



College of Science and Mathematics

Department of Mathematics
and Statistics

Kennesaw Mountain Undergraduate Mathematics Conference

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Kennesaw State University

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KEYNOTE ADDRESS AND INVITED TALKS

(the information in brackets refers to the room and session time)

Keynote Address

[BB 151 11:00]

Blown Away: What Knot To Do When Sailing

by Sir Randolph Bacon III

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Being a tale of adventure on the high seas involving great risk to the tale teller, and how an understanding of the mathematical theory of knots saved his bacon. No nautical or mathematical background assumed.

Invited Talk

[BB 151 1:00]

How many cycles can you guarantee?

Patrick Bahls

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In graph theory, a *cycle* is an alternating list of vertices and edges in which no vertex or edge is repeated other than the first and last vertex, which are identical. A graph with n vertices is said to be *Hamiltonian* if it contains a cycle of length n , and *pancyclic* if it contains at least one cycle of every length in the set $\{3, \dots, n\}$. Since it is easy to see that not every graph is pancyclic, it is natural to ask just *how* pancyclic a given graph is; that is, how many cycle lengths *does* a given graph contain? We define the *cyclicity* $\beta(G)$ of a graph G as a means of answering this question, and we use a now-classical result from extremal graph theory to develop means of guaranteeing a certain lower bound on $\beta(G)$. No prior knowledge of graph theory is assumed.

Invited talk

[BB 151 1:45]

Game Theory and Competitive Bidding

Brett Katzman

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Several distinct auction formats are introduced and modeled in complete and incomplete informational environments. The concepts of Nash and Bayes-Nash equilibrium are introduced and applied to the auction models. Revenue and efficiency results are then drawn based on equilibrium strategies.

ABSTRACTS OF CONTRIBUTED TALKS

(the information in brackets refers to the room and session time)

Non-central Chi Square

[MS 113 10:00]

John Aldridge

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If Z is a standard normal variable then Z^2 is a chi squared with 1 degree of freedom (central χ^2). If Z is normal with a nonzero mean μ and variance 1 then Z^2 is a non central χ^2 with 1 degree of freedom and non centrality parameter μ^2 . Some of the applications of the χ^2 distribution are testing variances for normal populations, independence, and goodness of fit just to mention a few. The focus of this presentation is the power of a goodness of fit test. If the null hypothesis is false the test statistic follows a non-central χ^2 distribution. We will estimate the power of a goodness of fit test using various SAS generated data.

On some relations between chemical indices on trees

[MS 108 4:10]

Marcus Bartlett* and Elliot Krop

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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.

On Calculations of p -Typical Formal Group Laws

[MS 113 3:10]

Eddie Beck

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Formal group law theory provides computational tools with which to explore algebraic topology and homotopy theory. This paper studies the formal sum and the cyclic power operation for p -typical formal group laws, specifically to reduce prohibitive computation times through algorithm and time complexity analysis. We provide a combinatorial algorithm that directly computes terms of arbitrary degree using Mahler partitions. We also provide an *online* algorithm for computing the cyclic power operation, meaning that the precision of the calculations can be increased without restarting the computations. We measured the time complexity by counting the number of monomial multiplications required. These algorithms are at worst sub-exponential on the degree of the precision. Our algorithm substantially reduced previous computation times and shows that the McClure formula on MU_{17} is non-zero.

Mining Research Gems From Your Calculus Homework

[MS 118 2:30]

John J. Boncek

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Many beginning mathematics students have a difficult time finding topics for their first research paper or talk. In this presentation, we will show how you can use standard classroom material and homework problems from first-year calculus to develop meaningful research ideas. Suggestions on how to keep a research notebook will also be discussed.

Adaptive Interpolation of Hyperbolic Functions by Linear Splines: Local Estimate

[MS 109 9:00]

Shannon Bryce*, Teagan Bryce, Yuliya Babenko

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Approximation by various types of splines is one of the standard procedures in many applications (computer-aided geometric design, image processing, numerical solutions for partial differential equations etc.). In all these applications, there is a standard distinction between uniform and adaptive methods. In the uniform case, the domain of interest is decomposed into a partition where elements do not vary much. Adaptive partitions, on the other hand, take into consideration local variations in the function behavior and therefore provide more accurate approximations. However, adaptive methods are highly nonlinear and no polynomial time algorithm exists to provide an optimal approximant for each given function. Therefore, the next natural question would be to construct asymptotically optimal sequences of partitions (that are triangulations when we use linear splines) and approximants on them. To that end we first need to find a triangle that is locally (for some small region) optimal. In this talk we shall discuss how we find the optimal shape of the triangle in the case of approximating the bivariate functions with negative curvature by interpolating linear splines, and the approximation error on it.

Adaptive Interpolation of Hyperbolic Functions by Linear Splines: Global Estimate

[MS 109 9:20]

Teagan Bryce*, Shannon Bryce, Yuliya Babenko

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Once we have found the local L_2 -error of approximating the bivariate functions with negative curvature by interpolating linear splines, we will put it together to obtain the global estimate for the optimal error. We shall discuss a sketch of an algorithm to construct asymptotically optimal sequences of triangulations and computing the asymptotics of the optimal error.

1 = 2: The Banach-Tarski Paradox

[MS 109 2:30]

Julian Buck

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The Banach-Tarski Paradox is an extremely unintuitive result on the nature of infinite sets, which states that it is possible to take the closed unit ball in 3-dimension space, break it up into pieces, move those pieces around rigidly (so without stretching or deforming them), and re-assemble them into two copies of the closed unit ball. We will discuss some of the mathematics that goes into the statement and proof of this bizarre statement, which leads into the very rich branch of mathematical analysis called measure theory.

Professor's Add-Drop Rates and Cost Effectiveness

[MS 118 3:10]

Cameron Caligan
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Among colleges, professors are often-times limited in the number of students they are allowed to have seated in a single classroom. The number of students seated is typically considered the optimal number of students per professor. The result of these limitations is that a professor who originally had 24 students in his or her classroom has only 15 at the end of the semester. This results in a waste of the time of the students who could have otherwise sat in that classroom. Additionally, these empty seats represent an increase of expenses by the colleges as they must not only enroll the students that could have otherwise been in that classroom, but also re-enroll the students that dropped the class in the first time. In this talk, we looked at this in a generalized approach in order to develop a theorem that finds the probability of a student dropping a particular professor and a particular class (id est, Math 1001 section 1). By using this theorem, colleges will be able to eliminate wasteful use of time by sitting a certain number of students at the beginning of the semester and ending with their preferred or optimal number of students by the end of the add-drop date.

Having Fun With "P vs. NP": Take the Heuristic Challenge on Crossword Puzzles

[MS 113 8:40]

George Cazacu
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The "P vs. NP" millennium problem is one of the seven one-million-dollar problems proposed by the Clay Mathematics Institute. It is, as best known thus far, unsolved. Crossword puzzle generation is one example of the many NP type problems. Why not become . . . , ok, not rich, not famous, but . . . proud of tackling it.

Mutually Orthogonal Sudoku Latin Squares

[MS 113 2:50]

Nate Coursey

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A Latin square of order n is an $n \times n$ matrix where each row and column is a permutation of the integers $1, 2, \dots, n$. Two Latin squares A and B , both of order n , are orthogonal if all n^2 ordered pairs formed by juxtaposing the two matrices are unique. It is well known that there exists a pair of orthogonal Latin squares of order n for every positive integer $n \neq 2, 6$. A family of mutually orthogonal Latin squares (MOLS) of order n is a collection of Latin squares of order n such that each Latin square in the collection is orthogonal to every other Latin square in the collection. It is relatively easy to show that the maximum size of a collection of MOLS of order n is $n - 1$.

A gerechte design is a an $n \times n$ matrix where the matrix is partitioned in n regions S_1, S_2, \dots, S_n where each row, column and region is a permutation of the integers $1, 2, \dots, n$. The popular puzzle Sudoku is an example of a gerechte design.

Results about mutually orthogonal Sudoku Latin squares of order $n = k^2$ are beginning to appear in journals. This talk discusses the adjustments that must be made when n is not a perfect square and the size of critical sets (clues) of mutually orthogonal Sudoku Latin squares.

Mini-Lecture on Robust Design Optimization

[MS 109 8:20]

Ana-Maria Croicu

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The goal of this talk is to familiarize the audience with the goals and meanings of robust design optimization or optimization under uncertainty. Some strategies to approach robust design will be described. Real-life applications of robust optimization will be included.

Congruences for Restricted Compositions

[MS 108 10:00]

James Diffenderfer

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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 Srivinasa 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.

Modeling the Hypothalamic Pituitary Adrenal Axis System with Dexamethasone Treatment

[MS 113 9:00]

Carolyn Drobak

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The hypothalamic pituitary adrenal axis (HPA) system regulates stress in the brain. When this system experiences dysfunction, such as during cancer treatment, there can be a number of unwanted side-effects like depression and chronic fatigue syndrome. I utilize ordinary differential equations to adapt pre-existing models for the HPA system to account for the administration of Dexamethasone, a pharmaceutical drug used in cancer treatments to prevent potential HPA dysfunction. 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.

Construction of the Real Number System using the Hyperreals

[MS 109 3:30]

Michael Dykes, Trey Gay

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Many of you (especially among the faculty) are no-doubt familiar with the two major constructions of \mathbb{R} : Dedekind's Method using Dedekind Cuts, and the method of Cantor, using Real-Valued Sequences. In this presentation, both Trey and myself shall present a third major construction of the reals using the hyperreals. Basically, a hyperreal is a number greater than any number of the form:

$$1 + 1 + 1 + \cdots + 1.$$

Note also that the hyperreals (while not constituting an algebraic field) do form a commutative ring, and we do find a copy of \mathbb{R} embedded inside the structure of the hyperreals.

Using the Miller Rabin Test to Find Large Primes Maybe

[MS 113 4:10]

Jeffrey Ehme
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Cryptosystems, which routinely use prime numbers having more than 100 digits, have made it necessary to find large prime numbers in a timely manner. In this presentation, we discuss a standard, quick, probabilistic technique for finding large prime numbers, the Miller Rabin test. We also discuss some extensions of this test which increase its reliability.

On Cross Polytope Numbers

[MS 108 9:20]

Jack Farnsworth
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This study on recursive definitions of Cross Polytope numbers was motivated by finding a formula for the number of lines spanned by all paths of length n from a fixed origin along the d -dimensional lattice. This led to the equivalent problem of finding the maximum number of non-adjacent vertices a distance $n - 1$ along the same lattice. These are precisely the Cross Polytope numbers. Certain properties of this set of lattice points can then be generalized to the Cross Polytope numbers and reveal certain useful recursions.

A Few Classical Problems in Probability and Their Modern Solutions

[MS 109 4:10]

Anda Gadidov
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In this talk we will discuss a few classical problems that contributed to the birth of the modern theory of probability. Among them: the problem of points and the St. Petersburg paradox.

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

[MS 113 9:20]

Halcyon Garrett and Michael Friedrich
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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" in which he determined the most nutrient-rich diet possible with a limited 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.

Total Efficient Domination in Cayley Graphs

[MS 113 2:30]

Keegan Gary

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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 $n \not\equiv 1 \pmod{4}$, and that a TEDS S exists for the cycle graph, C_n , if and only if $n \equiv 0 \pmod{4}$. The cycle graphs are a special class of circulant graphs, which in turn, are a special class of Cayley graphs. The **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.

What Problem Solving Can Teach Us About Mathematical Research

[MS 118 2:50]

Laurie Huffman

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Working through an example from a student-faculty problem solving session at Georgia College, we explore not only the mathematics involved in the process of finding a solution to this problem but also the appropriate strategies that may be applied to the broader context of mathematical research. The requisite mathematical knowledge required to tackle this problem is surprisingly elementary, yet the lessons learned along the way shed light on the sometimes daunting, or even mysterious, process of engaging in mathematical research.

Applications of Lagrange Multipliers in Economics

[MS 113 8:20]

John Hunt, Jr.

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Background:

In the field of Economics, multi-variable equations with constraining factors are used as models of real-world scenarios. Complex computer programs and equations are needed to

optimize these models for different values. Lagrange Multipliers provide methods to minimize and maximize multi-variable equations subject to constraints. Methods and examples of Lagrange Multipliers in economics are reported here.

Results:

Applying Lagrange Multipliers allowed for successful optimization of Economic problems subject to constraints.

Conclusion:

Lagrange Multipliers provide a viable method of Economic optimization that eliminates guess-based iteration.

Isoperimetric Problem on Bounded Domains in the Plane

[MS 109 3:10]

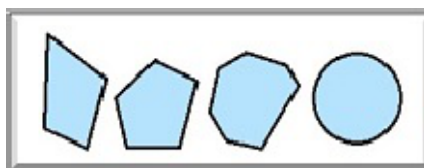
Zachariah Ingram

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Pappus of Alexandria (c.290-c.350) was one of the last great Greek mathematicians of antiquity. Pappus wrote, "Bees know just this fact which is useful to them, that the hexagon is greater than the square and the triangle and will hold more honey for the same expenditure of material in constructing each." Pappus was not concerned with the intelligence of bees, but rather the question of what plane figure, given equal perimeters, would yield the maximum bounded area, also known as the isoperimetric inequality.

This investigation addressed the question of: Among all curves consisting of a fixed perimeter in the two dimensional domain, which curve maximizes the area? Geometry and basic calculus concepts were the only tools used for this project, thus it can be understood by individuals who have limited mathematics background. The ideas from this essay draw upon a series of comparisons between polygons and convex hull shapes. A discovery was made that an increase in the axis of symmetry correlated to an increase in the area. The area increases with the addition of each axis of symmetry, but the magnitude of the increase diminishes with each new axes. A triangle has lesser area compared to a quadrilateral, four axis of symmetry. The quadrilateral has lesser area compared to the pentagon, five axis of symmetry, and so on. The isoperimetric inequality of $4\pi A \leq L^2$ symbolizes this trend. The number of sides increases, but they are always less than infinite sides. When infinite sides are present the equality is achieved and a circle is produced. A comparison was then established that a decrease in the convex hull led to an increase in area with a decrease in area. Which illustrates that a deformed curved shape is of lesser area in comparison with a circle.



Combinatorial Proofs of Fibonacci Identities by Means of the Path Graph

[MS 108 3:10]

John Jacobson

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In 1982, Prodinger and Tichy define the Fibonacci number of a graph G , $i(G)$, to be the number of independent sets (including the empty set) of the graph. They do so because the Fibonacci number of the path graph, P_n , is the Fibonacci number F_{n+2} . Nelson's *Proof without Words* series provides numerous visual arguments for several mathematical identities, some of which feature the Fibonacci sequence. In *Proofs that Really Count*, Benjamin and Quinn provide purely combinatorial proofs of several mathematical identities, some of which feature the Fibonacci sequence. This talk marries these visual and combinatorial features to prove Fibonacci identities by means of the path graph.

Mathematics meets Oncology

[MS 118 4:10]

Philippe Laval

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There is a need for a closer collaboration between mathematicians and scientists involved in cancer research. If you like mathematics and would like to make a difference in the medical field, there are many opportunities to have a rewarding career. In this talk, we will explore how mathematics can be used in the fight against cancer. Several tumor growth models will be presented and discussed.

Approximations and Complete Orthogonal Systems

[MS 109 10:00]

Lars Lötgering

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Complete Sets of Functions are a powerful means to solving a variety of problems in Mathematics and Applied Science. The goal of this talk is to present methods of Linear Algebra for obtaining approximations of functions.

From Thurston to Siblings: A New Definition for d -invariant Laminations

[MS 109 2:50]

Joe Olson

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In the 1980's, William Thurston introduced invariant laminations to study the dynamics and parameter space of complex polynomials of degree $d > 1$. He showed that many polynomials correspond directly to a d -invariant lamination. Rather than study the space of polynomials directly, the idea is to study it indirectly by understanding the space of laminations. Thurston created a definition for d -invariant laminations and used it to thoroughly study quadratic invariant laminations. However, in this paper, an alternative definition is

proposed which maybe useful, especially for polynomials of higher degree. Thurston's definition will be referred to as Thurston d -invariance while the definition described here will be called sibling d -invariance. A lamination is a closed family of chords of the unit disk which meet at most in a common endpoint. Both definitions require that the image of a leaf (under the map $\sigma_d(z) = z^d$ on the unit circle) is a leaf or a point. The main difference between the two definitions is that Thurston d -invariance requires any leaf in the lamination to have d disjoint pre-images and that gaps be invariant while sibling d -invariance requires any non-degenerate leaf with non-degenerate image to have $d - 1$ sibling leaves which map to the same leaf so that all d leaves are pairwise disjoint and imposes no conditions on gaps. Nevertheless in this paper we will prove that a lamination which is sibling d -invariant is also Thurston d -invariant. We will also provide a count for the number of possible families of d -disjoint leaves in a full sibling family which map to the same leaf which is neither a point nor a diameter.

Counterexamples to a Conjecture Due to Noy and Ribó

[MS 108 2:50]

Aaron J. Ostrander

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In a publication by Noy and Ribó, it was shown that recursively constructible families of graphs are recursive. The authors also conjecture that the other direction holds; that is, recursive families are also recursively constructible. In this talk, we provide two specific counterexamples to this conjecture, which we extend to an infinite family of counterexamples. We then adjust the conjecture accordingly.

Convex Hulls and the Casas-Alvero Conjecture for Polynomials over the Complex Plane

[MS 113 3:30]

Thomas Polstra

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It has been conjectured by Casas-Alvero that polynomials of degree n over fields of characteristic 0, share roots with each of its $n - 1$ derivatives if and only if those polynomials have one root of degree n . Using the analytic theory of polynomials, the Casas-Alvero conjecture can be approached for polynomials over the complex field. Developing ideas on a polynomial's convex hull, the smallest convex subset of the complex plane that contains the roots of a polynomial, a statement that is equivalent to the Casas-Alvero conjecture can be made that brings new insight to the problem.

The Effects of Uniform Noise on a Hopfield Neural Network under Excitation

[MS 109 9:40]

Kelvin Rozier

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The study of neural networks has become prominent due to the wide range of applications to artificial intelligence and for simulations of the electrical activity in the brain. The Hopfield Neural Network (HNN) is seen as one of the simplest models which illustrate some of the brain's properties, such as pattern recognition, memory, and visual processing. Noise is a general factor that affects the activity of the neural circuits, and there are suggestions that it plays constructive role in the brain. It has been shown [1] that HNN without the effects of noise yields exponential and linear growth of oscillation amplitudes in fully and partially connected neural networks, respectively. This paper numerically investigates the activity of the network when noise is introduced. The HNN is modeled by a set of 10 ordinary differential equations with time delay. The uniform noise component is generated on the interval of (γ, γ) , where γ ranges from 0.01 to 1.0 to vary the strength of noise, and was added to each differential equation. The fourth order Runge-Kutta method is used to obtain solutions to the system. The results of simulations show exponential growth in the neural network output amplitude with an additive oscillatory component. When noise is added to the model, the rate of the growth increases, and the saturation is achieved at earlier time moments in the time series comparing to those for the neural network without noise. In addition, the noise also increases amplitude of the oscillatory component, which becomes comparable to the magnitude of the exponentially growing component.

[1] Rozier K. Role of Asymmetry and Connection Type in a Hopfield Neural Network Model. In: 2010-2011 RIMMES Projects, Georgia State University, 2011, p. 14-20.

Toward a Proof of the Erdős-Faber-Lovász Conjecture

[MS 108 8:20]

John Samples

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The Erdős-Faber-Lovász Conjecture is an unresolved problem in graph theory, formulated in 1972 by Paul Erdős, Vance Faber and Laszlo Lovász. The conjecture is as follows:

"If k complete graphs, each having exactly k vertices, have the property that every pair of complete graphs has at most one shared vertex, then the union of the graphs can be colored with k colors."

Using only elementary aspects of graph theory, set theory and enumerative combinatorics, the conjecture can be proven for several special cases, by deriving different k -colored unions of graphs from transformations on a particular a priori, k -colored union. This presentation will explain the methodology used to prove the conjecture in these cases, and preliminary work toward a solution for the general case.

Circle Packing: Combinatorics and Geometry

[MS 108 9:40]

Christopher Sass

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The modern topic of circle packing was introduced by William Thurston in 1985. Many areas in this evolving field are highly accessible, and students can acquire intuition through computer experimentation involving visual images. I will discuss the relationship between the combinatorial pattern of external tangencies of a circle packing and the geometry (euclidean, hyperbolic, or spherical) in which the circle packing is realized. I will also introduce two variations of the basic circle packing notion: branched packings and packings on non-simply connected surfaces.

Polygons in Polar!

[MS 109 3:50]

Jason Schmurr

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We discuss the problem of writing down a function in polar coordinates whose graph is a regular polygon.

Why Computer Science Needs Mathematics

[MS 118 3:50]

Gene Sheppard

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Algorithm analysis does not require a computer; it requires a solid foundation in mathematics. In this session, the definition of a solution from a computer science perspective will be discussed. Two classic algorithms – Euclid’s GCD algorithm and the Tower of Hanoi – will be used to illustrate why mathematics is needed to analyze algorithms and develop solutions.

The Bollobás-Riordan-Whitney-Tutte Polynomial and Ribbon Graph Operations

[MS 108 2:30]

T. Scott Spencer* and Neal Stoltzfus
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Given a ribbon graph \mathbb{D} and a collection of pointed ribbon graphs \mathbb{M}_r for each edge of \mathbb{D} , Farmer has defined the generalized iterated parallel connection and iterated two sum. Essentially, this replaces each edge in \mathbb{D} by the chosen ribbon graph (with the edge deleted for the two-sum). Brylawski developed these ideas of series and parallel connections in graph theory and found formulae for their Tutte polynomial (essential for computational complexity results on the Jones polynomial). We develop new techniques that lead to a formula for the topological rank polynomial of Bollobás-Riordan-Whitney-Tutte for ribbon graphs and corresponding formulae for other operations. The explicit formulae are expressed in terms of the three polynomial constituents of the pointed ribbon graph polynomial of Farmer and a decomposition of the base ribbon graph \mathbb{D} .

Domination and Independence on the Triangular Honeycomb Chessboard

[MS 108 3:30]

Hong Lien Tran
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Puzzles on the chessboard have long been studied by mathematicians. Across the Board: The Mathematics of Chessboard Problems by John Watkins is an indispensable collection of mathematically themed chessboard problems. We do not restrict ourselves to the standard 8×8 chessboard. Generalizations are quickly made to the square board of sides other than $n = 8$, mn rectangular boards and other variant surfaces. Chessboard problems are most frequently set in the context of Graph Theory. Two classic problems in Graph Theory that appear again and again are those of dominating sets of minimum cardinality and independent sets of maximum cardinality. For chessboards the question of a minimum dominating set transforms into how to threaten or occupy every square on the board with the fewest pieces. Maximum independent sets become the problem of how to place the most non-attacking pieces. Our project explores these two combinatorial problems on the variant triangular honeycomb chessboard for the rook, bishop, knight and king.

An Introduction to Ramsey Theory

[MS 108 8:40]

Will Trott
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Ramsey Theory is the area of mathematics concerned with combinatorial structures that are guaranteed to exist in sufficiently large sets. We provide a brief introduction to this area and some of its standard results and techniques.

Access control logic

[MS 113 9:40]

Kayla von Hagel

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Access control in computer security presents a unique situation for mathematicians, engineers and security professionals to develop solutions for the military. Mission assurance, as opposed to information assurance, allows military commanders to have high confidence of the components within the mission to achieve success in a contested environment. Access control is concerned with the policies and mechanisms that permit or deny the use of a resource or capability in a military operation. There exists no standardized method to reason about or represent access control, so mathematicians can utilize Access Control Logic to reason and prove the soundness of access control designs and specifications.

The Information Assurance internship in the summer of 2011 allowed 13 students to explore the elements of Access Control Logic and Mission Assurance in order to design, develop and verify cutting edge systems for the United States Air Force. The interns modeled the secure transmission of mission orders through a contested cloud environment. The application of Access Control Logic consisted of rigorous proofs pertaining to confidentiality, integrity, availability, authentication and attribution. Each proof was analyzed, compared and verified by the Air Force Research Lab and Department of Defense mentors.

The research done at the Information Assurance internship in Rome, NY gave precedence for support for the program by high ranking Air Force officials. Each solution gave the Air Force Research Laboratory valuable insight on the state of the military within cyber operations and is currently being used a framework for new solutions.

Math Circles for Students and Teacher

[MS 118 3:30]

Virginia Watson*, Mary Garner, Beth Rogers

Kennesaw State University

`vwatson@kennesaw.edu`

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 circles. Details will be given on how to join a math circle or start your own.

Elliptic Curve Cryptology

[MS 113 3:50]

Jasmine West

Spelman College

`jwest4@scmail.spelman.edu`

An elliptic curve is a curve having the form $y^2 = x^3 + ax + b$. In elliptic curve cryptology, a message is a point on an elliptic curve which is then enciphered by using an addition that is defined on the elliptic curve. The basic problem that we want to solve is how we can send information without an eavesdropper understanding what was sent. In this talk, we will define elliptic curves, give examples, and see how they relate to cryptology.

Mac Lane's Planarity Theorem

[MS 108 9:00]

Zach Wunderly

University of Alabama at Birmingham

`zwunder@uab.edu`

Saunders Mac Lane was an American mathematician who worked to generalize links between algebra and other disciplines of mathematics. His theorem for planar graphs reveals a relationship between the cycle space of a graph and the planarity of a graph. A graph is said to be planar if it can be embedded onto the plane so that none of the edges intersect. The cycle space of a graph is a vector space whose elements are cycles from the graph. Mac Lane's theorem says that a graph is planar if the cycle space of the graph has a particular type of basis. A simple proof of Mac Lane's theorem can be achieved by using Kuratowski's planarity theorem and elementary combinatorial arguments for the complete graphs K_5 and $K_{3,3}$.

On Cartesian products of graphs and the Roman domination function

[MS 108 3:50]

Elliot Krop and Tony Yaacoub*

Clayton State University

`TYacooub@student.clayton.edu`

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 , $\text{RDF}(G)$, 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.

Optimal recovery of twice differentiable univariate functions

[MS 109 8:40]

Xikai Zhao

Towson University

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What can we say about a function with bounded second derivative if we only know its values at n given points (nodes) and know its derivative at every other node? How well can we approximate the function between the nodes and what is the optimal approximation method? We will consider piecewise polynomial (or spline) methods.

One optimal method called perfect spline is known (we will define the optimality criterion in the talk). It interpolates the data and is piecewise linear. However, it is not smooth on the intervals between the nodes. We obtain two optimal methods (a mixed linear-quadratic spline and a cubic spline) which are smooth on the intervals between the nodes. We also find an optimal quadratic spline method. Although it partially loses the interpolation properties and is only continuous, it requires less computer memory to be stored.

CAREERS WITH MATHEMATICS PANELISTS

- *Kristina Corts*
Senior Statistical Analyst, CRIF
- *Dr. Marta D'Elia*
Emory University
- *Dr. Radu Gadidov*
Manager Operations Research, Georgia Pacific
- *Dr. Brett Katzman*
Associate Professor of Economics
Chair of the Department of Economics, Finance and Quantitative Analysis
- *Jim Piekut*, FSA, MAAA
Associate Vice President, Corporate Actuarial
- *Dr. Alessandro Veneziani*
Department of Mathematics and Computer Science, Emory University
Wallace H. Coulter Dept. of Biomedical Engineering, GA Tech & Emory University
Former Consultant for Brembo, Ducati, Siemens Medical Solutions

Friday, November 11

1:00 - 7:00	Registration (atrium of Mathematics and Statistics building)		
Inquiry-Based Learning workshop (faculty) Room: MS 108		Origami Workshop (students and faculty) by Robert Rumely Room: MS 109	
1:00 - 1:50	Cornelius Stallmann IBL Rewards and Challenges		
2:00 - 2:50	Patrick Bahls Guided Discovery in the Mathematics Classroom		
3:00 - 3:50	Ron Taylor The Many Faces of Inquiry Based Learning		
4:00 - 4:25	John Mayer Euclidean Geometry Rediscovered	4:00 - 5:00	Movie: "Between the Folds" (1st showing)
4:30 - 4:55	William Bond Impact of Blending Inquiry-Based and Computer-Assisted Instruction in Basic Algebra		
		5:00 - 6:00	Folding session (materials provided)
		6:00 - 7:00	Origami Lecture
		7:00 - 7:30	Pizza
7:30	Faculty Dinner (informal, for those who are interested)	7:30 - 8:30	Movie: "Between the Folds" (2nd showing)

Saturday, November 12

	Combinatorics/Graph Theory Room: MS 108	Numerical Analysis Room: MS 109	Applied Math Room: MS 113	Room: MS 118
7:45-8:20	Registration and Breakfast (catered in MS 111)			
8:20-8:35	John Samples	Ana-Maria Croicu	John Hunt, Jr.	
8:40-8:55	Will Trott	Xikai Zhao	George Cazacu	
9:00-9:15	Zach Wunderly	Shannon Bryce	Carolyn Drobak	Colin Adams
9:20-9:35	Jack Farnsworth	Teagan Bryce	Halcyon Garrett	
9:40-9:55	Christopher Sass	Kelvin Rozier	Kayla von Hagel	
10:00-10:15	James Diffenderfer	Lars Lötgering	John Aldridge	
10:20-10:50	Coffee break (Room: MS 111)			
10:50-11:00	KSU Mathematics Department Chair's welcome Room: BB 151			
11:00-12:00	Keynote address (Room: BB 151) by Sir Randolph Bacon III cousin-in-law to Colin Adams, Williams College			
12:00-1:00	Group photo and Lunch (catered in MS 111)			
1:00-1:30	Invited talk (Room: BB 151) Patrick Bahls (UNCA)			
1:45-2:15	Invited talk (Room: BB 151) Brett Katzman (KSU)			
	Graph Theory Room: MS 108	Analysis Room: MS 109	Algebra Room: MS 113	General Room: MS 118
2:30-2:45	T. Scott Spencer	Julian Buck	Keegan Gary	John Boncek
2:50-3:05	Aaron J. Ostrander	Joe Olson	Nate Coursey	Laurie Huffman
3:10-3:25	John Jacobson	Zachariah Ingram	Eddie Beck	Cameron Caligan
3:30-3:45	Hong Lien Tran	Michael Dykes, Trey Gay	Thomas Polstra	Virginia Watson
3:50-4:05	Tony Yaacoub	Jason Schmurr	Jasmine West	Gene Sheppard
4:10-4:25	Marcus Bartlett	Anda Gadidov	Jeffrey Ehme	Philippe Laval
4:30-5:00	Coffee break (Room: MS 111)			
5:00-6:00	Panel: "Careers with Mathematics" Room: BB151			
6:00	Closing remarks (Room: BB151)			