identity that shows that the difference of two Fibonacci squares is a Lucas Number.

AG.2 Risto Atanasov Western Carolina University
Tuval Foguel, Western Carolina University and Andrew Penland, Texas A&M

Equal Quasi-Partition of p-groups

Let S be a subgroup of a group G. A set $\Pi = \{H_1, \cdots, H_n\}$ of subgroups H_i $(i = 1, \cdots, n)$ with $G = \cup_{H_i \in \Pi} H_i$ is said to be an equal quasi-partition of G if $H_i \cap H_j \cong S$ and $|H_i| = |H_j|$ for all $H_i, H_j \in \Pi$ with $i \neq j$. In this presentation we will talk about finite p-groups such that a subset of their maximal subgroups form an equal quasi-partition.

❁ CAL.5 Leigh Atkinson UNC-Asheville

Unrealistic Calculus Problems

Calculus instructors often go to great lengths to include supposedly realistic problems in their courses. I shall urge that it's more enjoyable, and at least as effective, to go to great lengths in the opposite direction, and construct flagrantly unrealistic problems. A few examples will be offered.

❁ BF.2 Chad Awtrey Elon University

Computing arithmetic invariants of p-adic fields

First introduced over 100 years ago, the p-adic numbers have become an important tool in both mathematics and physics. Of particular interest to number theorists is the connection between both the p-adic numbers and the rational numbers as well as their respective field extensions. In this talk, we'll discuss a few motivating classical results and then delve into some current computational questions related to p-adic numbers and their finite extensions.

❁ DM2.1 Patrick Bahls University of North Carolina, Asheville
Nicole Gin, North Carolina State University

Clawfreeness of powers of graphs

Let n be a natural number. We describe a minimal list G_n of graphs such that if the nth power G_n of a graph G contains a claw then some graph in G_n appears as an induced subgraph of G. In case T is a tree, this gives a precise characterization of the claw-free powers of T.

❁ IB2.2 Brad Bailey North Georgia College & State University
Karen Briggs, North Georgia College & State University

How much Moore can Precalculus students take? Part 1

Along with another colleague, the presenters conducted a two-semester quasi-experimental study in which each of the three instructors taught a traditional lecture-based section of Precalculus and a section using an inquiry-based approach called a Modified Moore Method (MMM). The students in the MMM sections worked through instructor provided material and presented their solutions in class. A self-report Likert type survey was used to assess the students' attitudes and beliefs regarding mathematical learning as well as grade self-efficacy and task-specific self-efficacy, and a common final exam was used to assess student achievement. The results from the two teaching approaches were compared for the overall population and by each instructor.

We are aware of no other empirical study of this type and compared to other studies on inquiry-based learning, ours differs in it involves MMM in a freshman-level/introductory course, we compared the performance of MMM and traditional students on a common final exam, we statistically analyzed pre-course and post-course differences on the attitudes and beliefs, grade self-efficacy, and task-specific self-efficacy (for both MMM and traditional students), and our class sizes were three times the size recommended by many practitioners of MMM. Our presentation will include both a description of the Modified Moore Method and a summary of the results from our study. This research is supported by a grant from the Educational Advancement Foundation.

❁ AG.5 Paul Baker Catawba College

Using Topology to Solve a Geometric Existence Question

A simple topological argument readily answers the question "Do there exist two triangles with equal areas and equal perimeters that are not congruent?" in the affirmative. In fact, the argument easily shows that if p denotes a triangle's perimeter, for every A in the interval [0,p*sqr(3)/36] there exist two non-congruent triangles with area A.

❁ CAL.1 Julie Barnes Western Carolina University

Ball toss, crackers & cheese, and line dancing: Concrete ways to help students understand functions in precalculus.

In this talk, we look at a variety of ways to help students understand functions using tactile teaching techniques. In particular we will use a ball toss to explain the definition of a function, an activity with crackers & cheese to demonstrate function composition, and line dancing to practice shifting and stretching functions.

UGC.5 Marcus Bartlett Clayton State University
Elliot Krop, Clayton State University

On some relations between chemical indices on trees

The Wiener index of a graph G is defined to be the sum of distances between every pair of vertices of G. When G is a k-ary tree, Hua Wang found a surprising relation between this index and the sum of distances between every pair of leaf vertices of G (called the gamma index) and showed a counterexample for another conjectured functional relationship. In this talk, we define two new natural indices (the spinal index and the Bartlett index) which when summed with the gamma index above, yield the Wiener index. We then show analogous relations to that of Wang, produce a counterexample to a functional relation for the spinal index, and state a conjecture about the Bartlett index.

❁ APP.3 J. Gregory Bell Wingate University
Undergraduates D. Addison Smith and Daniel T. Hoagland,
James W. Hall (Chemistry faculty), Wingate University

Determination of the Volume of Interstitial Cavities

The optimum packing arrangement for equal-sized spheres has been shown to be hexagonal close packing (HCP) or cubic close packing (CCP) structures. Both structures have the same packing density since the local sphere arrangement in both is tetrahedral. For simple tetrahedral or octahedral stacking, the determination of the packing density and the volume of the interstitial cavity require the calculation of the overlap between the sphere and the 3D structure. This calculation became a complicated problem that required a combination of numerical analysis and calculus approaches before the solution was found. The three approaches to the calculation will be presented.

❁ APP.4 J. Gregory Bell Wingate University
Under graduates D. Addison Smith and Daniel T. Hoagland,
James W. Hall (Chemistry faculty) , Wingate University

Packing of Spheres in Interstitial Cavities

For the analysis of the optimum packing density of unequal spheres, the size and number of small spheres that fit into the interstitial cavity that is created by the stacking of larger spheres must be calculated. For simple structures such as tetrahedral, octahedral, and cubic arrangements, the largest single sphere that can fit in the cavity can be determined through three-dimensional geometric analysis. As the size of this sphere decreases, additional spheres can be placed in the gap. However, the number of adjustable parameters increases (even with just two spheres) to a point where 3D geometric analysis by hand becomes problematic. Additional analysis was provided by a computer program written for this purpose. A discussion of the analysis and trends discovered for tetrahedral and octahedral cavities will be presented.

UGE.1 Elizabeth Bentley Elon University
J. Todd Lee, Elon University

Ford's Condition for Pairwise Comparisons

Many disciplines use ranking systems as a means to compare related objects. There are many independently studied ranking techniques, this research focused on the Maximum Likelihood Approach, sometimes called the Zermelo (1926), or Bradley Terry Model (1952), and the Ford Method (1957). Previous assertions were made by Stob (1984) indicating the equivalence of the Ford and Jech ranking techniques. The first step of this research explored equivalent statements of Ford’s assumptions for the existence of a solution. Following this, the research detailed Ford’s proof of uniqueness of ranking. In working with the conditions with the Ford method, it was hoped that connections to Jech would be found proving Stob's initial assertion.

❁ GME.5 Daniel C. Biles Belmont University

Political Science and Mathematics

At Belmont University, students are required to participate in a Learning Community, in which the same students are enrolled in two different courses in which the content of the courses is "linked" in some way. In this presentation, I will overview the general education math course I am teaching this semester that is linked with a political science course, and how we are making the connections.

❁ IB1.1 Jack Bookman Duke University

Using Guided Worksheets to Introduce Inquiry Based Learning in a Practical Flexible Way

This presentation will address how to construct and use guided class notes in first year Calculus classes to introduce students to inquiry based learning in a way that is practical and flexible and allows teachers to meet the requirement of "covering" material. Strengths and weaknesses of various teaching strategies will be discussed with specific emphasis on enabling the teacher to observe and assess what students are learning. Examples of guided class notes will be shown.

❁ CAL.3 Nathan Borchelt Western Carolina University
Kelli Nipper, Clayton State University

Make Trignometry Fun With a Cheapo Clinometer

Isn't it great when we can get students out of their seats and have them work on challenging problems that are meaningful and fun? In this talk, we look at how a little creativity and some hand-made clinometers have been used to engage groups of precalculus students in a mathematical task that they won't forget. For anyone who is interested, materials will be provided to make your own clinometer and then test it out onsite.

GME.3 Nathan Borchelt Western Carolina University
Anthony Stinson, Clayton State University

Common Core State Standards: What's a Mathematics Educator to do?

Adoption of the Common Core State Standards for Mathematics poses challenges and opportunities for higher education and its responsibility for teacher preparation. This talk will provide a brief overview of the standards and discuss implications for designing appropriate methods and content courses that will prepare future teachers for success in the classroom.

❁ GME.4 Cindy Box Georgia Perimeter College
Ray Collings, Georgia Perimeter College

A Fresh Start in Mathematical Literacy

Last fall semester marked new beginnings for 26 mathematics faculty and 800 non-STEM students at Georgia Perimeter College. The course Quantitative Skills and Reasoning (MATH 1001) began, offering experiences for freshman and sophomore students in mathematics relevant to logical, financial, and statistical thinking. Course content, presentation and assessment methods, student and faculty testimonies, plus adjustments made in the spring semester offering will be discussed.

❁ IB2.3 Karen Briggs North Georgia College & State University
Brad Bailey, North Georgia College & State University

How much Moore can Precalculus students take? Part 2

This is a continuation of Brad Bailey's presentation. Please see that abstract for details.

❁ RES2.6 Mark Budden Western Carolina University

Character Difference Graphs and Generalized Ramsey Numbers

Motivated by the role Paley Graphs have played in the determination of lower bounds for certain Ramsey numbers, we define and study character difference graphs with the goal of exploiting their ``randomness'' to provide new lower bounds for certain generalized Ramsey numbers. For an odd prime p and a nontrivial character $\chi : \mathbb{F}_p^{\times} \longrightarrow \square^{\times}$ satisfying $\chi(-1) = 1$, the vertices of such a character difference graph are identified with the finite field $\mathbb{F}_p$ and an edge joins vertices a and b if and only if $a - b \in Ker\,\chi$. We will discuss how these graphs are related to generalized Ramsey numbers and how one might go about determining the clique number for such a graph.

UGF.5 Ryan Campbell Wofford College

Quantifying the Tower of Hanoi Graphs

Much is known about the classic Tower of Hanoi puzzle: graphs, labels, and coloring. The classic version has three pegs and d disks, each with different sized diameters. The *d* disks are stacked on one peg from largest to smallest, with the largest being on the bottom. The object of the puzzle is to have all *d* disks stacked from largest to smallest on another peg. The rules state that each disk must move one at a time, and a disk cannot sit on top of a smaller disk. Our research was conducted about a variation of this puzzle, adding a single rule: a disk can sit on the next smallest disk, but not any

smaller disks than that. We can expand the number of pegs to p pegs as long as $p \geq 3$. From here, we can make and quantify various graphs based on the arrangement of pegs and disks. Since it is almost impossible to draw them all, we found formulas for the vertices, edges, and degrees of the graphs in general terms, such as d disks and p pegs. The objective of the project was to compare the graphs of our variation to the well-known graphs of the classic version.

PUB.2 Karen Carson W. H. Freeman
Cara LeClair, W. H. Freeman and Bill Notz, The Ohio State University

Innovative Technology for Enhancing Students' Experience in Introductory Statistics

Please join WH Freeman to discover new ways to engage your students and help them learn statistics with our three exciting, new online tools:

- Learning Curve: Designed using recent educational research, this new formative assessment program combines adaptive question selection, personalized study plans, and state-of-the-art question analysis reports. Its game-like quizzing activities keep students engaged while helping them focus on the areas they need to study the most.
- CrunchIt! 3.0: This fully-functional statistical software package is powered by R and delivers accurate output with an easy-to-use interface and a spreadsheet-like data grid. CrunchIt! is completely web-based. There is no software installation required , and all of the data sets needed for exercises and examples come pre-loaded.
- LaunchPad: Instructors will save hours of prep time using LaunchPad's pre-built course modules. Each module offers a complete unit-by-unit breakdown of the textbook with carefully selected and arranged assignments, activities, and quizzes that can be used as is or modified to suit your course.

UGA.1 Steven Carter Birmingham-Southern College
Doug Riley, Birmingham-Southern College

Rational Decomposition of Polynomials

We determine conditions under which an arbitrary polynomial can be expressed as the composition of rational functions. We began with the work of J. Rickards on the conditions under which a polynomial could be decomposed into the composition of non-trivial polynomials. We developed a more rigorous algebraic structure in which to study the problem, allowing us to characterize the trivial decompositions as ones containing invertible elements, forming an elegant analogy with number theory and prime factorization. We fully explored this structure and characterize the invertible units. A necessary and sufficient condition for writing a polynomial as the composition of two rational functions was found and was proven to be equivalent to the condition found by J. Ricards. Therefore, polynomials are decomposable as non-trivial rational functions if and only if they are decomposable as non-trivial polynomials.

MOD.4 George Cazacu Georgia College & State University

Dynamical Polysystems viewed as closed relations

A dynamical polysystem is regarded as a closed relation. Chain recurrence and Lyapunov functions are studied under this approach.

✵ MLU.2 Rodica Cazacu Georgia College & State University

Mathematical Models in Real World

Most of the students, especially non-science majors, believe that math is a subject they must take in college but never use it again. Most of those students choose to take the Introduction to Mathematical Modeling course to satisfy their requirements for math. In this presentation I will talk about some of the methods I use in this class, methods that help me involve the students in the teaching and learning process and also make them aware of the many ways math can be used in real life even by a non-science major. I will also talk about the approach of these methods over time for different classes I taught and the impact they had on my teaching and my students' learning.

❁ MFG.3 Jing Chen University of Alabama
Zhijian Wu, University of Alabama

Most Likely Path to the Shortfall Risk in Long-Term Hedging with Short-Term Futures Contracts

Analysis and Management of financial risks is an important topic in Financial Mathematics. This study is to find the most likely path to the shortfall risk in long-term hedging with short-term futures contracts. Base on a simple model initially discussed in Culp and Miller, Mello and Parsons, Glasserman and a simple discussion about comparing risks of a cash shortfall and the most likely path to a shortfall by Glasserman, this study did analysis on the most likely path for four basic cases: mean reverting or not, hedged or not. In addition, based on Larcher and Leobacher's optimal strategy and Wu, Yu and Zheng's optimal strategy under the constraint of terminal risk, this study did analysis on and found the most likely path corresponding to each optimal strategy. These "optimal" paths give information about how risky events occur and not just their probability of occurrence.

❁ APP.5 Tieling Chen University of South Carolina Aiken

A spherical color model

A color model is a mathematical model to describe colors. The RGB color model describes a color with a tuple of three numbers representing the amount of the three primary colors red, green, and blue. Although the model is perfectly represented by the Euclidean 3D space and is conveniently used in color image processing, it does not provide the human vision a nature way of understanding colors. Alternate color models such as the HSV and HSL models use hue, saturation, and value or lightness to describe color attributes that are well recognized by human vision. However, the conversions between the RGB model and these alternate models are complicated and not easy to interpret. In this paper we introduce a transformed spherical model to represent the color space. The spherical model is well mathematically represented and the conversions between the model and the RGB model are less complicated too. Like the HSV and HSL models, the spherical model also describes the color attributes recognized by human vision. Formulas of the conversions between the spherical model and the RGB model are given, and the comparisons with the HSV and HSL models are made in the paper.

BF.1 Marcela Chiorescu Georgia College & State University
Fred Richman, Florida Atlantic University

Minimal Zero-Dimensional Extensions

Let R be a commutative ring with Noetherian spectrum in which zero is a primary ideal. We present the structure of minimal zero-dimensional extensions of R when every height-one prime ideal of R is contained in only finitely many prime ideals. This extends previous results for $\dim(R) \leq 1$. We also present a characterization of the poset of prime ideals in a ring with Noetherian spectrum.

❁ DM1.1 Jeffrey Clark Elon University

Using Google's PageRank to Motivate Student Study of Markov Chains

This talk will discuss an application of Markov Chains in the teaching of Discrete Mathematics: a simplified version of the PageRank algorithm used by Google to sort responses to a search. The focus will be on how best to present the topic to students.

❁ AG.6 Robert E. Clay Dalton State College
Jason Schmurr, Dalton State College

An Elementary Visual Proof of the Euler Number of a Convex Polyhedron

Consider a convex* polyhedron. By triangulating the faces and using an interior point as a new "vertex", we can partition (disassemble) the polyhedron into tetrahedra. We inductively reassemble the polyhedron one by attaching one tetrahedron at a time.A tetrahedron has the Euler Number. We use concrete models to show that the Euler Number is preserved when an additional tetrahedron is attached to a partially reassembled polyhedron.

* in fact any polyhedron homeomorphic to the sphere.

BF.5 Jill Cochran Berry College

Beginning Research with Undergraduates

Through working with undergraduate students on research projects in the areas of mathematics education and graph theory I have found opportunities to explore new ideas and motivate my own research. This presentation will focus on experiences related to finding opportunities to do research with undergraduates, selecting appropriate and interesting topics/problems, presenting and publishing opportunities for undergraduates and staying appropriately involved.

❁ GS.3 Alex Collins Georgia Southern University

Colton Magnant and Hua Wang, Georgia Southern University

Graceful labeling of graphs of diameter 4

In recent years, there has been much work put into characterizing trees which are super edge-graceful.
In this talk we will survey some results for super edge-graceful labelings on trees. As part of some preliminary results, we will show that a tree, T, of order n and has a super edge-graceful labeling that is tight can be used to construct a tree, T' of order $n+2$ which itself is super edge-graceful. Some super edge-graceful trees constructed this way will also be shown.

UGA.3 K. J. Cox Samford University

Solving Robot Arm Problems with Groebner Bases

We first consider a plane robot arm that consists of three segments and two revolute joints. The first segment is attached rigidly to a flat surface making a right angle. The second segment is attached to the first and likewise the third segment is attached to the second. The hand of this robot will be attached to the end of the third segment. We define θ_1 as the angle between the second segment and the horizontal axis that is perpendicular to the first segment at joint 1. Similarly we define θ_2 to be the angle between the third segment and axis extended through the second segment.

Each θ_1 and θ_2 will determine the location of the end of the third segment. The main problem is to determine which settings for θ_1 and θ_2 will result in a desired position for the hand.

To solve this problem we need to solve four polynomial equations in the variables $\cos\theta_1$, $\cos\theta_2$, $\sin\theta_1$, and $\sin\theta_2$. To solve these equations, we will use the method of Groebner Bases to find a simpler set of equations that is equivalent to original.

RES2.2 Shilpa Dasgupta University of North Alabama

David E Brown, Utah State University and J. Richard Lundgren, University of Colorado

Characterization of interior 2-caterpillars

Recently 2-trees that are probe interval graphs have been characterized, and a natural next step is to characterize 2-trees that are unit probe interval graphs. To do this, one needs eneralizations of paths and caterpillars to 2-trees that are called 2-paths and 2-caterpillars, and then a special class of 2-caterpillars called interior 2-caterpillars. A 2-path is an alternating sequence of distinct 2 and 3-cliques, (e0, t1, e1,.....,tp, ep) starting and ending with a 2-clique and such that ti contains exactly two distinct 2-cliques e(i-1) and ei. A 2-leaf is a vertex whose neighborhood is a 2-clique. A 2-caterpillar P is a 2-tree in which the deletion of all 2-leaves results in a 2-path, called the body of P. A 2-caterpillar P is an interior 2-caterpillar if for any 2-leaf v, v is adjacent to any interior edge ei of any longest 2-path of P. In this paper we give a forbidden subgraph characterization of 2-caterpillars and interior 2-caterpillars. We then use this to show that a 2-tree that is a unit probe interval graph must be an interior 2-caterpillar. A major incentive towards this result is that later we use these results for subsequent work where we characterize 2-paths that are unit probe interval graphs.

❁ CAL.4 Robert Davidson East Tennessee State University

The Three Stooges, Ellipses, Implicit Differentiation, and Perspective

With the upcoming release of "The Three Stooges" movie, interest in the classic comedy team is expected to peak. Capitalizing on this interest, we present an in-class mathematical exercise suitable for the freshman calculus student. We

take a frame from the 1946 Three Stooges short "A Bird in the Head" and walk students through several measurements and computations based on the image. Students are required to calculate scaled distances and slopes of lines. They manipulate the equation of an ellipse and its implicit derivative to estimate a distance in the picture. All computations are based on the known height of one of the stooges. This project (presented to students as a worksheet) is an interesting application of several of the concepts from algebra, trigonometry, and calculus. We contend that the use of the Three Stooges in this setting presents the students with a very intellectually-unintimidating classroom environment!

UGD.5 Will Decker Furman University
Jordan Lyerly, Rob Picardi, and Aaron Markham, Furman University

Ranking Systems Applied to Major League Baseball: Variations on the Colley and Massey Matrix Methods

The traditional ranking system in Major League Baseball is the Win-Loss percentage, a ratio of the number of games won by a team to the number of games lost. While this ratio is telling of a team's ability, it does not take into account the strength of a team's opponents, the margin of victory or the skill of the players that compose the team. We use the Colley and Massey Matrix rating methods to help take these into account. By treating individual plate appearances as games and assigning points based on the events at those plate appearances, we are able to rate the players individually. Teams are then rated by an average of their players ratings weighted by position.

UGE.3 Courtney DeHoet University of Tennessee at Martin
Ashley Martin (student) and Curtis Kunkel, University of Tennessee at Martin

Singular Third Order Boundary Value Problems on Purely Discrete Time Scales

We study singular discrete third order boundary value problems with mixed boundary conditions of the form
\begin{eqnarray*}
& -u^{\Delta^{3}}(t_{i-2}) + f\left(t_{i}, u(t_{i}), u^{\Delta}(t_{i-1}), u^{\Delta^{2}}(t_{i-2})\right) = 0, \\
& u^{\Delta^{2}}(t_{0}) = u^{\Delta}(t_{n+1}) = u(t_{n+2}) = 0,
\end{eqnarray*}
over a finite discrete interval $\T = \{t_{0}, t_{1}, \ldots, t_{n}, t_{n+1}, t_{n+2}\}.$ We prove the existence of a positive solution by means of the lower and upper solutions method and the Brouwer fixed point theorem in conjunction with perturbation methods to approximate regular problems.

❁ STA.3 Joe DeMaio Kennesaw State University
Amy Hillen, Kennesaw State University

Incorporating Writing Into an Introductory Statistics Course Focused on Sports and Games

The ability to reason statistically is critical to becoming an informed citizen and intelligent consumer (Aliaga, et al., 2010). Despite its importance, research indicates that students struggle to reason statistically and that students typically enter introductory statistics courses "under sufferance, with levels of resistance related to their beliefs of the relevance of statistics" (Howley, 2008).

One approach for helping students make sense of complex mathematical ideas is to situate the ideas in real-world contexts that have meaning for students. We contend that the context of sports and games might be particularly promising, because: 1) it is a rich site for studying statistical ideas (e.g., probabilities in card and board games; correlation of player and/or team statistics); and 2) it is likely of interest to a wide range of students. In this talk, we describe writing assignments used in a general education elementary statistics course that focused on sports and games, and discuss student reflections on the efficacy of such assignments.

❁ GS.1 James Diffenderfer Georgia Southern University
Andrew Sills, Georgia Southern University

Congruences for Restricted Compositions

A composition of an integer n is any representation of n as a sum of positive integers. For example, there are eight compositions of 4: 4, 3+1, 1+3, 2+2, 2+1+1, 1+2+1, 1+1+2, 1+1+1+1. A partition of an integer n is a representation of n as a sum of positive integers, but where the order of the summands is considered irrelevant. Thus, 2+1+1, 1+2+1, and 1+1+2 are distinct compositions of 4, but are all the same partition. In all, there are five partitions of 4.

The theory of partitions began with Euler in the 1700's. He was the first to consider partitions with restrictions on which summands can appear, and proved that for any integer n, the number of partitions of n into odd summands equals the number of partitions of n where no summand may be repeated. Another famous result in the theory of partitions is due to Srivinvasa Ramanujan during the WWI era. He proved that the number of partitions of any number congruent to 4 modulo 5 is a multiple of 5, and several other related results.

Drawing on these two results for inspiration, I proved some analogous results in the theory of compositions. For example, the number of compositions of a multiple of 8 is always a multiple of 9.

❁ TEK.2 Lothar A. Dohse UNC Asheville

Spicing up Linear Algebra with visualization

Key topics taught in Linear Algebra lend themselves very well to visualization. These topics include linear transformations, matrix operations, and eigenvalues. I will present simple pseudo codes based on matrix algebra that transform and manipulate images. These codes can easily be transcribed into Mathematica, Excel or programs for calculators. The resulting images generated by these codes serve as an educational tool that allows students to experiment with mathematical concepts thereby strengthening their understanding of Linear Algebra. Examples include testing pairs of matrices that (may) generate fractal images.

UGD.4 Nicole Dowling Kennesaw State University

Developing a Mathematical Demand Function Model using Hysteresis Phenomena

One of the principal problems of mathematical simulation in economics is a problem related to balanced pricing process analysis.

The classical approach to supply-and-demand function mapping considers pricing analysis within the cobweb model or its analogs. The up-to-date research shows that the economic system state in some period of time depends not only upon a current parameter value but also upon its values in previous time periods.

In this goal we:

- analyzed currently developed mathematical models for pricing
- developed a model for the function of consumer demand in respect to time

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UGB.2 Carolyn Drobak Rhodes College

Modeling the Hypothalamic Pituitary Adrenal Axis System for Dexamethasone Treatment

The hypothalamic pituitary adrenal axis (HPA) system regulates stress in the brain. When this system experiences a dysfunction, such as during chemotherapy treatments, there can be a number of unwanted side-effects such as depression or chronic fatigue syndrome. I utilize systems of nonlinear ordinary differential equations to adapt pre-existing models for the HPA system to account for the administration of Dexamethasone, a pharmaceutical drug used to lessen side-effects of some cancer treatments and to prevent some HPA dysfunctions. My adaptations will account for the administration of this pharmaceutical drug and hopefully uncover new medical information for treatment of cancer. Latin hypercube sampling, a form of uncertainty analysis, is used to model the variability in the model parameters. Sensitivity analysis will be used to determine how sensitive the model is to small parameter changes. Preliminary results will be shown.

UGD.3 Lauren Dubuke UNC Asheville
Patrick Bahls, University of North Carolina, Asheville

Generalizing the Channel Assignment Problem on Cayley Graphs

The channel assignment problem for a graph involves assigning valid labels such that for a distance i, the value of $|x_0 - x_i| \geq k_i$. This has been well studied for two parameters, (k_1, k_2), but little work has ventured to a third parameter. In this talk we look at an extension of the distance-2 labeling by Patrick Bahls, which allows for a distance-3 labeling for certain types of groups.

❁ IB2.5 Chis Duncan Lander University
Kevin Dove and Andre Lubecke, Lander University

Using Inquiry-Based Activities in a Primarily Lecture-Based Intro Statistics Class

Knowing that an all-inquiry-based intro stats class could have consequences in terms of the breadth of material covered, our approach is a hybrid format which includes experiential classroom activities to introduce/discover central concepts. We will discuss strengths and weaknesses of some activities we have developed.

❁ MOD.1 Aniekan Ebiefung The Univeristy of Tennessee at Chattanooga

Choice of Technology and Industrial Pollution

A mathematical model for controlling the generation of industrial pollution by choosing the right set of technologies is provided. The method is based on the Leontief input – output techniques. It is shown that the model is equivalent to a vertical linear complementarity problem, an optimization problem with manifold areas of applications. Using results from complementarity theory, we provide conditions for existence of solutions for the model.

UGF.2 Mary Beth Edwards Georgia Southern University
Nathan Dunn and Hua Wang, Georgia Southern University

A Modified Network Flow Algorithm for Intergovernmental Spending

How our government spends and transfers money and the possible effects these actions have on the economy has long been a subject of interest to many people. Using a variation of the Maximum Flow Algorithm, we develop a model to represent this transferring of money between different levels of governments and examine its effects on the local economy. In more details, we will discuss the construction of efficiency curve for each district before the application to data of larger scale. Based on data from the Census Bureau we display the application of this model to an example state aid distribution.

UGB.4 Trevis Elser Southern Polytechnic State University

Removing Constant Volatility From The Black-Scholes Model

The Black-Scholes Model is a classical model for predicting the price of European Style options. There are a number of assumptions that this model is built around. Of particular interest is the assumption of constant volatility. Since this assumption is not realistic I am examining the results of removing the assumption. In order to achieve this goal the constant volatility is replaced by a number of periodic functions and the results analyzed.

❁ MAU.6 Jon M. Ernstberger LaGrange College

Reflections on the Initiation of a Modeling-Focused Undergraduate Research Program

Many will argue that undergraduate research must receive priority within a mathematics department. A junior faculty member at a private liberal arts institute shares his experiences concerning the initiation of his own undergraduate research agenda. How did he choose a research focus? How are students attracted to the program? These issues and more will be addressed.

❁ RES2.4 Martene Fair Tennessee State University
Stephen Campbell, North Carolina State University

Active Incipient Fault Detection With Multiple Concurrent Faults

The problem of detecting small parameter variations in linear uncertain systems due to incipient faults by injecting an input signal to enhance detection is considered. This work focuses on the multi-parameter case and it is assumed that multiple faults are occurring simultaneously. The method is an extension of a multi-model approach used for the construction of auxiliary signals for failure detection and it can be applied to both discrete time and continuous time systems. The questions examined are for what failures can the fault be detected within a given system and how does the detection signal computed change depending on the threshold for detecting the fault.

UGF.3 Gregory Ferrin Western Carolina University
Michaela Stone (also presenting), Alfred University

Independence polynomials of regular caterpillars

We offer a background of independence polynomials and their importance in graph theory. Specifically, we look at the independence polynomials of regular caterpillars. We will introduce a new closed-form of the standard recursive formula for the independence polynomials of regular caterpillars of any finite size. We will then apply our formula to identify modes of the independence polynomials for certain regular caterpillars.

❁ RES1.6 Rigoberto Florez University of South Carolina Sumter
Leandro Junes , University of South Carolina Sumter

GCD Properties in Hosoya's Triangle.

The *Hosoya's triangle* is an arrangement of numbers where each entry is the product of two Fibonacci numbers. An hexagon in Hosoya's triangle gives rise to two triangles, these two triangles form what is called *Star of David.*

In this talk we prove that the greatest common divisor (gcd) of all points in each triangle of the Star of David is equal to one. We also give a criterion to determine whether a sequence of points in a polygon or in a rhombus have gcd equal to one. Joint work with Leandro Junes University of South Carolina Sumter.

UGB.6 Halcyon Garrett University of North Carolina Asheville
Michael Friedrich and Patrick Bahls, University of North Carolina Asheville

What's for Dinner: Linear Analysis of Nutritional Data and an Application to Community Health

One misconception regarding food in America is that eating well is more expensive than eating highly-processed foods of relatively low nutritional quality. However, this mistaken belief can be disproved by analyzing dietary requirements mathematically.

George J. Stigler was the first to use linear algebraic techniques to analyze the nutritional content of various foods. In 1945, he published "The Cost of Subsistence" [illegible] which described a method to determine the most nutrie number of foodstuffs and a pre-established budget. Since that time, similar studies have analyzed foods available in developing countries in order to provide optimal nutrition to populations living beneath the poverty line. This method is extremely useful as it can be applied to any demographic with a set of food items, given nutritional and budgetary constraints.

In our study we generate a list of foods that are inexpensive, nutrient-dense, and widely-available through local supermarkets. We then present several diets which meet the recommended daily allowances (RDAs) of key nutrients as established by the FDA. These meal plans can be integrated into a local program which promotes health awareness and financial literacy within the Buncombe County community in North Carolina.

UGA.2 Keegan Gary Kennesaw State University
Mari Castle and Joe DeMaio, Kennesaw State University

Total Efficient Dominating Sets in Cayley Graphs

A set $S \subseteq V$ is a **dominating set** of $G = (V, E)$ if each vertex in V is either in S or is adjacent to a vertex in S. A set $S \subseteq V$ is a **total efficient dominating set** (or **TEDS**) of a graph $G = (V, E)$ if each vertex in V is adjacent to exactly one vertex in *S*. While the problem of domination is one of optimization, the question surrounding a TEDS is that of existence. In 2002, Gavlas and Schultz showed that a TEDS S exists for the path graph P_n if and only if $n \not\equiv 1 \bmod 4$, and that a TEDS S exists for the cycle graph, C_n, if and only if $n \equiv 0 \bmod 4$. The cycle graphs are a special class of circulant graphs, which in turn, are a special class of Cayley graphs. The \textbf{Cayley graph} $C(A, X)$ for a group A with generating set X has the elements of A as vertices and has an edge directed from a to ax for every $a \in A$ and $x \in X$. In this talk we will classify all circulant graphs that admit a TEDS, and begin to investigate the existence of a TEDS in Cayley graphs.

❁ DM1.4 Mark Ginn Appalachian State University

Graph Theory in Sports

Graph theory can be used to model many different situations including many from sports. Scheduling and tournaments are two standard examples from sports that come up often in discrete mathematics courses. We will explore some nonstandard examples including blitzes and blocking schemes from football.

❁ MFG.4 Maydison Ginting University of West Alabama
Zhijian Wu, University of Alabama at Tuscaloosa

Capping the Variance of Cash Flow of Hedging Strategy

On an optimal strategy to reduce the running risk in hedging a long-term supply commitment with short-dated futures contracts, we introduce a cap function to define scenarios of running risk over the hedging horizon.
We introduce a linear cap function and wish to find a hedging strategy G with the smallest constant F such that the variance of the cumulative cash flow is less than or equal the multiplication of a cap function and the constant F. The objective is to seek the best function G(s) to cap the variance of cash flow under a given non-negative cap function.
We also implement the result in MATLAB by creating a Graphical User Interface application that enables the user to see the various results of the variance of cash flow of the best hedging scenario.

MOD.3 Jerome Goddard II Auburn University at Montgomery
E. Lee and R. Shivaji

Population models with diffusion, strong Allee effect, and nonlinear boundary conditions

We discuss the steady state solutions of a diffusive population model with strong Allee effect, namely,
\begin{eqnarray*}
-\Delta u & = & a(x)u + b(x)u^2 - m(x)u^3 -ch(x); \quad \Omega\\
\alpha(u)\frac{\partial u}{\partial \eta} & + & \left[1 - \alpha(u) \right]u = 0; \quad \partial \Omega
\end{eqnarray*}
where Ω is a subset of $\mathbb{R}^n$ with $n \geq 1$, $a(x), b(x)$, and $m(x)$ are Holder continuous functions such that $b(x), m(x)$ are strictly positive on the closure of Ω with $a(x) < 0$ for some x in Ω, $c \geq 0$, $\alpha(u): \mathbb{R} \longrightarrow [0,1]$ is a non-decreasing smooth function, and $\frac{\partial u}{\partial \eta}$ is the outward normal derivative. Our study is focused on a population that satisfies a certain nonlinear boundary condition and on its persistence when constant yield harvesting is introduced. We establish our existence results by the method of sub-super solutions.

UGC.4 Rachel Griffin Samford University

Decomposing Kn into Cycles of Lengths 3 and 4

Let K_n denote the complete graph on n vertices. We discuss decompositions of K_n into cycles of lengths 3 and 4. The edge disjoint collection of 3-cycles and 4-cycles form a partition the edge set of K_n.

❁ RES1.2 William Griffiths Southern Polytechnic State University
Daniel Karasek, Southern Polytechnic State University

Permutation Ups and Downs

Descents and Inversions are long studied permutation statistics, their properties well documented. Two of these properties are log-concavity and the real zero property (that all zeros of the generating polynomial are real and negative), of which the former is shared by both descents and inversions, while the latter do not have the real zero property. What sort of measure is 'in between' these two statistics, and where is the real zero property lost? We share our most recent discoveries, including projects recently assisted by and accessible to undergraduates.

❁ DM2.4 Martin L. Hall Georgia Southern University

Improved upper bounds for Gallai-Ramsey numbers of paths and cycles

Given a graph G and a positive integer k, define the Gallai-Ramsey number to be the minimum number of vertices n such that any k-edge coloring of K_{n} contains either a rainbow (all different colored) triangle or a monochromatic copy of G. In this work, we improve upon known upper bounds on the Gallai-Ramsey numbers for paths and cycles. All these upper bounds now have the best possible order of magnitude as functions of k.

❁ IB1.2 Queen Harris Georgia Perimeter College

Students Doing the Unthinkable: Coming to class ONE HOUR early! (Increasing Student Success in Calc I)

Ever wish that your students would perform better in your classes? I've tried a NEW technique and it is working! We will learn this technique and see a video of students who successfully used this technique.

❁ IB2.6 Queen Harris Georgia Perimeter College

Creating a Service Learning Project for Statistics and Calculus students

Could there ever be Service Learning Projects for Mathematics Students? We will hear of a Service Learning project from its inception to implementation for Statistics and Calculus classes.

❁ MAU.4 Janine M. Haugh UNC-Asheville

Designing a final project for math modeling students: Vampires, iPods, rabid dogs, and more

Last spring, I taught an intro course in mathematical modeling at UNC-Asheville which culminated in the study of ODE models. The final project was left fairly open-ended; students were to develop a dynamic model involving two or more interrelated populations related to any topic of their choosing. In this talk, I will discuss the overall experience, including the resulting project topics and the hurdles we hit along the way.

❁ AG.4 John Hawkins Georgia Southern University
David Stone, Georgia Southern University

Complementary trapezoids living in the same circle

Problem 5153 in the SSMA Journal Problems Section posed the situation of two trapezoids (1, 1, 1, x) and (x, x, x, 1) both inscribed in a circle. The goal of the problem was to find x and the size of the circle.
We show that there are only three possible solutions and that, surprisingly, the Golden Ratio shows up in the answers. Then we generalize to two trapezoids (a, a, a, b) and (b, b, b, a). Finally, we show how the solutions arise from inscribed decagons.

UGA.4 Daniel Heslop Savannah State University
Julain Rayford, Savannah State University

My Facinating Journey with Perfect Numbers

Number theory is one of the oldest branches of pure mathematics and is concerned primarily with the properties of numbers. Since the discovery of numbers, mathematicians have been fascinated in the patterns and properties surrounding them. They also noticed that certain numbers are equal to the sum of their proper divisors. Four numbers that exhibit this property are 6, 28, 496, and 8128. These are the first four perfect numbers. The search for perfect numbers began long ago as the ancients believed they had important numerological applications. In this paper we will investigate important properties of perfect numbers and prove important theorems which play key roles in the mathematical theory of perfect numbers. A simple method of finding perfect numbers using basic number theory is given, which students who have not taken a calculus course would be able to understand.

❁ RES1.1 Sarah Holliday Southern Polytechnic State University
Kelly Bragan, Peter Johnson, Auburn University
Matthew Walsh, Indiana University/Purdue University Fort Wayne

CNUC graphs

Given a graph *G*, consider the set of closed neighborhoods of vertices. We shall classify the family of graphs that is Closed Neighborhood Union-Closed (CNUC), and consider related properties.

❁ TEK.1 Wanjun Hu Albany State University
Xiaomei Zheng and K. C. Chan, Albany State University

How much does touch screen technology help under-prepared students in science and math classes?

Teaching mathematics and sciences using touch screen technology has been introduced to many classrooms. However, our study shows that there is no significant difference between using TI calculator and iPad when teaching College Algebra to under-prepared students, and students show no preference to either iPad or Excel when teaching Chemistry to that same group of students. In an experiment involving two sections of College Algebra by the same instructor, student survey results show that students do not feel much different when using TI Graphical Calculator or Wolfram Alpha in iPad. In another experiment of one section of chemistry using both iPad and Excel, student survey results show no preference to either software application.

❁ STA.5 Patricia Humphrey Georgia Southern University

Probability Facts, Fallacies and Flim Flam

Students (and the general public) often take probabilities (or proportions) and apply them incorrectly. This talk will highlight some erroneous ways of thinking and explain the misunderstandings inherent, along with ways we might form correct interpretations.

UGF.1 Laura Huntington Nipissing University

Minimizing the Atom Bond Connectivity Index of Chemical Trees

This paper is an investigation of the trees that minimize the Atom-Bond Connectivity or ABC index. The investigation is limited to chemical trees, i.e. trees in which the maximum vertex degree is 4. The chemical trees were introduced to reflect the structure of the carbon chains and the molecules based on them. The approach explored in this paper is algorithmic. It identifies certain types of edges (chemical bonds) that are important and occur frequently in chemical trees. Further, the paper contains a study of how the removal of a certain edge, the introduction of certain edge or the contraction of certain edge affect the ABC-index of the tree. There is particular attention paid to the examples of minimal ABC index chemical trees provided by Dimitrov.

UGC.3 John Jacobson Kennesaw State University
Joe DeMaio, Kennesaw State University

Combinatorial Proofs of Fibonacci Identities by Means of the Path Graph

A graph is defined as a set of vertices and a set of edges such that an edge connects two vertices. Two vertices connected by an edge are considered to be adjacent to one another. An independent set of vertices of a graph is a collection of vertices such that no two vertices are adjacent. In 1982, Prodinger and Tichy realized that the number of independent sets of vertices of a graph corresponds to the Fibonacci Sequence, and therefore defined the Fibonacci Number of a Graph to be the number of independent sets of the graph. This research focuses on the Fibonacci Number of the Path Graph and how it can be used to combinatorially prove various Fibonacci identities. The visual nature of the path graph provides different proofs of standard identities and has already led to the discovery of a new identity.

❁ GME.1 Keshav Jagannathan Coastal Carolina University

Are our students prepared for College Mathematics - An effort to raise the preparedness level of freshmen at Coastal Carolina University.

In this presentation, we will discuss the apparent decline in mathematical ability and preparedness of incoming college students nationwide. A recent study by the Department of Mathematics and Statistics at Coastal Carolina University showed that Coastal Carolina students are following this trend; the pass rate for College Algebra is UNDER 50% !!! In this talk, we will compare pass rates across disciplines as well as across institutions. We will also address the implementation of certain measures which are aimed at improving the overall mathematical ability of our students and their success in future science and mathematics courses.

DM2.3 Susan Janiszewski Emory University
Ronald J. Gould, Emory University

3-connected, claw-free, generalized net-free graphs are hamiltonian

Given a family of graphs F, we say that a graph is F-free if it contains no subgraph isomorphic to any graph in the set F. The graphs in this set are known as {\it forbidden subgraphs}. In this talk, we work to classify pairs of forbidden subgraphs that imply a 3-connected graph is hamiltonian. First, we reduce the number of possible forbidden pairs by presenting families of graphs that are 3-connected and not hamiltonian. Of particular interest is the claw, as we show that it must be included in any forbidden pair. Secondly, we complete the classification of generalized-nets such that a 3-connected, claw-free, generalized-net-free graph is hamiltonian, where a generalized-net is the graph obtained by rooting vertex-disjoint paths at the vertices of a triangle.

UGE.5 Stephanie Jessie Austin Peay State University

Connections between illustrations and mathematical beliefs

Analyzing illustrations drawn by middle Tennessee students, regarding mathematics, we are able to discover their beliefs and attitudes regarding mathematics. An analysis of these pictures for encoded mathematical beliefs showed in general, that we could divide the belief structure and attitudes of students into categories that were mostly consistent with established belief categories. However, there emerged a new category, that showed a belief system inconsistent with known categories.

❁ GME.2 Edward Johnson UNC Asheville

Tracking Student Resource Usage

In these austere times many departments struggle to defend ancillary services against shrinking budgets. The Mathematics Assistance Center (AKA Math Lab) at UNC Asheville is an excellent example of such a service. One tool that our department uses to help secure funding for this essential student facility is software written to conveniently track student usage. The software not only logs the total hours of Math Lab use, but how students use it and for what courses. I will demonstrate the software with examples of data analysis and offer it free to any department that could utilize this potentially valuable tool.

❁ GS.2 Dan Jones Georgia Institute of Technology and
Yan Wu, Georgia Southern University Colorado State University

Controlling the chaotic Lorenz system

Analytical and experimental work from the past two decades shows that it is possible to suppress chaotic behavior in a number of systems using various perturbation schemes. In this work, we show that the classical Lorenz system can be stabilized in this fashion using a closed-loop quotient controller. Using linear perturbation theory and a geometric approach adapted from epidemiology, we prove that the only locally stable equilibrium point of the controlled system is also globally stable. Finally, we present some scaling relationships that provide insight into the dynamics of the Lorenz system.

❁ RES1.5 Leandro Junes University of South Carolina Sumter
Rigoberto Florez, University of South Carolina Sumter

A Relation Between Triangular Numbers and Prime Numbers

In this talk we discuss several results that relate triangular numbers, factorials and prime numbers. In particular, we state an analog to Fortune's conjecture for the product of triangular numbers. That is, if T is the product of triangular numbers, are there infinitely many primes of the form $T \pm 1$? We provide strong evidence that suggest that this conjecture is true and show that there are infinitely many cases for which $T \pm 1$ is composite. Undergraduate students with a passion for number theory will find this talk entertaining and understandable.

❁ STA.6 Jennifer Kaplan University of Georgia

Simulations, Clickers and Conceptual Understanding of Statistical Inference

This talk will present an activity designed to help students develop conceptual understanding of the process of hypothesis testing as well as the meaning of the p-value. The activity has been implemented in a large lecture introductory statistics course in which the students use calculators to perform a trial of a simulation and personal response systems (clicker) to report the results of the trial. Slides and student responses will be shared along with an extension of the activity designed to improve student understanding of Type I and II errors and power.

❁ MLU.1 Samuel R. Kaplan UNC Asheville

Mathematical Modeling in the Everyday

Good models arise in applications, issues of social justice and many other venues. However, we also want to address how to find models in the everyday. I will discuss “The Laundry Problem” as well as how we can expand a given question to enrich the mathematics involved. In the Laundry Problem, we try to model how often we run white, color or dark loads if we know the distribution of our daily laundry pile.

UGB.1 Kevin Kern Coastal Carolina University

Where to Park a Spaceship: Lagrange Points and Their Stability

Every body in the solar system acts on every other body in the solar system with a force determined by Newton's law of gravitation. We consider a three-body system in which the mass of the third body is negligible in comparison to the other two. As such, we find that the motion of the two more massive bodies behaves like a two-body system. In such cases, we find that there are locations in space where the sum of the forces acting on the third body is zero. These locations in space are known as Lagrange points. In the rotating reference frame these points have no motion with respect to the more massive bodies. This talk determines the locations of all of the Lagrange points. So, if you happen to be on an intergalactic mission and you need a place to park your space ship, you'll want to know where the stable Lagrange points are - they're the Universe's cosmic parking spots.

UGA.6 Andrew Kimball Western Carolina University
Liljana Babinkostova and Kameryn Williams, Boise State University
Alyssa Bowden, Loyola Marymount University

On the Design of Simplified DES Based on Elliptic Curves

The Data Encryption Standard (DES) is a symmetric key encryption system that was published in 1975 by the National Bureau of Standards. DES is a block cipher that involves the use of a Feistel permutation which sends $2n-bitstring$ (L,R)$ to $(R, L + f(R))$ where f is a length-preserving function and $+$ represents the operation that acts on n-bit strings. The major non-linear component of the DES is the function f that involves substitution boxes (S-boxes). The main security of this cryptosystem lies in the structure of the S-boxes.

Since it is computationally infeasible to analyze DES directly several simplified versions of DES have been introduced. Few publications address security features of these versions of DES. Additionally all of these systems are based on the bitwise XOR operation.

The main focus of this research is to study the properties of the S-boxes in DES, and the binary operation used in the encryption and how they affect the security. For educational purposes we created our own DES-like cryptosystem that is

different from other known simplified DES algorithms. Our cryptosystem is implemented over the group generated by an elliptic curve, and we named this cryptosystem E-DES. Some of the criteria that we wanted our cryptosystem to satisfy are: (1) E-DES is implemented over a group that is not ZZ_2, (2) E-DES permutation would not generate the alternating group, and (3) S-boxes would be more secure than in other simplified versions of DES.

We continue to investigate the structure of the S-boxes.

This work is supported by the REU-NSF grant DMS 1062857 and Boise State University.

❁ DSL.2 Ben Klein Davidson College

Too Good to be True

We will consider a collection of results from a variety of fields – potentially including combinatorics, plane geometry and complex analysis -- in which either the result or its proof is to be "too good to be true". In most cases, the result itself is surprising, and in the others the proof provides a surprising insight into the result.

Nearly all of the results will be accessible to students who have taken, or are currently taking, a calculus course. The entire talk will be accessible to students who have taken an undergraduate course in complex analysis.

❁ AG.3 Vicky Klima Appalachian State University

Investigating Musical Groups

The first few topics in a music theory course and those of an abstract algebra course have much in common. In this talk we introduce activities that ask students to look at (and listen to) musical scales and chords, observing mathematical properties along the way. We then discuss using these activities to help students observe and explain properties of dihedral and finite cyclic groups.

UGG.4 Karen Larson Davidson College

Unwrapping Rap

We apply cluster analysis to efficiently classify drum breaks that are sampled by rap songs. Clustering takes objects from a group and puts them into subsets that have similar characteristics. We preprocessed the data to produce signals that can be compared and used agglomerative hierarchical clustering and QT-clust to form the clusters. The resulting clusters contain different collections of similar sounding drum breaks, and could be used to form various sub-genres of rap music.

❁ RES1.4 Jeffrey Lawson Western Carolina University
Matthew Rave, Western Carolina University

His boy Elroy: A descriptive approach to geometric phase

(Preliminary report) Geometric phase in a dynamical system can be visualized as the interplay between the two characteristic periods of a closed orbit which go in and out of "synch". In this talk we will use the example of Elroy's beanie, a simple mechanical system on a torus, to illustrate three approaches to determining geometric phase: direct computation from the equations of motion, normal mode analysis, and use of conservation laws.

The elegant simplicity of this last approach can be explained by observing invariants under an action of the circle group on the torus. We conclude by describing in brief how the onservation law approach extrapolates to the general method of reduction by symmetry.

DM2.2 Rao Li University of South Carolina Aiken

Spectral Conditions for Some Stable Properties of Graphs

Let P be a property defined on all graphs of order n. Let k be a nonnegative integer. The P is said to be k - stable if whenever G + uv has property P and $dG(u) + dG(v) \geq k = k(n, P)$, where uv is not in E, then G itself has property P. Using the spectral invariants of graphs, we present sufficient conditions for some stable properties of graphs.

❁ TEK.6 Shinemin Lin Savannah State University

Online Instructions in College Mathematics

Online teaching is a worldwide trend. Several researches have been done in the topics of Online Teaching at variety fields. Online learning and teaching are easier at certain fields than the other fields. In the field of mathematics, many professors are still looking for a user-friendly way to deliver online teaching.

It has long been a common practice in colleges and universities for students to copy lectures for later review. This often results in the students busy copying notes from whiteboard and never listing to the lectures. The use of online instructions would allow a "perfect" version of a lecture to be made available for students to play on their computers. This also creates an excellent back-up if the professor is ill or unable to attend classes. Also To learn mathematics in depth, we have to try them again and again and experience the application of the problems.

However, it takes lots of manpower to provide immediate feedbacks and new questions to students. Online tutorials and instructions can provide solution for this issue. Online tutorial and instructions also allow students to study or review course subjects at their convenience while joggling between family, school, and professional business.

The intent of this study is to investigate the impact of new educational software technologies on school performance, attrition, and persistence of students from low social-economics society and possibly develop a web-enhanced tutorial with integrated mathematics and engineering technology courses at Savannah State University. I started web-enhanced classes in 1996. Later I adopted WEBCT using publishers' epacks. In the academy year 2006, I chose Educo Learning Systems for my blended of online courses. Finally our department decided to use WEBASSIGN as out official online instruction tool in 2010. This presentation will cover analysis of student data of all my previous web-enhanced and online courses.

❁ MAU.3 Wesley Long LaGrange College
Jon M. Ernstberger, LaGrange College

Modeling the Atmospheric Carbon Dioxide Over the United States

In this undergraduate research project, we implement a published, component-based model of the total carbon dioxide concentration in the atmosphere above the United States. To do so we use a simple ordinary differential equation to quantify the behavior of the carbon cycle (as described in published NOAA findings), compute lines of best fit to approximate carbon dioxide contributions due to emissions from fossil fuels and forest fires, and employ Henry's law to estimate the overall oceanic effect. Finally, via residual comparison, model parameters are estimated.

❁ TID.4 Robin Lovgren Belmont University
Glenn Acree, Belmont University

Using Conway's Game of Life to Teach Problem Solving and Iterative Processes

Many students today enjoy the animation and computer effects that accompany some of Hollywood's biggest blockbusters. Several of these effects including mountain landscapes and flames of fire are created using fractals and iterative processes. In a Mathematical Reasoning course students see the Nova video "Hunting the Hidden Dimension" which shows several applications of fractals, and then they try their hand with the iteration process in a simple form using John Conway's Game of Life. The game will be demonstrated along with associated exercises and questions that promote creative thinking and build problem solving skills.

UGD.6 Jordan Lyerly Furman University
Will Decker, Rob Picardi, and Aaron Markham, Furman University

Insights into Major League Baseball: Results of modified Colley and Massey Matrix Rating Systems

After rating Major League Baseball players and teams using modified Colley and Massey rating systems, several interesting insights were observable. The first that we will discuss is the question of whether or not money wins games. We examine the relationship between ratings and salaries of players and teams. We also compare rankings by these systems with those by other statistics such as runs scored and win-loss percentage. There are also some interesting examples of outliers, players whose ratings don't seem to match up with their statistics. In some cases these players have experienced a change in their statistics towards what is reflected by their rating.

❁ DM2.5 Colton Magnant Georgia Southern University

Edge-colorings without a rainbow triangle behave much like 2-edge-colorings.

When a colored subgraph is forbidden from an edge-colored complete graph, this local condition frequently implies global structure on the coloring. In this talk, we explore the structure of edge-colored complete graphs when certain rainbow or properly colored subgraphs are forbidden. The most well-studied such subgraph is the rainbow triangle and we discuss how some interesting properties of 2-colored complete graphs also hold in rainbow triangle-free colorings of complete graphs. We also discuss other colored subgraphs. In particular, forbidding a proper 4-cycle implies extremely strong structure while forbidding a proper 5-cycle or proper 6-cycle gives significantly weaker structure.

❁ GS.4 Marco V. Martinez The University of Tennessee

Inverted classroom: A Pre-calculus experience

An inverted classroom is an approach where students do a pre-class activity that is designed to let them develop knowledge about the upcoming topics by viewing print and media resources. Then, in class, they use that knowledge for various activities, where the teacher is available for help. I will talk about how I implemented this approach in my pre-calculus class and discuss student reactions and how they changed during the semester. Also we will look at some of the student feedback.

❁ TEK.5 Catherine Matos Clayton State University

Enhancing your Mathematics Courses with Camtasia, Both Inside the Classroom and Out

By using a tablet, TechSmith's Camtasia, and a program such as OneNote or Windows Journal, you can quickly and easily record class lecture, capturing both lecture notes and work done in other programs such as Maple. Those videos can then be made available to your students online. For the traditional classroom, this means an easy source of review material for the students, as well as an end to the "Did I miss anything important in class today?" emails. For Hybrid and Online courses, this means the opportunity to increase the support provided to those students, giving them a larger exposure to the instructor's explanations of course material. It becomes very easy to create tutorials for a variety of topics, from using Maple in Calculus class to statistics software in Introductory Statistics. But you can go beyond the classroom (virtual or physical) and use these tools to enhance your interactions with students outside of class. As an instructor at a school with a large non-traditional student population, I have found that my time on campus often does not line up with when many of my students have the time available to come for help. Synchronous methods such as Skype or WebEx are a great option when both individuals can be online at the same time. Camtasia offers an asynchronous option for providing help to mathematics students, allowing the instructor to answer student questions by recording a short video at the instructor's convenience. This talk will demonstrate how I use these resources in my courses, their advantages and disadvantages, as well as provide some preliminary feedback from students on their usefulness.

❁ IB2.4 John C. Mayer University of Alabama at Birmingham
William O Bond, University of Alabama at Birmingham

Inquiry-based Sessions in Developmental Algebra and Their Learning Impacts

Experiments were conducted in the Fall 2009 and Fall 2010 in a developmental algebra course at UAB. Students were randomly split into treatment groups. While all treatments shared a computer assisted instruction component in a mathematics lab, the classroom meetings differed among treatments. In Fall 2009 there were two treatments: one had an inquiry-based meeting (involving collaborative group work) combined with computer work and the other had a lecture with computer work. In Fall 2010 there were three treatments: two inquiry-based meetings, two lectures, or one each of lecture and inquiry, all with the same computer work each week. Statistical results concerning student test scores, final grades, scores on both open-ended and objective pre/post tests, and student success in subsequent mathematics courses will be presented. For example, students receiving inquiry-based sessions performed statistically significantly better on open-ended problems. Factors studied influencing student performance in subsequent mathematics courses include: treatment and nature of subsequent mathematics course (intermediate algebra or finite mathematics). We will also present the reasons for how UAB now teaches this developmental algebra course based on the previously mentioned data, analysis of it, and a student satisfaction survey.

❁ APP.2 Hope McIlwain Mercer University

Mathematical March Madness: A Case Study

In their paper, "Bracketology: How can math help?", Chartier et. al. introduce several methods for ranking sports teams. Such methods involve solving linear systems of equations. In this paper, we discuss the application of these methods to ranking men's basketball teams in the Atlantic Sun Conference for the 2009-2010 and 2010-2011 seasons. We attempt to see if the mathematically produced methods can accurately predict the outcome of the conference tournament. In addition, we will discuss other factors that might be considered when ranking teams.

❁ MAU.5 Erin McNelis Western Carolina University

Individual (Agent) Based Models in Mathematical Modeling

Differential equations in biology are most commonly associated with aggregate models. Aggregate models consider a population as a collective group, and capture the change in the size of a population over time. Individual (agent) based models, however, look at population dynamics from an individual's perspective. Rather than modeling the aggregate change to the entire population, individual based models track the behavior and number of a collection of individuals in a population. Individuals move and interact with their environment based on a set of rules and probabilities, and are thus stochastic in nature. This talk will compare simulating population dynamics using the aggregate approach and the agent based approach and how both methods can be used successfully in a mathematical modeling course.

UGC.1 Katie Milhous Georgia Southern University

Cryptography and Combinatorics: A Prime Form of Communication

An encryption system should have three main criteria: How secure is the system? A system can be considered secure if no useful information can be gained from discovering any permutation of the system at any given step of the encryption process. Each permutation of the system must act as if it is in a private channel so that it is infeasible for a hacker to be able to penetrate the system. Second, how applicable is the system? A system is only useful if it can be used in a practical amount of time. That is, an encryption system must have time parameters in place that bound or limit the system. Thirdly, is the system hard to invert? This criterion is usually achieved by the use of a one-way function, a function that is easy to evaluate but for which it is hard to find the pre-image of the function. The weakness of today's most common cryptosystem (RSA) is that it relies on the inability of computers to be unable to find the prime divisors of large numbers. However, there is one key weakness in this. Computers are clearly becoming faster, which means that they will soon be able to break down large numbers. While the idea of simply using larger numbers is a solution, it is only a temporary one. A better solution seems to be to devise a completely new system.

❁ MLU.2 Andy Miller Belmont University

Mowing the Lawn: An Introductory Modeling Activity

Anyone who has to mow a lawn in the middle of July will quickly decide that he or she needs to find the quickest way of accomplishing this task. This optimization problem makes a good first-day modeling activity: it requires no special knowledge, there is publicly available relevant data, and considering the problem forces one to make many simplifying assumptions and modeling choices. The author will describe this activity and highlight the modeling concepts it introduces.

UGG.1 Maria Morales-Beale Clayton State University
Kelli Nipper, Clayton State University

Little Man Tate and Other Great Minds

A marriage of school psychology and math education is necessary in supporting the development of young minds. The following scenario is presented: You are teaching an elementary math class, moving at an appropriate pace conducive to a good learning environment. How do you accommodate a student who is capable of going beyond what is being taught in the classroom, while simultaneously maintaining the pace at which the other students are learning? We aim to answer this pertinent question through a series of methods and evaluation of certain mathematical and psychology definitions. We will begin with a brief introduction consisting of a clip of the movie "Little Man Tate." We will use this clip as the catalyst for discussion of the connection between psychology and mathematics. This will include a discussion of "social facilitation",

maintenance versus improvement, and clarity of basic math terminology. Toward the conclusion, we will revisit the earlier movie clip and warm-up exercise in review of the thorough definitions of “even”, “odd” and “divisibility.” A second-grade assessment will be shown at the conclusion, prompting the question to the audience, “As a math teacher, what steps would you take in response to the student and the classroom environment?”

❁ DM1.2 Michael Mossinghoff Davidson College

Metropolis for the Metropolis

Due to recent population shifts, the largest county in North Carolina (Mecklenburg county, which contains Charlotte) recently needed to redraw its district lines for electing county commissioners and school board members. Faced with this problem, a county advisory board published a number of desired qualities for a new districting plan, including some legal requirements and some recommended demographic attributes. It also asked that the new districts be created by using only existing voting precincts; new precincts could not be created. However, the board did not know if it was even possible to partition the 195 precincts into six districts in a way that possessed all of the desired qualities, and it solicited public input. We describe an algorithmic approach to this combinatorial optimization problem for the Charlotte metropolis, employing a method originally described by Nicholas Metropolis.

❁ IB2.1 Bernadette Mullins Birmingham-Southern College
Faye Clark, Ann Dominick, and Sherry Parrish, University of Alabama at Birmingham

Inquiry-Based Instruction and the Standards for Mathematical Practice

Undergraduate students in elementary and secondary education must be well prepared to enter the profession in the era of the Common Core State Standards (CCSS). In addition to content standards, the CCSS includes eight standards for mathematical practice that are well aligned with inquiry-based instruction. Although these practices are second-nature to mathematicians, pre-service and in-service teachers find many of them (such as modeling with mathematics, making use of structure, and expressing regularity in repeated reasoning) unfamiliar and difficult to comprehend. We describe an inquiry-based approach to helping future and practicing teachers come to an understanding of these standards for mathematical practice though investigating rich mathematical tasks that elicit them.

UGB.5 Stephen Nanney Western Carolina University
Christine Heitsch, Svetlana Poznanovik, and M. Shel Swenson, Georgia Institute of Technology

Analyzing Optimality Criterion for RNA Secondary Structures Prediction

We describe a method of analyzing functions that score RNA secondary structures. Given a linear scoring function with unspecified coefficients, we construct polytopes that assist us in choosing a set of coefficients for which the structure with an optimal score is similar to the native structure. This was done with functions that are based on the nearest neighbor thermodynamic model (NNTM). The new functions were used to predict the secondary structures of several RNA sequences of various types. The accuracy of the predictions was close to the accuracy of the NNTM and exceeded the accuracy of the NNTM for certain sets of RNA sequences.

UGC.6 Michael Ngo Clayton State University
Elliot Krop, Clayton State University

On new bounds for the monophonic number of Cartesian products of graphs

Given two vertices u,v in a graph G, a chordless path from u to v is also known as a monophonic path. Let JG[u,v] be the monophonic closed interval consisting of all vertices on all monophonic paths from u to v. For any subset of S of vertices of G, let JG[S] be the set of all monophonic intervals for every pair of vertices from S. A set S is called a monophonic set of G if JG[S] is the set of all vertices in G. The minimum cardinality of S, for all S subsets of vertices of G, so that JG[S] is a monophonic set, is called the monophonic number of G and is denoted mn(G). In this talk, we further describe these concepts, beginning with an introduction of basic graph theoretic terminology. We then discuss some new bounds discovered by A.P. Santhakumaran and S.V. Ullas Chandran on the monophonic number of graphs C which are Cartesian products of two graphs G and H. Finally, we mention some open problems in the subject.

❁ IB1.3 Steve Nimmo Piedmont College

Teaching Abstract Algebra Through Discovery, Conjectures, and Proof

The presenter will talk about his experience teaching Abstract Algebra with a computer lab component.These labs force students to think deeper about the material and to visually see what is going on. By working through the labs and writing up the results, students discover theorems, make conjectures, and write proofs.

❁ STA.1 William Notz The Ohio State University

Are You Getting Your Daily Dose of Data?

One of the six recommendations of the GAISE guidelines for teaching statistics is to use real data. What is behind this recommendation and how might you implement it more effectively in your teaching? In this talk I will share some of my thoughts and experiences based on nearly 30 years of teaching statistics. First, I will describe why I believe the use of real data and real examples are important. Second, I discuss how I use real data and examples in my teaching (including some less than successful attempts). And third, I will provide suggestions and sources for where you can find a variety of real data and examples. My goal is to encourage you to develop the habit of seeking out and collecting good, real data and examples on a regular basis.

❁ IB1.4 Ben Ntatin Austin Peay State University

Revatalizing a Business Calculus Course

Students are often taught to conceptualize calculus as an abstract mathematical discipline emphasizing rigorous formal understanding of concepts and computational skills. This often leads to a high drop-out rate or poor performance. In order to improve retention rate, the business calculus course at APSU was revitalized. The revitalized course incorporates changes in content and methods of instruction. The students are routinely asked to work together cooperatively in small groups and complete group projects at home. An innovative feature involves student exploration of mathematical ideas and complex, open-ended, interdisciplinary applications using interactive features of the Geometer's sketchpad. In this talk, we describe some of the different approaches to instructional teamwork, student-centered instruction, and some special features that were implemented. Changes in students' attitudes about the usefulness of the pedagogical and curricular components of the revitalized course are analyzed. Quantitative data are presented that compare the achievement and retention of students in the revitalized course with a control group from the standard calculus section of this course.

UGG.3 Keyona Osborne Elon University

A Simulation Study of Estimators Using Contaminated Data

Not all data sets are created equal. The following study seeks to understand the role that the trimmed mean plays in effective statistical analysis of contaminated data sets. Furthermore, the study defines the sample statistics best suitable for analyzing a contaminated data set. Through a Monte Carlo Simulation study using the statistical software package, R, many samples are generated from a population with set parameters, and the mean, symmetrically trimmed mean, and metrically trimmed mean are calculated. Adjustments to the estimators presently used are described and simulated, providing reason to suggest that the trimmed mean estimates the center of a distribution more accurately than the sample mean under certain conditions. These results are then applied to a real data set, testing the accuracy of estimating the true mean using the adjusted mean, symmetrically trimmed mean, and metrically trimmed mean.

❁ AG.1 David Peifer UNC Asheville

One hundred years of Infinite Group Theory: The legacy of Max Dehn.

The study of infinite groups began in earnest with a paper by Max Dehn from 1912. In that paper Dehn introduces the Word Problem, Conjugacy Problem, and the Isomorphism Problem for groups. We will examine Dehn's work and talk about hisinfluence on the study of infinite groups over the last 100 years. In particular, we will examine how Dehn was able to use geometric ideas to solve algebraic questions. Similar ideas have recently been used by M. Gromov and W. Thurston to analyze infinite groups.

❁ TID.1 Daniel Pinzon Georgia Gwinnett College

A project on Geometry and Art

I will discuss my experiences with a Geometry and Art project in a general math course for liberal arts students and a Geometry course for pre-service elementary teachers. The project has students write about the significance of symmetries and geometrical shapes that they find in Renaissance paintings using Geometer's Sketchpad. This talk will include student samples and their comments.

❁ CAL.2 Kathy Pinzon Georgia Gwinnett College

A Hands-On Writing Project for Pre-Calculus

The project consists of students creating multiple models of a "quadratic" tunnel that must meet many restrictions then write a statement to determine which model they consider "best" meets the restrictions. The presentation will include a detailed description of the project, sample student work, and a possible extension portion to calculus.

UGG.6 Kwasi O. Platt Savannah State University

Using Random Walk to find a General Equation for Stationary Probabilities

Most phenomena in our nature don't have formulated functions in a closed form. Instead, there are differential equations with certain common properties which can explain natural phenomena. Any arbitrary nth order equation $y^{((}n)) = F(t, y, y\text{^}', ..., y^{((}n-1)))$ can be transformed into a system of *n* first order equations, $x'_1 = F_1(t, x_1, x_2, ..., x_n), x'_2 = F_1(t, x_1, x_2, ..., x_n), x'_3 = F_2(t, x_1, x_2, ..., x_n), \ldots, x'_n = F_n(t, x_1, x_2, ..., x_n)$ and solutions of this system of equations can be considered as a set of n dimensional parametric equations. For a given time, $a < t < b$, these *n* dimensional parametric equations give n coordinate values, $x^i = (x_1(t_i), x_2(t_i), ...x_n(t_i))$ at arbitrary time $a < t_i < b$ and it can be viewed as one point, x^i in the space. These values are changing generally as time is changing. The collection of these points corresponding to the given time forms a curve which is called a trajectory. In this research, x^i is jumping to a randomly chosen point $x^{(i+1)}$ which can be interpreted as a random walk on a trajectory when we divide the given time into finite n sub-intervals, $a = t_0 < t_1 < ... < t_n = b$ therefore a stationary distribution could be found for the random walk on a trajectory in 3 by 3 and also could be extended to *n* by *n*.

UGD.2 Elise Prete Furman University
Clarisse Quandt, Furman University

Gamma Graph Disconnectedness

As introduced in the paper by Fricke, et al., given a graph $G = (V, E)$, the γ-graph $G(\gamma) = V(\gamma), E(\gamma))$ is the graph whose vertex set corresponds in a one to one relationship with the γ-sets, or minimum cardinality dominating sets, of G. Two γ-sets, say S_1 and S_2, are adjacent in the gamma graph if there exists a vertex $v \in S_1$ and a vertex $w \in S_2$ such that v is adjacent to w in G and $S_1 = S_2 - \{w\} \cup \{v\}$, or equivalently, $S_2 = S_1 - \{v\} \cup \{w\}$. In this poster presentation, the connectivity of $G(\gamma)$ will be explored. It will be shown that if G contains certain structures, $G(\gamma)$ will be disconnected. The conjecture that all disconnected γ graphs might contain a certain set of structures will be considered.

❁ MLU.6 Aaron A. Rafter Clayton State University

Instructional Technology: Using a Graphing Utility in a Mathematical Modeling Classroom

Students struggle to connect words to algebra. In mathematical modeling, we try to encourage a graphical or visual approach to learning for different learning styles. Students often make a connection when seeing a graph used instructionally. Additionally, students perform better on tests when they are able to use a graphing utility. This action research will display the increased performance of students that were allowed to use a graphing utility in a test condition versus students that were not allowed to use a graphing utility in a test condition.

❁ GS.5 Ashley Rand University of Tennessee, Knoxville

Math Videos: Teaching Outside the Classroom

Calculators can be time savers, but not if class time is wasted teaching students how to use programs on them. We have created videos for students to view outside of class that work through the use of the program, so we can spend class time working on solidifying understanding of the mathematics. We will talk about how the videos are being used and the feedback we gotten thus far.

❁ RES2.1 Christopher Raridan Clayton State University

Keith Driscoll, Elliot Krop, and Scott M. Bailey, Clayton State Unviersity

Some new bounds for edge-magic graphs

We show that if G is an r-regular graph with p vertices and q edges in Vizing class 1 with p divisible by r, then the edge-magic index of G is at most *p/r*. For edge magic graphs *G* with longest induced path of length l, we show that q is at least $p(l+1)/2$. We also produce a simplified means of testing whether a general graph G is edge-magic.

❁ RES2.5 Joshua Roberts Piedmont College

Introduction to Applied Algebraic Topology

In the past decade or so the results and techniques of algebraic topology have yielded dramatic and unexpected applications to robot motion, sensor networks, statistics, and medicine, among other areas. Topological techniques have been used to capture characteristics of point-cloud data sets that "persist" in a dynamical setting. We will introduce some of the basic topological machinery involved as well as look at a few examples.

❁ TEK.4 Lila F. Roberts Clayton State University

An Interactive Sampler for Mathematics

The release of iBooks Author and iBooks 2 provides a development environment for building interactive books for iPad. This session will focus on an overview of capabilities along with a short demonstration of how one can start building interactive iBooks.

MOD.2 Tatiana Rudchenko Kennesaw State University

Modern applications hysteresis phenomenon in economics

The fact that a hysteresis phenomenon can be found in economics was noted by multiple scientists. In early 1930s a lot of economists recognized cycles of activity in economics. Attempts to explain this effect based on the linear models were proven unsuccessful. The main struggle of this problem is a selection of investment functions. In 1950 Dr. Hicks introduced a model where a function of investment was defined in a way to set limits of change in capital. This model did not take into consideration a lag of economic processes and did not explain mechanics of lags when investments were moved to assets. Similar problems apply to a lot of current macroeconomic models. Therefore, it is important to create and research mathematical models of economic processes that vividly exhibit hysteresis behaviors in following directions:

- developing a model for pricing on mono-product market in nonlinear finite-different equation of the 1st order. It can predict trajectories for the change in price depending on time based on the different parameters of the market.
- analysis of finite-different model of the pricing process to determine existence of nontrivial stable decisions, limited cycles and bifurcations, which will allow to research stability of the market with different parameters.

❁ TID.3 Alan Russell Elon University

An origami manipulative for undergraduate mathematics

This talk will share the results of a grant from the Japan Foundation's Center for Global Partnership. The grant, Using Origami as a Gateway for the Study of Japanese Culture and Society, explored math, science, language arts, and social studies throughout the K-12 curriculum. We will focus on one successful example using origami in secondary

mathematics. We will then explore using this origami model as a manipulative to investigate topics from several undergraduate mathematics courses.

❁ TID.2 Josie Ryan Lander University

My Experiences with Using Origami in Teaching

My experiences using Thomas Hull's Project Origami book in class, what worked well and where my students needed an alternate starting point. Also, how I used it to introduce basic Graph Theory to two different groups of upper level math students and how they responded. How I modified the projects to fit time constraints and student folding experience or ability.

❁ MFG.1 Jan Rychtar University of North Carolina Greensboro

Does knowing more hurt? A surprising effect of information asymmetry.

The biologically motivated Producer-Scrounger game theoretical model deals with the following situation. One individual finds a resource and starts using it. Sometimes later, before the resource has been completely used, a second individual appears and attempts to use the same resource. The individuals could either 1) split the resource evenly, 2) fight for it, or 3) one of them can give it up. We will study the effect of information asymmetry. It is conceivable that the first individual has better knowledge about the resource than the one that joins later. However, contrary to any intuition, a careful analysis reveals that having more information yields to giving up more often, and consequently getting lower payoffs. This quite surprising result could mean that too much knowledge hurt. Yet, the most important feature is that even the second individual knows something – it knows that the first one knows. Hence, at least to some individuals, knowledge can be beneficial after all.

❁ MAU.2 Ramanjit K. Sahi Austin Peay State University

Connecting the Mathematical Dots

"Why, Where, and When I will use Mathematics?" is a question often asked by my students. In response, I tell 'Mathematical Modeling'. In this talk, I will show how different mathematical dots, i.e., concepts, techniques, methods etc. learnt by the students over the course of their education can be connected to solve real-life problems arising in various fields. In the process of solving open ended real-life problems, students learn how to think outside the box, come out of their comfort zone, and appreciate the beauty of mathematics. Some of these problems are open-ended which takes students on different paths of discovery that can eventually become an undergraduate research project. I will discuss some of the challenges I have faced while teaching the modeling course to students with basic programming skills and a calculus background.

UGD.4 Sarah Sexton Coastal Carolina University

Solving the Shallow- Wave Equations on an Unequally-Spaced Cartesian Grid with Irregular Domain

Solving the shallow-water wave equations on a regular Cartesian grid is relatively simple, but unrealistic. Being able to model on irregular boundaries allows for the formulation of more realistic models for lakes, estuaries, rivers or any area with an irregular boundary. This produces more precise approximations for velocity and wave height. Using a finite difference method which allows for an irregular boundary is difficult because the boundary nodes are not guaranteed to coincide with the physical boundary. The most popular methods for dealing with an irregular boundary include using finite volume or finite element methods. However, when using these methods, the simple elegance of finite differences is lost. If one wants to preserve the elegance of finite differences, methods of coping with an irregular domain include techniques such as constructing ghost cells or nodes at the boundary. As an alternative, we will use a mesh generation algorithm that creates a Cartesian grid with unequal spacing which guarantees that the boundary nodes lie on the physical boundary.

UGB.3 Zachary Shore High Point University

Real-Time Physics Simulation in a Cube-Based Game World

Minecraft is a widely popular game that takes place within a world constructed entirely of uniform cubes. The basic goal of the game is to construct objects using blocks. The only physical property of these blocks is a hardness factor. The

hardness factor can be seen while mining for blocks with different tools inside the game. So what if the same game was built, but with each block possessing additional properties? Suppose we include such properties as rigid-body dynamics and energy loss. If a block was displaced, the block could display realistic physics as it fell, and it could exhibit energy loss upon hitting a solid surface and rebounding. Collision detection could also occur between blocks, be they moving, placed, or part of the original terrain.

This talk will explore the development of a physics game engine incorporating these properties. Once completed, this engine could be easily modified to include additional physical properties for blocks. Implementation of this engine will be done using OpenGL and C++.

❁ CAL.6 Andrew Simoson King College
Charles Groetsch, The Citadel

Spurtacular fountains

Imagine a cylindrical tank of radius r which is kept filled with water at depth H. Open a circular array of n holes at height h, $h < H$, on the surface of the cylinder. Under the force of gravity, water spurts through these holes perpendicular to the cylinder's surface, and creates an aura of a water surface S. As $n \to \infty$ the illusion is more or less complete. What h value maximizes the surface area of S or the volume under S?

UGG.5 Aaron Smith Coastal Carolina University

Blackjack Card Counting Techniques

Since the early days of casino Blackjack, mathematicians and players alike have been interested in a mathematical analysis of the game that could help determine the best playing strategy. A mathematician's interest in the card game is twofold; he is motivated both by obtaining an optimum zero-memory strategy as well as the possibility of maximizing profits by varying the bet size. In this talk, we trace the evolution of the modern day Blackjack strategy from its origin in a 1956 paper in which Blackjack is given its first rigorous mathematical treatment. Since then, casinos have changed the way that the game is played to minimize the player's advantage. Today, Blackjack strategies can be tested empirically with the use of specialized computer programs. We will present results from a MATLAB Blackjack simulator used to test different playing strategies and card counting methods. In particular, we will compare the hi/lo card counting technique with a simpler, but still effective â€œfivesâ€ counting technique in order to determine their effectiveness and efficiency.

PUB.1 Reade Snellings Hawkes Learning Systems

Mastering Math, not the System

You know the scenario: Students seem to be doing well on homework, yet perform poorly on exams. With Hawkes, students can no longer “cheat the system” to get through assignments. Instead, they are held accountable for mastering the material without relying entirely on learning aids. Discover how Hawkes motivates students to succeed! By attending, you will also receive the chance to win an Amazon Kindle!

❁ TID.6 Cynthia Stenger University of North Alabama
James Jerkins and Janet Jenkins, University of North Alabama

An Instructional Design Using Computer Programming to Improve Mathematical Reasoning

Common Core State Standards emphasize the mathematical practice of abstract reasoning as students progress from grade to grade. The National Council of Teachers of Mathematics recommends that all secondary mathematics curriculum and instruction focus on infusing the classroom with reasoning and sense making. It follows that our undergraduates preparing to teach secondary mathematics need knowledge of and experience with explicit instruction in mathematical reasoning.

We have designed, developed and piloted a theory-based instructional treatment to address the lack of precise and clearly delineated instruction in this area. Our instruction uses computer programming to push students to form the mental structures needed for the application of abstraction and generalization in problems requiring infinite iteration. We have piloted the instructional treatment in a professional development workshop for high school math teachers, in our undergraduate classes for math and computer science majors and in regional high school math classrooms.

In this talk we will discuss our research experience with eleven secondary mathematics pre-service teachers. We will give details of the instructional design and report our preliminary findings. The prospective secondary math teachers participated in the research design as if they were high school subjects. Our preliminary results indicate that the pre-service teachers thought computer programming would be useful in their future classrooms. We also found that undergraduates benefited from taking part in our lessons written for secondary students in that their abstract reasoning skills improved.

❁ DSL.1 David Stone Georgia Southern University

The Most Interesting Numbers and Neatest Problems

I'll talk about some interesting collections of numbers, including the primes, Fibonacci numbers and Pascal's Triangle, as well as some neat problems involving them (and some which don't).

RES1.3 Jessica Stovall University of North Alabama

A Measure Associated with a Nonlinear Operator on a Banach Lattice

Any Dedekind complete Banach lattice with a quasi-interior point is lattice isomorphic to a space of continuous, extended real-valued functions defined on a compact Hausdorff space. My research uses this result of H.H. Schaefer to relate support sets to operators. In this talk, I will discuss my development of a measure associated with a nonlinear, orthogonally additive, continuous, monotonic, and subhomogeneous operator T, which maps a Banach lattice with a quasi-interior point and an order continuous norm into the reals. The resulting measure is complete and can be used as a way to bridge the gap between the nonlinear operator T and results that I previously developed in a linear setting.

❁ BF.6 Patrick Taylor Clayton State University
Joseph Neggers, University of Alabama

Order Accessibility of the Non-negative Rational Numbers

We will create a vertex labeling function to label the vertices of a digraph via the natural numbers. This will in turn induce an edge labeling function to label the edges via the positive rational numbers. We will then use these functions to define order accessibility of digraphs over the non-negative rational numbers.

TEK.3 Lisa Townsley University of Georgia

WebAssign Testing in Precalculus: NO GRADING NECESSARY

The presenter will discuss the online testing of more than 2000 undergraduate students of precalculus each year at University of Georgia. The platform is currently WebAssign, although other platforms have been used successfully over the years at UGA. Students in each section are assured of covering the same content in the same depth, and their progress is assessed via timed, IP-restricted tests administered in a proctored computer lab outside of lecture. The advantage to scantron testing is immediate: students are expected to enter symbolic answers, not just guess or check multiple choice options, and students are marked correct for all correct versions of an answer. The presenter will discuss other pros/cons of this operation and show how easy it is to program one's own questions.

RES2.3 Tzvetalin Vassilev Nipissing University
Stefan Pape, Nipissing University

Visibility: Finding the Staircase Kernel in Orthogonal Polygons

We consider the problem of finding the staircase kernel in orthogonal polygons, with or without holes, in the plane. Orthogonal polygon is a simple polygon in the plane whose sides are either horizontal or vertical. We generalize the notion of visibility in the following way: We say that two points a and b in an orthogonal polygon P are visible to each other via staircase paths if and only if there exists an orthogonal chain connecting a and b and lying entirely in the interior of P. Furthermore, the orthogonal chain should have the property that the angles between the consecutive segments in the chain are either $+90^\circ$ or -90°, and these should alternate along the chain. There are two principal types of staircases, NW-SE and NE-SW. The notion of staircase visibility has been studied in the literature for the last three decades. Based on this

notion we can generalize the notion of star-shapedness. A polygon P is called star-shaped under staircase visibility, or simply s-star if and only if there is nonempty set of points S in the interior of P, such that any point of S sees any point of P via staircase path. The largest such set of points is called the staircase kernel of P and denoted ker P. Our work is motivated by the work of Breen [1]. She proves that the staircase kernel of an orthogonal polygon without holes is the intersection of all maximal orthogonally convex polygons contained in it. We extend Breen's results for the case when the orthogonal polygon has holes. We prove the necessary geometric properties, and use them to derive a quadratic time, $O(n^2)$ algorithm for computing the staircase kernel of an orthogonal polygon with holes, having n vertices in total, including the holes' vertices. The algorithm is based on the plane sweep technique, widely used in Computational Geometry [2]. Our result is optimal in the case of orthogonal polygon with holes, since the kernel (as proven) can consist of quadratic number of disjoint regions. In the case of polygon without holes, there is a linear time algorithm by Gewali [3], that is specific to the case of a polygon without holes. We present examples of our algorithm's results.

Keywords: computational geometry, polygons with holes, s-stars

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❁ STA.2 John Wagaman Western Carolina University

Bored with the Board: Collecting Data for Introductory Statistics

We have several courses at our university which serve as introductory courses in statistics for many students. Among these are a service course in applied statistics, a first course in calculus-based probability and statistics and graduate courses in experimental design and regression analysis. Not all of the students have an appreciation for mathematics, so it becomes imperative to find interesting data if I hope to keep students engaged. In this talk I'll share some ideas that I have used, which include the use of rock-paper-scissors to illustrate the binomial distribution and the sampling of doughnut holes for breakfast for the hypergeometric distribution. On class days where students are more stationary, we have generated interesting data sets using bird and leaf identification and celebrity recognition.

❁APP.6 Barrett Walls and Iason Rusodimos Georgia Perimeter College

Thoughts on Collatz' Conjecture

Starting with a positive integer, form a sequence by multiplying by three and adding one if the integer is odd and dividing by two if the integer is even, and repeat until you get a one. Lothar Collatz conjectured that the sequence will always eventually get to one. This problem remains unsolved but we discuss some interesting patterns that arise through analysis of this question.

❁ DM1.3 Dennis Walsh Middle Tennessee State University

Toy Stories and Combinatorial Identities

Suppose an elf has n different toys to be distributed among x boys and y girls, and we are interested in how many distributions are possible. Upon placing certain restrictions on how the toys may be distributed, we derive several combinatorial identities involving the number of possible distributions. We then generalize the results into a theorem about the cardinalities of certain families of functions with finite domain and codomain.

❁ DM1.5 Hua Wang Georgia Southern University
Stephan Wagner, Stellenbosch University

Cospectral mate of a random tree

We show that a number of graph invariants are, even combined, insufficient to distinguish between nonisomorphic trees or general graphs. Among these are: the set of eigenvalues (equivalently, the characteristic polynomial), the number of independent sets of all sizes or the number of connected subgraphs of all sizes. We therefore extend the classical theorem of Schwenk that almost every tree has a cospectral mate, and we provide an answer to a question of Jamison on average subtree orders of trees. The simple construction that we apply for this purpose is based on finding graphs with two

distinguished vertices (called pseudo-twins) that do not belong to the same orbit but whose removal yields isomorphic graphs.

❁ GME.6 Virginia Watson Kennesaw State University
Mary Garner and Beth Rogers, Kennesaw State University

Math Circles for Students and Teachers

A brief history of math circles for students and teachers will be discussed. We will show how a math circle works and give some example problems used in our circles. Details will be given on how to join a math circle or start your own.

❁ MLU.4 Tessa Weinstein Coastal Carolina University

A First Year Modeling Course

In today's world there is an increasing demand for scientists who have some degree of proficiency in scientific computing. In response to this demand at Coastal Carolina University, we have developed a mathematical modeling course that is accessible to students having only a Calculus I background. The course focuses on the intersection of computing and modeling, introducing students to the modeling process and with an eye towards using a high level programming language to help visualize solutions. The course draws students from a variety of majors, including physics, pre-engineering, chemistry and marine science. This talk will give an outline of the overall structure of the course, and present a variety of the problems employed.

❁ STA.4 Cathy Whitlock UNC Asheville

Critical Thinking in Introductory Statistics Class

Those of us who teach Introductory Statistics sincerely believe that we are helping our students develop their critical thinking skills, and we are, of course, correct. As campuses begin to assess their students' critical thinking abilities across disciplines, we may be called upon to defend, or at least better explain, our particular approach this aspect of student learning. The good news is that our efforts to be more explicit may actually pay off in a variety of ways. How do we help our students, and possibly our colleagues from other departments, understand how a first statistics class can improve critical thinking?

BF.4 Zahava Wilstein Berry College
Mohammad Rammaha and Daniel Toundykov, University of Nebraska-Lincoln

Energy Decay Rates of Potential Well Solutions to a Nonlinear Wave Equation with p-Laplacian Damping

We consider a nonlinear wave equation with p-Laplacian damping and Dirichlet boundary conditions. In this problem we have a strong source which is allowed to have a super-supercritcal exponent. This source term on its own causes solutions of the problem to blow up in finite time. The influence of this source is offset by the damping term which dissipates the energy. In the linear case p=2 the p-Laplacian (which is the regular Laplacian) is known to yield a very strong dissipative mechanism; however, for p>2 it becomes a semilinear term with a degeneracy (an overdamping in some sense) which may no longer provide uniform exponential decay rates of decay. Under suitable restrictions on the parameters we prove the existence of a global solution and estimate the decay rates of the energy. Through careful analysis of the non-autonomous ODE controlling the energy of potential well solutions we obtain an explicit estimate on the energy decay.

❁ MAU.1 Zahava Wilstein Berry College

Dams and Pendulums - Working With Calculus I Concepts

Applying mathematical concepts is often a valuable experience for calculus students. Not only are these projects typically more engaging to the students, but they can also force students to deepen their understanding of the topics covered in class.

In this talk we'll discuss two projects that use technology (specifically Maple, although most if not all of each project can be done on any mathematical software), to reinforce and explore some of the concepts in a first semester calculus course. The first project motivates Riemann Sums and integrals in a natural, but non area-based way. The second project explores differentials, linearizations and their use in differential equations, without requiring the ability to solve differential

equations. This second project is particularly exciting for physics students as they discover how certain familiar formulae come about.

UGA.5 Yeng Xiong — University of Tennessee at Martin
Angela Reddick, University of Tennessee at Martin

The primality of one

It is often said that the number one was once considered to be prime, but recently, for convenience, the definition has been change. However, the truth is more complicated than that. We will look at the primality of one in the modern context, and then explore the definition historically.

UGF.4 Tony Yaacoub — Clayton State University
Elliot Krop, Clayton State University

On Cartesian products of graphs and the Roman domination function

For any graph G, the Roman domination function of G is a function f that maps the vertices of G to the set {0,1,2} such that every vertex with 0 has a neighbor with 2. The Roman dominating number of G, RDF(G), is the minimum sum of all labels over all Roman dominating functions of G. We apply the method of S.Suen and J.Tarr from their work on Vizing's conjecture, as well as that of Y. Wu, to show an inequality for the Roman dominating number of the Cartesian product of two graphs in terms of the Roman dominating numbers and dominating numbers of the two graphs.

❁ MFG.2 Carl Yerger — Davidson College
Paul Britton, Davidson College

Boxing in Basketball: A Round-By-Round Analysis of the College Game

In the last two decades, basketball coaches have increasingly relied on statistical analysis to determine teaching points for their teams. Davidson College men's basketball coach Bob McKillop divides each game into ten "rounds", with a round ending at each media timeout and at halftime, and gives his team several "round" goals for every game. Two particular goals are winning both rounds five and ten, and winning several rounds overall. We tested McKillop's "rounds" concept by recording the round-by-round score for every conference game in the ACC and Southern Conference over the 2009-2010 and 2010-2011 seasons, for a total of 453 games. Using a logistic regression method, we found that over the entire sample, each round is a significant predictor of the game outcome at a p-value of less than .001. While certain rounds had smaller p-values than others, no rounds, including rounds five and ten, were significantly better predictors than each other round. We also found a team winning at least seven rounds won over 99% of games played, and teams winning 5.5 or more rounds won nearly 90% of games. Bob McKillop's rounds concept is highly predictive of game outcomes, and a focus on "one round at a time" is a salient coaching strategy for any college basketball team.

❁ IB1.5 Andy Q. Yingst — University of South Carolina Lancaster

An Inquiry Based First Differential Equations Course

Over the past two years, I've developed an inquiry-based differential equations course intended for a student who has completed Calculus II, but without a linear algebra prerequisite. In this talk I will describe the structure and content of this course, offering some best practices, sample course materials, pitfalls to avoid, and lessons learned.

❁ APP.1 Laurie Zack — High Point University

An Application of Google's PageRank to NFL Rankings

Research has been conducted recently in the areas of rankings and social networks, in particular the analysis of Google's PageRank algorithm applied to other real life scenarios. This talk will briefly explain the PageRank algorithm and its application to the ranking of football teams via the GEM method. We then modified and extended the GEM method with the addition of more football statistics to look at the possibility of using this method to more accurately rank teams. Lastly, we compared both methods by aggregating each statistical ranking using the Cross-Entropy Monte Carlo Algorithm.
