MAA Student Chapters

The MAA Student Chapters program was launched in January 1989 to encourage students to continue study in the mathematical sciences, provide opportunities to meet with other students interested in mathematics at national meetings, and provide career information in the mathematical sciences. The primary criterion for membership in an MAA Student Chapter is “interest in the mathematical sciences.” Currently there are approximately 550 Student Chapters on college and university campuses nationwide. This year we are celebrating the 20th anniversary of undergraduate student talks at MathFest.

Pi Mu Epsilon

Pi Mu Epsilon is a national mathematics honor society with 327 chapters throughout the nation. Established in 1914, Pi Mu Epsilon is a non-secret organization whose purpose is the promotion of scholarly activity in mathematics among students in academic institutions. It seeks to do this by electing members on an honorary basis according to their proficiency in mathematics and by engaging in activities designed to provide for the mathematical and scholarly development of its members. Pi Mu Epsilon regularly engages students in scholarly activity through its *Journal* which has published student and faculty articles since 1949. In addition, the society awards monetary prizes for mathematics contests and awards established by chapters. Since 1952, Pi Mu Epsilon has been holding its annual National Meeting with sessions for student papers in conjunction with the summer meetings of the Mathematical Association of America (MAA).

Schedule of Student Activities

Except where noted, events are in the Fairmont Hotel

Thursday, August 2

3:00 pm - 5:00 pm	CUSAC Meeting	20th Floor Conference Room
5:00 pm - 6:00 pm	MAA/PME Student Reception	Regency Foyer

Friday, August 3

8:00 am - 11:30 am	PME Council Meeting	The Fairmont Hotel
8:30 am - 10:30 am	MAA Session #1	Fairfield
8:30 am - 10:30 am	MAA Session #2	Glen Ellen
8:30 am - 10:30 am	MAA Session #3	Piedmont
8:30 am - 10:30 am	MAA Session #4	Belvedere
9:00 am - 5:00 pm	Student Hospitality Center	Imperial Ballroom (Exhibit Hall)
1:00 pm - 1:50 pm	MAA Student Lecture	Regency 1
1:00 pm - 4:00 pm	Invited Paper Session	Gold Room
2:00 pm - 6:15 pm	PME Session #1	Rm 224, MacQuarrie Hall, SJSU
2:00 pm - 6:15 pm	PME Session #2	Rm 233, MacQuarrie Hall, SJSU
2:00 pm - 6:15 pm	PME Session #3	Rm 234, MacQuarrie Hall, SJSU
2:00 pm - 4:00 pm	MAA Session #5	Rm 222, MacQuarrie Hall, SJSU
2:00 pm - 4:00 pm	MAA Session #6	Rm 223, MacQuarrie Hall, SJSU
4:15 pm - 6:15 pm	MAA Session #7	Rm 222, MacQuarrie Hall, SJSU
4:15 pm - 6:15 pm	MAA Session #8	Rm 223, MacQuarrie Hall, SJSU
8:00 pm - 9:30 pm	Math Jeopardy	Club Regent

Saturday, August 4

8:30 am - 10:30 am	PME Session #4	Belvedere
8:30 am - 10:30 am	PME Session #5	Cupertino
8:30 am - 10:30 am	PME Session #6	Piedmont
8:30 am - 10:30 am	MAA Session #9	Fairfield
8:30 am - 10:30 am	MAA Session #10	Glen Ellen
9:00 am - 5:00 pm	Student Hospitality Center	Imperial Ballroom (Exhibit Hall)
1:00 pm - 1:50 pm	MAA Student Activities Session	Club Regent
2:00 pm - 5:00 pm	PME Session #7	Belvedere
2:00 pm - 5:00 pm	PME Session #8	Cupertino
2:00 pm - 5:00 pm	MAA Session #11	Fairfield
2:00 pm - 5:00 pm	MAA Session #12	Glen Ellen
6:00 pm - 7:45 pm	PME Banquet and Awards Ceremony	SJSU
8:00 pm - 8:50 pm	J. Sutherland Frame Lecture	Regency Ballroom
9:00 pm - 10:00 pm	20th Anniversary Celebration for MAA Student Paper Sessions	Crystal Room

Sunday, August 5

9:00 am - 1:00 pm	Student Hospitality Center	Imperial Ballroom (Exhibit Hall)
9:00 am - 10:30 am	MAA Modeling (MCM) Winners	Gold Room
1:00 pm - 2:15 pm	Student Problem Solving Competition	Club Regent

J. Sutherland Frame Lecture

NEGAFIBONACCI NUMBERS AND THE HYPERBOLIC PLANE

Donald E. Knuth
Stanford University

All integers can be represented uniquely as a sum of zero or more "negative" Fibonacci numbers $F_{-1} = 1$, $F_{-2} = -1$, $F_{-3} = 2$, $F_{-4} = -3$, $\ldots$, provided that no two consecutive elements of this infinite sequence are used. The NegaFibonacci representation leads to an interesting coordinate system for a classic infinite tiling of the hyperbolic plane by triangles, where each triangle has one 90° angle, one 45° angle, and one 36° angle.

The J. Sutherland Frame Lecture is named in honor of the ninth President of Pi Mu Epsilon, who served from 1957 to 1966 and passed away on February 27, 1997. In 1952, Sud Frame initiated the student paper sessions at the annual Pi Mu Epsilon meeting, which is held at the Summer MathFests. He continually offered insight and inspiration to student mathematicians at these summer meetings.

MAA Student Lecture

Splitting the Rent: Fairness Problems, Fixed Points, and Fragmented Polytopes

Francis Edward Su
Harvey Mudd College

How do you divide the rent among roommates fairly? My friend's dilemma was a question that mathematics could answer, both elegantly and constructively. We show how it and other "fair division" questions — the most famous of which is the problem of Steinhaus: how do you cut a cake fairly? — motivate a host of "combinatorial fixed point theorems" and problems about polytopes. They provide excellent examples of how mathematics can address an old class of problems in new ways, and conversely, how problems in the social sciences can motivate new mathematics— where topology, geometry, and combinatorics meet social applications, and where research by undergraduates has played a big role.

MAA Student Speakers

Name	School	MAA Session
Nikhil Agarwal	Brandeis University	12
Heather Akerson	College of Saint Benedict	5
Rachel Allen	Williams College	12
Alexandra Appel	California State University Chico	6
Nicholas apRobertsWarren	Wheaton College	11
Christine Barnes	Augustana College	5
Rachel Bayless	Wheaton College	11
Zachary Beamer	Michigan State University	3
Victoria Bennett	Wheaton College	11
Eleanor Birrell	Harvard University	8
Bryan Bischof	Westminster College	2
William Boney	Grinnell College	3
James Boston	Kenyon College	9
Dale Bowring	Wheaton College	11
David Breisch	Augustana College	5
Jessica Brown	University of Texas Arlington	5
Shaun Callighan	Augustana College	8
Trisha Carr	Wheaton College	11
Anna Castelaz	University of North Carolina, Asheville	10
Ryan Causey	Mississippi State University	7
Katelyn Chabot	Wheaton College	11
Hunan Chaudhry	Benedictine University	12
Brian Chen	California State Polytechnic University Pomona	10
Phillip Compeau	Davidson College	6
Arkajit Dey	Massachusetts Institute of Technology	1
Matt Deyo-Svendsen	Stetson University	7
Jim Dickson	Davidson College	6
Ryan Eberhart	Harvard University	8
Michael Fink	Warren Wilson College	2
Christina Gillen	Augustana College	5
Chad Griffith	Sonoma State University	11
Daniel Guillot	Louisiana State University	10
Ryan Hake	California State University Chico	8
Nick Haught	Youngstown State University	3
Emily Hendrickson	Slippery Rock University	7
AJ Hergenroeder	Davidson College	1
Hieu Hoang	San Jose State University	10
Joy Holowicki	Benedictine University	9
Katrina Honigs	Grinnell College	7
Sophy Huck	California State University Chico	6
Jorge Ibanez	University of Texas Pan American	5
Charise Kazmierczak	Ohio Northern University	10

MAA Student Speakers (Continued)

Name	School	MAA Session
Daniel Kearns	Penn State - Capital College	4
Marc Kelechava	Boston University	9
Joshua Kelly	Truman State University	9
Tirasan Khandhawit	Duke University	12
Hanna Komlos	Rutgers University	10
Kenji Kozai	Harvey Mudd College	6
Daniel Kravatz	Millersville University	10
Coriann Lanni	Wheaton College	11
Christine Lee	University of Colorado Denver	6
Jessica Lin	New York University	3
Antonio Lopez	University of Texas Arlington	11
Sean MacRae	Sonoma State University	8
Erica Manoppo	Michigan State University	3
Miguel-Angel Manrique	University of Southern California	6
Vincent Martinez	The College of New Jersey	7
Jason Miller	Truman State University	9
Tri Nguyen	Evergreen Valley College	4
Roberto Palomba	University of Mary Washington	2
Ziying Pan	Michigan State University	3
Laura Printz	Hood College	4
Hillary Sackett	Smith College	8
Megan Sawyer	University of Colorado Denver	4
Jonathan Schneider	University of Illinois Chicago	12
Amanda Seitz	Sam Houston State University	4
Mary Servatius	Worcester Polytechnic Institute	7
Dan Shaffer	Michigan State University	3
Gregory Shinault	California State University Bakersfield	11
Alexander Shvonski	Wheaton College	11
Robert Simione	New York University	9
Chase Smith	Duquesne University	1
Kristen Stewart	McNeese State University	2
Phillip Studans	Michigan State University	3
Renee Tatge	Bethany Lutheran College	9
Rory Tiedemann	Mount Union College	1
Chris Tou	Augustana College	12
Anarghya Vardhana	Stanford University	8
Ashley Weatherwax	University of Texas Dallas	4
Dana Wheaton	Sam Houston State University	1
Danielle Williams	Augustana College	11
Glen Wilson	The College of New Jersey	2
Michael Curtis Wilson	University of California Santa Cruz	6
Mary Wootters	Swarthmore College	12

Pi Mu Epsilon Delegates

Speakers

Name	School	Chapter	PME Session
Vanessa Abrisqueta	St. Peter's College	NJ Epsilon	5
Jennifer Anderson	The University of Texas at Arlington	TX Iota	3
Frank Ballone	Youngstown State University	OH Xi	5
Melissa Barrick	Hood College	MD Delta	5
Tyler Bryson	Linfield College	OR Epsilon	4
Lisa Cangelose	Texas A&M University	TX Eta	7
Shawn Case	Fitchburg State College	MA Eta	1
Brittany Lynn Chase	Carthage College	WI Epsilon	2
Lea Cluff	Youngstown State University	OH Xi	8
Jeff Cornfield	Youngstown State University	OH Xi	3
Kristin Creech	University of Texas Arlington	TX Iota	7
Jennifer Crounse	Fitchburg State College	MA Eta	1
Tara Cruickshank	Youngstown State University	OH Xi	8
Marie Nicole Dailey	John Carroll University	OH Lambda	3
Carrie Davis	Youngstown State University	OH Xi	8
Kyle Diederich	St. Norbert College	WI Delta	1
Tyler Drombosky	Youngstown State University	OH Xi	1
Joseph Esposito	Duquesne University	PA Upsilon	1
Krista Foster	Youngstown State University	OH Xi	5
Kensey Foushee	Meredith College	NC Mu	8
John Fulk	Texas A&M University	TX Eta	6
Ellen Galo	St. Lawrence University	NY Epsilon	7
William George	Case Western Reserve University	OH Sigma	2
Rachel Grotheer	Denison University	OH Iota	7
Jeffrey Hatley	The College of New Jersey	NJ Theta	3
Brent Hawker	University of Utah	UT Alpha	3
John Hoffman	Youngstown State University	OH Xi	8
Laura Homa	Mount Union College	OH Omicron	5
David Horn	Elmhurst College	IL Iota	2
Dylan Hower	Duquesne University	PA Upsilon	1
Michelle Jackson	Pepperdine University	CA Xi	2
Sara Jensen	Carthage College	WI Epsilon	7
Brendan Kelly	The College of New Jersey	NJ Theta	1
Kevin Kreighbaum	Mount Union College	OH Omicron	5
Mark Krines	St. Norbert College	WI Delta	2
Jason La Corte	Texas State University, San Marcos	TX Rho	6
Mark Lane	Sam Houston State University	TX Epsilon	2
David Ledbetter	Mount Union College	OH Omicron	3
Arielle Leitner	California State University, Chico	CA Omicron	3
William Ryan Livingston	Youngstown State University	OH Xi	5
David Martin	Youngstown State University	OH Xi	8
Micah Martin	Pepperdine University	CA Xi	2
Andrew Matteson	Texas A&M University	TX Eta	7

Pi Mu Epsilon Delegates (Continued)

Name	School	Chapter	PME Session
Kerry McIver	John Carroll University	OH Lambda	1
Stefanie Meyer	Sam Houston State University	TX Epsilon	8
Cara Montgomery	Texas A&M University	TX Eta	7
Amanda Moore	Denison University	OH Iota	2
Meghan Moreland	Mount Union College	OH Omicron	1
Brittany Mosby	Spelman College	GA Delta	1
Lindsey Nagy	Hood College	MD Delta	6
Ryan Pavlik	St. Norbert College	WI Delta	3
Jason Percival	University of Massachusetts - Lowell	MA Delta	3
Erika Peterson	Concordia University Irvine	CA Pi	4
Heather Peterson	Concordia University Irvine	CA Pi	4
Jason Pfister	Texas A&M University	TX Eta	7
Mauricio Alexander Rivas	Sam Houston State University	TX Epsilon	2
Amanda Rohde	Rose-Hulman Institute of Technology	IN Gamma	4
Anne Rollick	John Carroll University	OH Lambda	3
Jared Ruiz	Youngstown State University	OH Xi	3
Joseph Salisbury	Rhode Island College	RI Beta	1
Bruce Salter	Aquinas College	MI Lambda	8
Chelsea Sprankle	Hood College	MD Delta	5
William Stanton	Kenyon College	OH Pi	4
Ashley Swandby	Longwood University	VA Epsilon	1
Jeff Swartzel	The University of Akron	OH Nu	4
Mimi Tsuruga	Hunter College - CUNY	NY Beta	1
Matthew Voigt	Saint John’s University	MN Delta	2
Doug Wajda	Youngstown State University	OH Xi	8
Matt Ward	Youngstown State University	OH Xi	3
Jeffrey Ward	Clarkson University	NY Omicron	2
Michael T. Williams	University of Massachusetts - Lowell	MA Delta	3
Rebecca Winarski	Case Western Reserve University	OH Sigma	2
Amy Winslow	Randolph-Macon College	VA Iota	2
Moriah Wright	Youngstown State University	OH Xi	6
Jordan Yoder	Goucher College	MD Theta	7

Additional Delegates

Name	School	Chapter
Kristel Ehrhardt	University of Maryland, Baltimore County	MD Gamma
Benny Godin	University of North Carolina, Charlotte	NC Theta
Eteri Svanidze	SUNY Fredonia	NY Pi

MAA Session #1

Fairfield **8:30A.M. – 10:30A.M.**

8:30–8:45

Win Probabilities in California Football

Rory Tiedemann
Mount Union College

The goal of this project is to determine the probability of the University of California winning a football game based on the situation (time remaining, point differential, field position, and possession). The probabilities were calculated on SPSS using data for all drives, which are defined as a possession in which the offense runs at least one play, under current head coach, Jeff Tedford. An aim of the experiment is to use the final results as a tool to evaluate the offensive, defensive, and special team units' performance.

8:50–9:05

Tree-Realizability of a Distance Matrix

Arkajit Dey
Massachusetts Institute of Technology

A fast unified algorithm for both testing the tree-realizability of a distance matrix and constructing the optimal tree-realization is presented. The fastest existing algorithms only do either realizability or realization. The improvements offer early halting upon non-realizability and a running time that is just as fast as existing construction algorithms on input that is realizable. Tree-realizations can make naturally difficult problems such as the traveling salesman problem more easily solvable optimally over a tree-metric. Other applications exist in varied disciplines such as molecular and evolutionary biology, organic chemistry, internet network topology, internet performance, and analysis of mental function in psychology.

9:10–9:25

Billiard Mathematics

Dana Wheaton
Sam Houston State University

During this talk, we will conduct a geometric look into billiards. We will study the angles required for shots and where error can occur. This examination will include not only error gotten from the table, but from the ball and cue as well.

9:30–9:45

A Nystrom/ACA approach for integral equations

Chase Smith
Duquesne University

In this talk, we discuss the feasibility of solving the Poisson-Boltzmann Equation using an integral equation formulation whose solution is approximated using a locally corrected Nystrom Method. The approximate solution satisfies a system of linear equations which requires a significant amount computational resources to store and solve. The Adaptive Cross Approximation (A.C.A.) uses efficient low-rank approximations to store the coefficient matrix and allows the method to be applied to large problems which would otherwise be impractical. The primary application of this approach is to provide an efficient method for computation of electrostatic potentials for use in molecular dynamics.

9:50–10:05

Analysis of Non-exponential Fluorescence Decays

AJ Hergenroeder
Davidson College

In an experiment in chemical physics, we use a spectrometer to measure the sum intensity exponential decay in a sol gel glass sample doped with Tb3+ ions. The natural logarithm of the net observed intensity is non-exponential because there are multiple distinct local environments in which Tb3+ ions exist, and for each of these environments there is a unique lifetime of exponential decay, the sum of which is non-exponential. We consider mathematical problems involving optimizing instrumentation and filtering background noise in this setting. Additional applications from Matrix Analysis and Wavelet theory may be included.

MAA Session #2

Glen Ellen **8:30A.M. – 10:30A.M.**

8:30–8:45

Invariant Theory and the Symbolic Method

Glen Wilson
The College of New Jersey

Invariants are polynomial functions whose values remain unchanged under a group action. For the special case of a binary quadratic form, there is only one fundamental invariant, the familiar discriminant $b^2 - 4ac$. This talk will discuss some of the methods that have been developed to compute and classify invariants like the symbolic method.

8:50–9:05

Bicyclic Antiautomorphisms of Triple Systems

Kristen Stewart
McNeese State University

We will give the necessary conditions for the existence of a Mendelsohn triple system of order v with an antiautomorphism having two cycles of lengths M and N, $1 < M \leq N$.

9:10–9:25

Some Algebra of Partition Regular Matrices

Michael Fink
Warren Wilson College

A matrix A is called Kernel Partition Regular (KPR) if for any partition of the set $\mathbb{N}$ of natural numbers into finitely many classes $C_1, C_2, ..., C_r$, there exists a vector x whose coordinates all belong to the same C_j and for which $Ax = 0$. In this presentation, we will examine the algebraic properties of such matrices.

9:30–9:45

Semigroup Structure in Conjugate Categories

Roberto Palomba
University of Mary Washington

In any category, the set of endomorphisms of a fixed object forms a monoid. We use structural results of semigroup theory to identify the subgroups of such a monoid when the category in question is part of a conjugate pair. We provide a characterization of the idempotents in such a category and use this to classify the various subgroups of the endomorphism monoids. All of this structure is illustrated by a simple example involving basepointed sets and functions.

9:50–10:05

On the Images of Integer Coefficient Polynomials

Bryan Bischof
Westminster College

It is well known that a non-constant polynomial $f(x)$ with integer coefficients produces at least one composite image . We improve this elementary result and show that $f(x)$ produces an infinite number of composite images. We will also show that $f(x)$ produces an infinite number of images with an arbitrary number of prime factors. More precisely, we will show that given a positive integer n, we can find an infinite number of images that are divided by at least n distinct primes, and an infinite number of images that are divided by a prime power p^m where $m > n$.

MAA Session #3

Piedmont **8:30A.M. – 10:30A.M.**

8:30–8:45

Frame Potential for Infinite Frames

William Boney
Grinnell College

The notion of frame force and frame potential has many applications to finite frames, including the proving of the sufficiency of the Fundamental Inequality for the length of tight frames. This presentation will expand notions to certain infinite frames and explore some of their properties.

8:50–9:05

The Cauchy-Riemann Equations and $\bar{z}$

Nick Haught
Youngstown State University

Using the Cauchy-Riemann Equations, we show that analytic functions are characterized by the fact that they respect the complex structure of z.

9:10–9:25

Tent-Maps and Cantor-Like Fractals

Zachary Beamer*
Michigan State University

In this presentation, we investigate the relationship between various classes of tent-like functions and corresponding fractal sets similar to the traditional Cantor set. We begin by considering the well-known link between the standard tent map and the Cantor set. We then proceed by creating different functions with an additional parameter, each of which the traditional tent map is a special case. Each function results in a class of resulting fractals similar in structure to the Cantor set. We go on to consider the question of a possible one-to-one correspondence between Cantor-like sets and Tent-like maps.

*Joint work with: Erica Manoppo, Dan Shaffer, Phillip Studans (*Michigan State University*)

9:30–9:45

The Dynamical Behavior of Quadratic Maps

Ziying Pan
Michigan State University

The dynamical behavior of the quadratic family $f_c(x) = x^2 + c$, where c is a real parameter, has been thoroughly studied and is well understood. In this project we investigate the impact of geometric transformations such as vertical and horizontal shift as well as vertical and horizontal stretching on the dynamic behavior of $f_c(x)$. We will characterize the nature of fixed and cycle points, and chaotic behaviors for the transformed family of quadratic maps. Theoretical arguments, computer generated orbit and bifurcation diagrams, and Mandelbrot sets will be presented. As an example we apply our results to the logistic map.

9:50–10:05

Managing Infinite-Dimensions by Induced Dynamics

Jessica Lin
New York University

In 2003, Ott and Yorke explored the idea of using induced dynamics to deduce properties of complex dynamical systems on finite-dimensional Euclidean spaces. We extend the work of Ott and Yorke by studying complex dynamical systems in the infinite-dimensional setting, with an emphasis on Hilbert and Banach spaces. In the spirit of Ott and Yorke, we formulate Platonic theorems that allow us to compute invariants of the full system from the induced dynamics. We aim to apply our results to flows on function spaces that are generated by the partial differential equations of fluid mechanics.

MAA Session #4

Belvedere **8:30A.M. – 10:30A.M.**

8:30–8:45

Tic-Tac-Toe and Related Games in Higher Dimensions

Tri Nguyen
Evergreen Valley College

We analyze an n-dimensional Tic-Tac-Toe game, in which the first player making three in a line wins, and a related Toe-Tac-Tic game, in which the first player making three in a line loses. These games lead to certain graph coloring problems regarding the geometry of hypercubes. If all the cells of an n dimensional 3 by 3 by 3 hypercube are assigned either a red or blue color, there always exists a chromatic line of length 3. However, the corresponding assertion for a 3-dimensional k by k by k ... hypercube is false for any k greater than 3.

8:50–9:05

A Game of Wymsical Mathematics

Ashley Weatherwax
University of Texas Dallas

The game of Wym is a combinatorial game created by a UT Dallas professor from the merging of Nim and Wythoffs Game. In short, the game begins with random piles of tokens, and each player removes tokens on their turn. The object of the game is to remove the last token. The complete winning strategy is not yet known, but there are many interesting patterns and theorems that have been thus far discovered.

9:10–9:25

Rediscovering Rithmomachia

Daniel Kearns
Penn State - Capital College

Rithmomachia reigned as the most intellectually stimulating board game for much of the Medieval period. This Philosophers' Game involved intricate numerical relationships nested within a set of rules aimed at accenting the honor, wonder and homage paid to numbers in centuries past. Exemplifying the educational and recreational mindset of the Medievals, Rithmomachia necessitated rigorous mental exertion. This was believed to build both mental and spiritual character. A thorough analysis of Rithmomachia lends keen insight into the history of mathematics, from the Greeks' initial amazement at numerical relationships to their reemergence in the Medieval period.

9:30–9:45

Fun Fibonacci Facts

Amanda Seitz
Sam Houston State University

In the year 1202, Leonardo Fibonacci introduced the numerical pattern known as the Fibonacci sequence through a pattern known as the "rabbit problem." In this talk, we will discuss the history of the Fibonacci sequence, what the rabbit problem entails, the occurrence of the Fibonacci numbers in nature, the relationship between the Golden ratio and the Fibonacci sequence, and the mathematics behind this numerical pattern.

9:50–10:05

Constructible Numbers

Megan Sawyer
University of Colorado Denver

Throughout history, different types of tools have been utilized to define classes of constructible numbers. From the classical restrictions of straightedge and compass to modern integraph machinery, this paper investigates the correlation between the sets of numbers that can be constructed with each set of tools. Special attention is paid to the strengths and limitations of the marked straightedge.

10:10–10:25

Feminist Mathematicians in the Time of Euler

Laura Printz
Hood College

Maria Agnesi and Emilie du Chatelet were famous mathematicians in the time of Euler. We will look at their accomplishments and their opinions of women's education at this time.

Invited Paper Session

Gold Room **1:00P.M. – 4:00P.M.**

Perelman's stunning 2006 proof of the million-dollar Poincar é Conjecture needed to consider not just manifolds but "manifolds with density" (like the density in physics you integrate to compute mass). Yet much of the basic geometry of such spaces remains unexplored. Partitioning problems provide a good place to start.

MAA student speakers are indicated with an asterisk.

1:00–1:15

Manifolds with Density, Partitioning Problems, and the SMALL undergraduate research project

Frank Morgan

Williams College

1:20–1:35

The Story Behind the Proof of the Double Bubble Conjecture

Michael Hutchings

University of California Berkeley

1:40–1:55

Double Bubbles in Spheres and Gauss Space

Neil Hoffman

University of Texas, Austin

2:00–2:15

Optimal Partitions of the Sphere

Anthony Marcuccio*

Williams College

The least-perimeter way to partition the sphere into a large number of equal areas is given asymptotically by regular hexagons. Work of the 2007 SMALL Geometry Group.

2:20–2:35

Isoperimetric Inequalities

Max Engelstein*

Yale University

What is the least-perimeter way to partition the sphere into a small number n of equal areas? For $n = 2$, the answer is an equator. The solution is also known for $n = 3$ and $n = 12$. We discuss progress on the case $n = 4$. Work of Conor Quinn and the 2007 SMALL Geometry Group.

2:40–2:55

The Geometry of Manifolds with Density

Quinn Maurmann*

Brown University

The least-perimeter way to enclose prescribed area on the paraboloid $z = x^2 + y^2$ is a horizontal circle. What if you give the paraboloid a density weighting both area and perimeter? Work of the 2007 SMALL Geometry Group.

3:00–3:15

Perimeter-minimizing Regions in Surfaces with Density

Taryn Pritchard*
Williams College

The least-perimeter enclosure of prescribed area on the cylinder $x^2 + y^2 = 1$ in $\mathbb{R}^3$ is a disc or a band. What if you give the cylinder a density weighting both area and perimeter? Work of the 2007 SMALL Geometry Group.

3:20–3:35

PlanetMath.org and the Hyperreal Dictionary Project

Joseph Corneli
PlanetMath.org

3:40–3:55

Surprise Presentation

PME Session #1

Rm 224, MacQuarrie Hall **2:00P.M. – 6:15P.M.**

2:00–2:15

Plant Pathogen Dynamics

Brendan Kelly

The College of New Jersey, New Jersey Theta

The paper investigates the interaction of broomsedge with the smut fungus Sporisorium ellisii in the hopes of determining if the fungus can provide an adequate means of containing the invasive grass. The investigation will be carried out by constructing and analyzing a mathematical model that describes the host-pathogen interaction.

2:20–2:35

Measuring the Diskivity of a Plane Region

Kyle Diederich

St. Norbert College, Wisconsin Delta

This presentation will define the term diskivity and provide examples of diskivity values for simple shapes. Additionally, the presentation will provide examples about how diskivity changes as the number of sides of a figure is increased.

2:40–2:55

Visualizing Vortices: Vorticity in Navier-Stokes Flow

Mimi Tsuruga

Hunter College - CUNY, New York Beta

My goal is to better understand vortices by means of scientific visualization. Helmholtz Laws for vortex dynamics and its corollaries provide the basis for this investigation. To support the visualization, I am using a vector field arising from the Navier-Stokes equation applied to the flow through an obstructed channel. The vector field was generated via a FEM procedure. By looking at the vorticity field and flow streamlines I am able to infer the existence of vortex lines and hence vortex sheets.

3:00–3:15

The Perfect Shuffle: An Analysis

Kerry McIver

John Carroll University, Ohio Lambda

I will define "perfect shuffle", and compare the minimum number of perfect riffles required to obtain a perfect shuffle in a poker versus a pinochle deck. Also, I will compare shuffles using the two types of perfect riffles to see how the number of riffles changes with decks of various sizes.

3:20–3:35

A Comparison of Image Analysis Methods in cDNA Microarrays

Ashley Swandby

Longwood University, Virginia Epsilon

The method of data extraction through image analysis of cDNA microarrays to determine gene function can potentially lead to discrepancies in the conclusions drawn after analysis. This presentation will compare two methods of image analysis and identify any variation between the two methods through statistical analysis.

3:40–3:55

Effective Condition Number

Tyler Drombosky
Youngstown State University, Ohio Xi

The condition number, $\kappa(A)$, is very useful when determining the accuracy of solutions to linear systems when using numeric solvers. However, recent meshless techniques for approximating partial differential equations have been known to create ill-conditioned matrices, yet are still able to produce results that are close to machine accuracy. We consider the relationship between the effective condition number, $\kappa_{eff}(A, b)$, and the accuracy of approximations for ill-conditioned linear systems that arise when using the Method of Fundamental Solutions.

4:00–4:15

Mathematical Methods for Automated Grain Boundary Detection

Dylan Hower
Duquesne University, Pennsylvania Upsilon

Important properties of crystalline metals can be learned by studying the crystals' boundaries. Current techniques for detecting the boundaries are labor and time intensive. In this presentation, I will discuss mathematical methods for automating the grain boundary detection process including anisotropic diffusion, gradient-based edge detection, and image segmentation using geodesic active contours.

4:20–4:35

Elliptic Curves: Applications in Number Theory and Cryptography

Brittany L. Mosby
Spelman College, Georgia Delta

Elliptic curves combine elements from geometry, number theory, topology, group theory, and complex analysis. An elliptic curve is a type of cubic curve which can be simplified to the form $y^2 = x^3 + ax + b$ when the field in consideration does not have characteristic 2 or 3. But more than just a type of cubic graph, elliptic curves have been utilized in a cornucopia of fields, including computer science and physics. Elliptic curve equations have been used in solving a range of problems, from Fermat's Last Theorem to finding the factors of large integers in relatively quick amounts of time.

This presentation will discuss the three applications of elliptic curves seen most frequently today: primality testing, factoring of integers, and public key

4:40–4:55

Cryptology

Shawn Case
Fitchburg State College, Massachusetts Eta

My talk will demonstrate some of the more complex properties of cryptology. I will refer to various famous systems and try to create a simple system of my own. I will explain what succeeded and what failed for me.

5:00–5:15

The Personal Assignment Problem

Jennifer Crounse

Fitchburg State College, Massachusetts Eta

My talk will focus on the Personal Assignment Problem. This is an application of graph theory which involves n workers, $X_1, X_2, \cdots X_n$ available for n jobs, $Y_1, Y_2, \cdots Y_n$. Each worker is qualified for one or more of these jobs. The problem is to determine if all of the men can be assigned, one man per job, to jobs for which they are qualified? This problem has not been proven in general, so I will be examining finite examples.

5:20–5:35

Variational Methods for Image Decomposition

Joseph Esposito

Duquesne University, Pennsylvania Upsilon

One of the main problems in computer vision is the decomposition of images in such a way that one can extract important information. Recently there has been an a number of variational models for decomposing an image into the sum of components, each with a different geometric structure (e.g. a piecewise smooth function (commonly referred to as a 'cartoon') and an oscillating function containing textures and noise). In this talk we will discuss some recent mathematical techniques for decomposing these images based on the calculus of variations and partial differential equations, and show some results on real world problems.

5:40–5:55

Geometry and Foucault Pendulum

Meghan Moreland

Mount Union College, Ohio Omicron

This study examines the Foucault Pendulum which was created in the 19th century to show that the earth rotates along its latitude circles. Calculus on the sphere, or holonomy, will be used to explain the activity of the Foucault Pendulum.

6:00–6:15

Models of Synchronization: the many faces of the Kuramoto model

Joseph Salisbury

Rhode Island College, Rhode Island Beta

Models of coupled dynamical systems provide insight on many natural self-organizing systems. In particular, the Kuramoto model is a flexible method for studying synchronization of coupled nonlinear oscillators. Here we examine a variety of alterations to the Kuramoto model that have appeared in the literature, making suggestions for further exploration.

PME Session #2

Rm 233, MacQuarrie Hall **2:00P.M. – 6:15P.M.**

2:00–2:15

Two Interesting Binomial Identities

Michelle Jackson
Pepperdine University, California Xi

My talk examines two related binomial identities. I will discuss two approaches to the proofs of these identities. The first proof will use the binomial theorem and some simple complex numbers. The second proof will focus on the foundation of a combinatorial proof for the identities.

2:20–2:35

Binomial and Gaussian Coefficients

Micah Martin
Pepperdine University, California Xi

Binomial coefficients and their q-analog, the Gaussian coefficients, have long played an important role in combinatorics. I will discuss two interesting questions regarding these coefficients. The identities I will discuss have algebraic proofs, but their combinatorial proofs have remained elusive and I will discuss these combinatorial questions.

2:40–2:55

Finding and Maintaining Separable Preferences

Mark Krines
St. Norbert College, Wisconsin Delta

(Joint work with Jennifer Lahr from University of St. Thomas & GVSU REU). In a multiple-question referendum election, a voter's preferences on one set of proposals may depend on the outcome of other proposals in the election. The notion of separability is used to describe preferences that are free from this type of interdependence. In this talk, we will explore some algebraic and combinatorial questions pertaining to separable preferences.

3:00–3:15

A Combinatorial Morse Theory

Mauricio Alexander Rivas
Sam Houston State University, Texas Epsilon

In this discussion we will give an overview of what Morse Theory is and how it can be used in various aspects of the topology of manifolds. We then discuss a combinatorial version of Morse Theory (as outlined by Robin Forman) and examine how it can affect the topology and geometry of cw-complexes.

3:20–3:35

Lattices in Cryptography

Jeffrey Ward
Clarkson University, New York Omicron

Lattices have been used to learn hidden geometric objects. These techniques can be applied to break certain cryptosystems. I will give an overview of these previous techniques and my improvements upon them.

3:40–3:55

The Complexity of the Stars

Matthew Voigt

Saint John's University, Minnesota Delta

Through examining the roles of circuits and non-circuits in the Graver basis of complete bipartite graphs K_1, n and K_2, n cases we are able to computationally verify the conjecture by $K.$ Nairn that the Graver complexity of the $3\tilde{A} - 4\tilde{A} - r$ contingency table is greater than or equal to 27.

4:00–4:15

The Mathematics of the Game of Set

Brittany Lynn Chase

Carthage College, Wisconsin Epsilon

This presentation will introduce the card game Set as an example of a Steiner Triple System and will show some of my summer research in this area.

4:20–4:35

Cutting a Segment into Equal Areas without Cutting through the Curve OR Cutting Pie Fairly

David J. Horn

Elmhurst College, Illinois Iota

How can a sector of a circle be divided with m lines into m 1 equal areas; if m $1 > c > 0$ of the areas contain an arc of the circle? The problem is framed in terms of dividing a piece of pie into m 1 equal areas with c areas containing the crust.

4:40–4:55

Algebraic Combinatorics and Magic n-Circles

Mark Lane

Sam Houston State University, Texas Epsilon

We will show a one-to-one correspondence between the set of all magic n-circles and the set of all magic labelings of the complete bipartite multigraph $M(n, n)$ on $2n$ vertices. We will discuss the methods used in algebraic combinatorics that allow us to compute the minimal Hilbert basis used to construct any magic $n-$circle with magic sum s.

5:00–5:15

Interlocked Linkages: Finding a Key

Amanda Moore

Denison University, OH Iota

An equilateral linkage is a collection of equal-length rigid bars joined end to end with flexible joints. I have studied whether it is possible for both individual linkages and multiple linkages to become interlocked. This problem has potential applications in protein folding and robotics.

5:20–5:35

Modular Origami and the Trefoil Knot

Amy Winslow

Randolph-Macon College, Virginia Iota

Thomas Hull invented the PHiZZ origami module in order to make mathematical structures involving pentagons and hexagons. I will explain how I used these units to make a trefoil knot tessellated by polygons. I will show how to use graph theory to explore the possibility of creating a proper 3 coloring for this structure.

5:40–5:55

Superbraid Index and its Application to Knot Invariants

Rebecca Winarski

Case Western Reserve University, Ohio Sigma

Using the definition of braid index of a knot K as the minimum number of Seifert circles needed to form any projection of a knot, a superbraid index follows as a new invariant. We explore the relationship between these and other invariants.

6:00–6:15

Some Implications of the Total Curvature of Knots

William George

Case Western Reserve University, Ohio Sigma

We will discuss new methods with which we can make use of the idea of total curvature to establish numerical knot invariants.

PME Session #3

Rm 234, MacQuarrie Hall **2:00P.M. – 6:15P.M.**

2:00–2:15

Algebraic Invariants of Binary Forms

Jeffrey Hatley

The College of New Jersey, New Jersey Theta

Algebraic invariants of binary forms are polynomial functions whose values remain unchanged under a group action. For example, the determinant and trace of a matrix are invariants under matrix conjugation. This talk will discuss recent efforts to classify all invariants of binary forms of certain degrees.

2:20–2:35

Spheres on a Cayley Graph

Anne Rollick

John Carroll University, Ohio Lambda

We will define free groups, Cayley graphs of free groups, and distance functions on those graphs. We will show results on the numbers of points on spheres under various representations of F_2, the free group on two generators.

2:40–2:55

Quandle Basics

Jennifer R. Anderson

The University of Texas at Arlington, Texas Iota

A quandle is an algebraic structure satisfying idempodence, left invertability and right self-distribution. Presentation will be an expostitory talk discussing motivation, definition and basic theorems proved during 2006 REU at Kansas State University.

3:00–3:15

Building on Babel: Constructing Elements of High Order From a Tower of Finite Fields

Jared Ruiz

Youngstown State University, Ohio Xi

It is a relatively simple problem to phrase: given a finite field, find an element of high order. Easier said than done. By using an infinite tower of finite field extensions, we can generate a sequence of elements whose degree and order grows with every extension.

3:20–3:35

Calculating the area of a spherical triangle

Jason Percival

University of Massachusetts - Lowell, Massachusetts Delta

Since a triangle on the surface of a sphere is determined up to congruence by its three angles, it is possible to calculate its area. Using only trigonometry yields a system of equations too difficult to solve by elementary methods. However, using results in convexity, it is possible to construct another triangle, known as the dual, that bears an interesting relationship to the original triangle. Taking advantage of this relationship yields a much more elegant solution to the problem of finding its area.

3:40–3:55

Computational Intersection of Polygons - Intuitive Procedures and Practical Problems

Ryan Pavlik
St. Norbert College, Wisconsin Delta

Any reasonably nice closed figure can be approximated by a polygon, so an algorithm to find the area of intersection of two polygons can be used to approximate the area within two closed figures. We will discuss three general steps in one such intuitive algorithm and difficulties in its application.

4:00–4:15

Napoleon Triangles- A Brief Presentation

Jeff Cornfield
Youngstown State University, Ohio Xi

Napoleon Triangles states that given equilateral triangles erected outwardly on the sides of triangle ABC and containing centers X, Y, and Z; the triangle formed from the vertices X, Y, and Z is also an equilateral triangle. A proof of the Napoleon Triangles will be demonstrated, a brief history of the Napoleon Triangles will be discussed, and further research and applications of the Napoleon Triangles will be discussed, with a particular look at Fermat Points.

4:20–4:35

On a Number of Primes less than x

David Ledbetter
Mount Union College, Ohio Omicron

Over two millennia ago Euclid gave a groundbreaking proof that there are infinitely many primes. In that time dozens, if not hundreds, of other proofs have been found to show that the prime number set is infinite. The question that has remained unanswered in all of that time is the question I will focus on in this Presentation: how many primes are there less than the number x?

4:40–4:55

Divisibility Properties of 2007 and related numbers

Marie Nicole Dailey
John Carroll University, Ohio Lambda

We will prove some divisibility rules using modulo arithmetic. Then we will show their application to the number 2007 and related numbers. Obviously, 2007 is divisible by 9. Which related numbers are divisible by 9^2, 9^3, 9^4?

5:00–5:15

Arithmetic Derivatives and Number Theory

Arielle Leitner
California State University, Chico, CA Omicron

A derivative operator on integers satisfies the product rule for composite numbers and assigns 1 to all primes. In 2003, Ufnarovski and Ahlander described how this derivative could be applied to certain number theory problems. After introducing its basic properties, we will expand the technique to a variety of problems.

5:20–5:35

Continued Fractions with Gosper Grids

Michael T. Williams

University of Massachusetts - Lowell, Massachusetts Delta

This talk will demonstrate that it is possible and indeed relatively simple to develop an arithmetic of continued fractions. The method developed by Bill Gosper, known as a Gosper Grid, can be applied to various arithmetic combinations of continued fractions. Further applications of this Grid will also be explored.

5:40–5:55

Continued Fractions and Sums of Squares

Brent Hawker

University of Utah, Utah Alpha

Purely periodic continued fractions of reduced quadratic numbers with a fixed discriminant sit naturally in finitely many cycles. It is shown that the number of ways to write certain discriminants as a sum of two squares is equivalent to the number of cycles with a symmetry for that discriminant.

6:00–6:15

Are the Gaussian Integers Friends?

Matt Ward

Youngstown State University, Ohio Xi

We extend the sum-of-divisors function to the Gaussian integers. Next we can examine which properties of the function still hold in the Gaussian integers and which go wrong. Some of the main questions we ask are about the abundancy index and which Gaussian integers are friendly pairs.

MAA Session #5

Rm 222, MacQuarrie Hall **2:00P.M. – 4:00P.M.**

2:00–2:15

Mathematics in Theatre

Christine Barnes
Augustana College

Playwrights utilize mathematics thematically, symbolically and supportively in their theatrical works. In order to illustrate these uses, I will discuss two plays in particular: Nickel and Dimed by Joan Holden and Proof by David Auburn. In these plays, math is used to confuse and impress the audience, to give statistical support to claims made by the characters, and as an abstract and beautiful science.

2:20–2:35

Equally Related Genealogy Graphs

Christina Gillen
Augustana College

We consider the situation where a number of couples each have two children, a boy and a girl, and where after several generations each of the descendants is equally related to each of the original ancestors. We show that there are constraints on the pattern of marriages within each generation.

2:40–2:55

Instability in a Numeric Algorithm

David Breisch
Augustana College

Sometimes the most obvious algorithm doesn't work. I will present an algorithm for solving a partial differential equation - the heat diffusion equation. I'll demonstrate a Java implementation of the algorithm and show how wildly unstable it is. By examining a test case closely, I'll show how loss of significance leads to the observed instability.

3:00–3:15

Modeling HIV, the Immune System, and Drug Dynamics

Heather Akerson
College of Saint Benedict

Currently, there is still no cure for the HIV virus. However, with the use of multidrug treatments known as HAART (Highly Active Anti-Retroviral Therapy), there is hope for those infected to have a much longer life. I will present models based on nonlinear differential equations and probability to investigate the interactions between these drugs, the virus, and the immune system. Simulations using models like these can lead to a better understanding of the dynamics of the virus, immune system, and drugs and may suggest better strategies for using combinations of drugs in the future.

3:20–3:35

Exact solutions to the nonlinear Schroedinger equation

Jessica Brown
University of Texas Arlington

The nonlinear Schroedinger (NLS) equation is used to model the propagation of electromagnetic waves in optical fibers. We present certain explicit solutions to the NLS equation. Such solutions are written in terms of three matrices whose entries are complex constants, and they can be explicitly expressed in terms of trigonometric, exponential, and polynomial functions. Our results are based on the research performed in the 2007 MAA-NREUP at University of Texas at Arlington.

3:40–3:55

Mathematica exact solutions-nonlinear Schroedinger

Jorge Ibanez

University of Texas Pan American

We use Mathematica to obtain, display, and animate certain exact solutions to the nonlinear Schroedinger equation. Such solutions are written in a compact form using matrix exponentials, but they can be extremely lengthy when written in terms of trigonometric, exponential, and polynomial functions. The Mathematica programs developed during our 2007 MAA-NREUP enable us to easily produce such solutions and to view their animations.

MAA Session #6

Rm 223, MacQuarrie Hall **2:00P.M. – 4:00P.M.**

2:00–2:15

Intrinsic Knotting of Multipartite Graphs

Alexandra Appel*

California State University Chico

We report on recent progress in understanding the intrinsic knotting of multipartite graphs, especially partite graphs. We provide new families of intrinsically knotted graphs.

*Joint work with: Sophy Huck, Miguel-Angel Manrique, Michael Curtis Wilson (*CSU Chico, CSU Chico, USC, UC Santa*)

2:20–2:35

Hamiltonian Cycles in Reversal Graphs

Phillip Compeau and Jim Dickson

Davidson College

Signed permutations have been used to model stacks of objects in which each object has a positive or negative orientation. Accordingly, Cayley graphs generated by prefix reversals on signed permutationsor flips of the stackhave been known thus far as “burnt pancake graphs.” I will introduce reversal graphs, which are Cayley graphs generated by reversals on signed permutations, and provide an inductive proof that both graph varieties are Hamiltonian. This proof naturally leads to a recursive algorithm for the construction of a Hamiltonian cycle, an algorithm which has allowed us to create the first symmetric drawings of these graphs.

2:40–2:55

Irregular Graph Colorings of Paths and Cycles

Christine Lee

University of Colorado Denver

A proper coloring of a graph G is an assignment of colors to the vertices such that adjacent vertices receive different colors. An irregular coloring is a proper coloring in which the multisets of colors adjacent to vertices of the same color are distinct. The irregular chromatic number of a graph G is the minimum number of colors needed for an irregular coloring. In this talk we determine the irregular chromatic number of paths and cycles, which is considerably more difficult than in the standard case.

3:00–3:15

Linked Graphs in All Spatial Embeddings

Kenji Kozai

Harvey Mudd College

A graph that contains disjoint cycles that are linked in every spatial embedding is called intrinsically linked. It is known that all such graphs contain one of seven Petersen-family graphs. We find some examples of graphs that contain disjoint cycles with even linking number (possible they unlink) in all spatial embeddings, including a disconnected graph that is not also intrinsically linked. We characterize some properties of any other such graphs, if they exist, and explore intrinsically linked and knotted graphs in real projective space.

MAA Session #7

Rm 222, MacQuarrie Hall **4:15P.M. – 6:15P.M.**

4:20–4:35

Gravity and Gravitational Potential in Dimension N

Ryan Causey

Mississippi State University

Using several trivial physical assumptions, expressions for gravitational potential and force due to gravity are derived by solving LaPlace's equation. The expressions are developed for any finite number of dimensions greater than one. Specific attention is paid to the two dimensional case, and the results in the plane are compared to the three dimensional case.

4:40–4:55

Genetic Algs to Improve the Finite Element Method

Matt Deyo-Svendsen

Stetson University

Many implementations of mathematical modeling require solutions to systems of differential equations. The finite element method is a robust technique used to approximate these solutions. The grid chosen determines the accuracy of the finite element method. Hence, different grids yield approximations with different precision relative to the true solution. The machine learning technique known as genetic algorithms has been implemented to evolve better finite element approximations to an array of one dimensional boundary-valued problems.

5:00–5:15

Increasing Productivity at Staples, Inc.

Mary Servatius

Worcester Polytechnic Institute

The goal of this project was to optimize variable labor planning and execution in the processes of Breakpack Picking and Quality Control/Finalizing to improve productivity. Through plant tours, comparison analysis, root cause analysis, and simulation we were able to identify inconsistencies in the staffing procedures and tools used as well as make recommendations for increased productivity at three of Staples Inc. fulfillment centers in Montgomery, NY, Stockton, CA, and London, OH.

5:20–5:35

Stabilizing the Vibrations of a Thermoelastic Beam

Emily Hendrickson

Slippery Rock University

The vibrations of a one dimensional thermoelastic beam are modeled by a system of partial differential equations. It has recently been shown that the vibrations of the beam can be uniformly stabilized using the thermal properties of the beam or by applying mechanical damping to its boundary. The purpose of this talk is to provide a mathematical comparison of the effectiveness of the two different forms of damping. This work provides the foundation for future research involving thermoelastic plates and shells with numerous applications in aerospace engineering.

5:40–5:55

The Geometry of the Hausdorff Metric

Katrina Honigs and Vincent Martinez

Grinnell College and The College of New Jersey

The Hausdorff metric provides a measure of distance between compact sets in any complete metric space. The metric is important for its applications in image matching, visual recognition by robots and computer-aided surgery and is also important in Fractal geometry. In this presentation, Katrina Honigs and Vincent Martinez will provide essential background information on this metric and share results from their investigation at the Grand Valley State University REU into the geometry the metric imposes on certain spaces.

MAA Session #8

Rm 223, MacQuarrie Hall **4:15P.M. – 6:15P.M.**

4:20–4:35

An Introduction Into Partition Theory

Sean MacRae

Sonoma State University

Given an integer, how many representations of it as the sum of other integers exist? What at first appears a relatively easy combinatorics problem soon becomes quite difficult. In this exposition I will briefly discuss the very fascinating history surrounding this problem and also some problem solving techniques in determining the number of partitions of an integer.

4:40–4:55

Partition Regularity of Nonlinear Systems

Eleanor Birrell and Ryan Eberhart

Harvard University

A major question of Ramsey Theory asks for which equations there exists a monochromatic solution under any finite coloring of the natural numbers. Richard Rado answered the question for linear systems in his seminal thesis, but much less has been written about nonlinear equations. In this talk we discuss strategies for solving nonlinear systems and relate our discoveries to earlier Ramsey Theoretic results.

5:00–5:15

Jacobi Symbols for Mersenne Numbers

Anarghya Vardhana

Stanford University

If p is an odd integer > 1, and the sequence $s(1), s(2), ...$ is defined by $s(1) = 4$, $s(i+1) = s(i)^2 - 2$, then the number $2^p - 1$ is a prime number if and only if $S(p) - 1$ is congruent to $0\, mod 2^p - 1$. This is known as the Lucas-Lehmer primality test for Mersenne primes. Studying the problem of constructing universal starting values led to a property of Jacobi symbols that could be used to compute the Jacobi symbol of a pair of Mersenne numbers. In this paper, we prove this new theorem of Jacobi symbols for Mersenne numbers and extend the investigation by generating new starting values for the Lucas-Lehmer primality test.

5:20–5:35

On Zeta Functions of Weil and Igusa Type

Hillary Sackett

Smith College and Mount Holyoke College REU

I will address my work done investigating the p-adic integers and analogues of Zeta functions of Weil and Igusa type. The goal of my summer research is to study the variation in the analogue of the Weil Zeta function and compare it with the variation in the rationality of the Igusa Zeta function for the various reduction types of an elliptic curve modulo p. Our hope is to acquire more information on a combination Poincare Series, previously shown by Diane Meuser to be non-rational in general.

5:40–5:55

Number Theory and the classical Markoff equation

Ryan Hake
California State University Chico

In this talk we will introduce the classical Markoff equation, $a^2 + b^2 + c^2 = 3abc$ and the Markoff conjecture. We will discuss techniques for constructing positive integer solutions and, time permitting, solutions in certain quadratic number fields as well as solutions to generalizations of the classical equations.

6:00–6:15

Probabilistic Prime Testing

Shaun Callighan
Augustana College

We discuss the ideas behind Rabins probabilistic prime test. We show an implementation of that test as a Java program, and demonstrate the utility of this program for investigating questions in number theory. We find 10,679,131 of particular interest.

PME Session #4

Belvedere **8:30A.M. – 10:30A.M.**

8:30–8:45

Stable Multiplier Sequences

William Stanton

Kenyon College, Ohio Pi

A stable polynomial is a polynomial whose roots all lie in the open left half plane. Stable polynomials have important applications in control theory and differential equations. We introduce the notion of a stable multiplier sequence, a sequence that preserves polynomial stability under Hadamard multiplication, and discuss our recent results.

8:50–9:05

A Variable Neighborhood Search Algorithm Applied to a Final Exam Scheduling Problem

Amanda Rohde

Rose-Hulman Institute of Technology, Indiana Gamma

Final exam scheduling at Rose-Hulman often results in some students with schedules having two simultaneous finals or three consecutive finals. Finding exact optimal solutions takes considerable time and resources. Hence, a heuristic algorithm, specifically an application of a Variable Neighborhood Search approach, is considered.

9:10–9:25

Addition over Elliptic Curves

Heather Peterson

Concordia University Irvine, California Pi

This presentation examines addition of points on elliptic curves over different fields with a focus on applications to cryptography. There is a brief definition of an elliptic curve and a description of how the addition of points is used for elliptic curve cryptography using a version of the Diffie-Helman cryptography scheme.

9:30–9:45

Reed-Solomon Codes

Erika Peterson

Concordia University Irvine, California Pi

This project examines the mathematical theory behind Reed-Solomon Codes which are widely-used, error-correcting codes. Reed-Solomon Codes have many uses in this modern age of digital communication, the most common applications being found in CD and DVD players.

9:50–10:05

Two-Dimensional Packings of Elliptic Particles

Jeff Swartzel

The University of Akron, Ohio Nu

In this expository paper we explore the behavior of two dimensional arrays of elliptic grains. It has been experimentally demonstrated if the number of contact points on each grain equals exceeds a critical coordination number, then the fluid like distribution becomes stable and behaves like a solid. We seek to show that this state can be achieved in numerical simulations.

10:10–10:25

Competition Modelling in Biological Systems

Tyler Bryson
Linfield College, Oregon Epsilon

Using results from Nonlinear Dynamics, two realistic predator prey models will be analyzed. The results will then be applied to a three species predator-predator-prey model exemplified by the interactions of Neanderthal and Modern Man. Specifically, we will focus on the possibility of sustained populations of competing species.

PME Session #5

Cupertino **8:30A.M. – 10:30A.M.**

8:30–8:45

Ramsey Theory of Finite Groups

Vanessa Abrisqueta
St. Peter's College, New Jersey Epsilon

Given a finite group with non-identity elements x, y, z, not necessarily distinct, how many colors are necessary to avoid a "monochromatic solution" to $xy = z$? This question was answered in the 1970s for groups of 16 elements when researchers were working on Ramsey theory of graphs. Last summer, we were part of an REU that worked on this for other groups. Our results include a complete characterization of which groups require 3 colors.

8:50–9:05

Weird Dice

Kevin Kreighbaum
Mount Union College, Ohio Omicron

Everybody has used an ordinary pair of dice before; just two cubes whose faces are labeled with the numbers 1 through 6. By rolling them both, you have a probability of $1/36$ of rolling a sum of 2, $2/36$ of rolling a 3, all the way up to $6/36$ of rolling a 7, and back down to $1/36$ chance of rolling a 12. Why are these the only dice we are familiar with? Are there other ways of marking 2 cubes(or any polyhedron) to give us the same probabilities? If so, how many of these weird dice are there?

9:10–9:25

Quantitative Analysis of Literary Styles

Laura Homa
Mount Union College, Ohio Omicron

Authors are often thought to have distinctive literary styles. The study of literary analysis is quite interesting, and it also provides an opportunity to use different multivariate statistical techniques. Canonical discriminant analysis and principal component analysis will be used to differentiate between authors and assign authorship.

9:30–9:45

Steganography and Steganalysis

Frank Ballone
Youngstown State University, Ohio Xi

Steganography is the science of hiding information. Furthermore, it is a branch of cryptography that has become popular over the last decade. Even though new forms of digital cryptography have created unbreakable systems to transmit data, digital steganography can be used to send private data through various types of images, videos, music files, and programs. The advantage of using steganography over cryptography is that the message that is going to be transmitted is hidden, which does not draw in the same attention as an unhidden, encrypted message. With the increase of the digital content on the Internet, steganography has become a topic of growing interest in the mathematical and technological communities. More recently, popular programs have been designed to hide data in JPEG images. To find out whether or not certain JPEG images contain hidden data, new techniques and methods of steganalysis have been created. More importantly, various means of statistical analysis of the images in question can be used to detect whether or not hidden data is embedded into the image.

9:50–10:05

Statistical Observations on America's Colleges and Universities

William Ryan Livingston

Youngstown State University, Ohio Xi

The question always arises for students, "What is the best college accessible to me?" This question has many interpretations and great answers. This study attempts to answer this question in respect to the number of undergraduates who go on to receive a PhD in the mathematical sciences. This will be accomplished by looking at those "normal", down-the-street, accessible schools and examining key characteristics they have in common. Other, meaningful observations will be noted as well.

10:10–10:25

Too Tall for Volleyball

Krista Foster

Youngstown State University, Ohio Xi

Volleyball players usually appear to be taller than average. Does height translate to wins, or are other factors more significant? Through statistical analysis of college level volleyball teams, I will determine which factors contribute to a team's overall win percentage. I will study the correlations between various team statistics, including average height and division.

PME Session #6

Piedmont **8:30A.M. – 10:30A.M.**

8:30–8:45

A Textbook Fit for a Princess

Melissa Barrick

Hood College, Maryland Delta

A presentation of the history and mathematics of Leonhard Euler's *Letters to a German Princess*, one of the first widely distributed textbooks for mathematics and physics.

8:50–9:05

Maria Agnesi's *Analytical Institutions*

Chelsea Sprankle

Hood College, Maryland Delta

A description of Maria Gaetana Agnesi's life and an analysis of her textbook, *Analytical Institutions*. John Colson's English translation of Agnesi's text will be compared to her original Italian version.

9:10–9:25

Intervals of Freedom and Wavelet sets

John Fulk

Texas A&M University, Texas Eta

I will be presenting my results from the summer REU in Matrix Analysis and Wavelets at Texas A&M University regarding wavelet sets and intervals of freedom that can be used to construct wavelet sets in R.

9:30–9:45

Some applications of Markov Transition Matrices

Moriah Wright

Youngstown State University, Ohio Xi

Markov chains are used to represent evolving processes between a number of possible states of the processes. Matrices that describe the the states are called transition matrices. Various applications of these matrices will be considered.

9:50–10:05

Brouwer's Fixed Point Theorem in $\mathbb{R}^n$: A Combinatorial Proof

Jason La Corte

Texas State University, San Marcos, Texas Rho

The statement of Brouwer's theorem is that a continuous function of an n-dimensional closed ball into itself must have a fixed point. This theorem may be proven in several different ways. We present a short, illustrated proof using the Sperner's lemma and the Knaster-Kuratowski-Mazurkiewicz lemma. As time permits, we will introduce two important tools of algebraic topology, homotopies and homology, and outline a proof based on these ideas.

10:10–10:25

Laura Bassi.....Who?

Lindsey Nagy
Hood College, Maryland Delta

An exploration into physicist Laura Bassi's connection with mathematics during the Scientific Enlightenment, along with a look at the significance of her career at the University of Bologna and what it meant for women of the 18th Century.

MAA Session #9

Fairfield **8:30A.M. – 10:30A.M.**

8:30–8:45

Alterations of Least-Squares for Linear Regression

Robert Simione
New York University

Linear Regression encapsulates procedures that attempt to find a "best-fit" linear equation to describe relations between variables of any given set of experimental observations. The most popular method of doing this is Least-Squares, and this paper will present alterations to this method using principal component analysis in response to shortcomings in the least-squares method. In keeping with the mathematical biology theme of MathFest 2007, our motivating application of illness diagnosis using this procedure will be presented

8:50–9:05

On Lattice Path Enumeration and Epidemiology

Marc Kelechava
Boston University

We explore an application of lattice path enumeration to a problem in epidemiology. The problem asks, "What is the probability that a member of a population will contract a disease due to a hazardous waste site"? We show the equivalence between this problem and the number of under-diagonal lattice paths with unit steps in the eastern and northern directions from $(0, 0)$ to (m, n), for integral m, n. Then, closed-form expressions of the probabilities are stated and proved based on whether $m = n$, $m = nk$, $\gcd(m, n) = 1$, or $0 < \gcd(m, n) < \min(m, n)$.

9:10–9:25

Impulsive Two-Prey, One-Predator Model Dynamics

Joy Holowicki
Benedictine University

We discuss variations of two-prey, one-predator models with impulsive behavior. We discuss the dynamics of these models and describe when these models are permanent.

9:30–9:45

Parameterizing Caterpillars

James Boston
Kenyon College

How do you turn a real live caterpillar into a model surface you can view on a computer screen? That was the problem I tackled this summer, as I spent time working with both Biology and Mathematics trying to model and measure the surface of a type of caterpillar, the Manduca sexta. I worked in both the theoretical and concrete worlds as I researched how to turn a physical caterpillar into a parameterized model organism. In my talk, I will present some interesting aspects of my research project.

9:50–10:05

Statistical Analysis of Glowing Leaf Patches

Renee Tatge
Bethany Lutheran College

How can unconnected things work together without an external guide or any apparent communication? Recent studies suggest plants know how. Videos of stomata (distinct pores in leaves that open and close to absorb CO2 while regulating water loss) show "glowing patches" groups of stomata that cooperate to assume ideally-sized openings. The video data was converted into binary matrices. Zeros and ones represented open and closed stomata. We counted the size of the patches in the matrices representing closed stomata, organized the data into a histogram, and used the chi-square test to try to fit a well-known distribution to the histogram

10:10–10:25

Vocal Identification of Free-flying Bats

Joshua Kelly and Jason Miller
Truman State University

Measurements from echolocation recordings of seven species of bats were used to construct algorithms for identifying bats to species. Resulting classification rates compared well to those in the scientific literature. Not found in the literature are reports on the reliability of similar models and their susceptibility to biotic and aboitc variations in data. We show that classification trees are somewhat sensitive to such variation and that discriminant analysis models are more robust. We discuss the appropriateness of these models for determining species richness as well as the implications of using such models for conservation efforts of endangered species.

MAA Session #10

Glen Ellen **8:30A.M. – 10:30A.M.**

8:30–8:45

Geometry of Rose Windows

Charise Kazmierczak

Ohio Northern University

Rose windows, a main aspect in Gothic Architecture, originate from the Roman oculus and through architectural advances have become beautiful works of art. These windows are used in many churches to tell stories and represent ideas of faith. Rose windows are geometric wonders and although the individual components may not be difficult, when placed in intricate repetitious patterns, their beauty is transformed into a majestic wonder. Through Geometers Sketchpad software, the re-creation of these windows becomes possible and imagination allows for limitless personal creations.

8:50–9:05

Constructability of Angles on Lattices

Brian Chen

California State Polytechnic University Pomona

Can you construct a 30 degree angle on a square lattice? Can you construct a 45 degree angle on an equilateral triangular lattice? Hmm ... Can you make a smiley face lattice equivalent to a square lattice as far as angle constructability?

9:10–9:25

The Mother Worm Problem

Hieu Hoang

San Jose State University

The Mother Worm wishes to design a blanket that can cover her baby no matter what posture her baby sleeps in. Since they are poor, she wants to make the blanket as small as possible. Geometrically, we are searching for a two-dimensional region with the least area, that can cover any curve of a fixed length. We show how a partial solution made by a famed mathematician contains a mistake and we try to find ways to correct the mistake. Furthermore, additional research directions, possible applications, and open questions will be discussed.

9:30–9:45

Dynamics of the Dual Billiard Map

Hanna Komlos

Rutgers University

This work was done at the Grand Valley State University 2007 REU by Daniel Gorski and Hanna Komlos under the supervision of Professor Filiz Dogru. We studied the dual billiard map in the Euclidean and hyperbolic planes. In particular, we concentrated on regular polygonal tables which tile these planes. In the hyperbolic plane, we used the Klein model to explore the extension of the dual billiard map at infinity as a circle map.

9:50–10:05

Physical Double Bubbles in the Three-Torus

Daniel Kravatz
Millersville University

In 2002 Cornelli et. al conjectured and provided computational evidence that there exist ten types of double bubbles providing the least-area way to enclose and separate two regions of prescribed volume in the cubic three-torus. We produce physical soap bubble models of all ten types in a plexiglass box.

10:10–10:25

Equal Circle Packings on a Torus

Daniel Guillot and Anna Castelaz
Louisiana State University & University of North Carolina, Asheville

The study of maximally dense packings of n disjoint equal circles into various containers has developed over the past forty years. The optimal densities and arrangements are known for many packings of small numbers of equal circles into hard boundary containers, including squares, equilateral triangles and circles. In this presentation, we will explore packings of small numbers of equal circles into a boundaryless container, in particular a torus. We will provide several locally and globally maximally dense arrangements and describe proofs of their optimality.This work was done at Grand Valley State University REU

PME Session #7

Belvedere **2:00P.M. – 5:00P.M.**

2:00–2:15

What do monosaccharides, lipids, and amino acids have to do with mathematics?

Jordan Yoder
Goucher College, Maryland Theta

In order to understand gastrointestinal diseases such as Gastric Reflux, knowledge of the mechanisms that drive gastric motility, absorption, and transit is important. My research involves studying the biological background of the system to create a compartmental model of the digestive system using differential equations.

2:20–2:35

A Enzyme Kinetic Model of Tumor Dormancy

Andrew Matteson
Texas A&M University, Texas Eta

Tumor dormancy is modeled using rates of diffusion and decay of growth promoters/inhibitors to explain local metastatic suppression. Simulated surgical removal of a primary tumor reduces the effective suppression. The maximum distance of suppression is calculated as a function of the model's parameter space, using sensitivity analysis to diffusion coefficients.

2:40–2:55

Stochastic Model of the Progression of an Atherosclerotic Lesion

Jason Pfister
Texas A&M University, Texas Eta

Cardiovascular disease is a complex, multi-faceted process by which an arterial lesion is propogated by particle reactions, diffusion, and chemoattraction. Each event can be represented by a stochastic equation, with the concentrations of each of the reactive species represented by probability-based random variables. The lesion growth is a stochastic process which is studied by numerical simulation.

3:00–3:15

Finite Frames and Applications

Kristin Creech
University of Texas at Arlington, Texas Iota

I will be presenting some results regarding finite frames and their relationship with matrix analysis and operator theory as well as some of their applications. These results are based on the Research Experience for Undergraduates on Matrix Analysis and Wavelet Theory at Texas A&M University.

3:20–3:35

Modeling of master and slave oscillators of birds during migratory season

Lisa Cangelose and Cara Montgomery
Texas A&M University, Texas Eta

When migratory birds are kept in cages free from external stimuli and environmental cues, they still exhibit nocturnal activity during migratory season, known as Zugenruhe. This behavior is modeled through three coupled nonlinear osciallators, one master and two slave oscillators. The master oscillator switched between the two slave oscillators depending on the season. An attempt is made to validate the model with data gathered from the avian lab of Dr. V. Cassone.

3:40–3:55

Population Genetics and the ABO Blood Type

Sara Jensen

Carthage College, Wisconsin Epsilon

Population genetics, the most mathematical of the traditional disciplines of biology, looks at genetic variation in populations. This particular research uses stochastic processes to look at the variation of the ABO blood type in different societies. We will discuss such issues as ABO incompatibility, the affects of disease, and other societal concerns.

4:00–4:15

The tangled and knotted tale of two graphs

Rachel Grotheer

Denison University, Ohio Iota

In 2006, Ludwig and Arbisi asked if a straight-edge embedding ofK_n (the complete graph on n vertices), $n \geq 7$, with $k \geq 4$ external vertices and $m = n - k$ internal vertices, is always isomorphic to an embedding of K_n with n external vertices? We give a negative answer to this question. We also extend the work of Conway and Gordon (1983) by considering the frequency of knots in straight-edge embeddings of K_7. This talk is intended for a general audience.

4:20–4:35

Analysis of the Chartres Labyrinth with Implications for New Labyrinth Design

Ellen Galo

St. Lawrence University, New York Epsilon

Comparison of the Chartres Labyrinth analyses by Rosenstiehl, Hebert, Smith, and Frei lead to guidelines for creating new labyrinths containing a high degree of symmetry, and also allow for great flexibility in the number of levels and semi-axes. A brief overview of labyrinth history will put this discussion in context.

PME Session #8

Cupertino **2:00P.M. – 5:00P.M.**

2:00–2:15

No slip wheel rolling on function curves

Bruce R. Salter

Aquinas College, Missouri Lambda

We will look at the curve generated by a fixed point on a wheel as it rolls on a function curve. We will look at the general equation that suits all functions and all wheel sizes as well as the correlation between rotation speed and curvature.

2:20–2:35

The Mathematics of Free Throw Shooting

Carrie Davis

Youngstown State University, Ohio Xi

We will create a mathematical model for shooting free throws using calculus, optimization, numerical methods and differential equations. With this model, we will determine the ideal angle and velocity that must be used to guarantee a made shot.

2:40–2:55

Genetic Algorithms and the Traveling Salesman Problem

David Martin

Youngstown State University, Ohio Xi

Genetic algorithms are universally applicable optimization techniques drawing inspiration from Darwin's theory of evolution. Experimenting with varying population size and probability of mutation, as well as different methods of fitness evaluation, the speaker will test the robustness of these methods in solving the age-old traveling salesman problem.

3:00–3:15

Differential Equations of freefall and skydiving

Doug Wajda

Youngstown State University, Ohio Xi

A look into the differential equations that govern the motion of person in freefall and also with a parachute deployed, ultimately leading up to an answer to how long a person could wait to pull their parachute and still land safely on the ground.

3:20–3:35

Dawn of the Logistic Function

John Hoffman

Youngstown State University, Ohio Xi

The threat of a zombie attack looms in the future. Although the threat is not imminent, it is better to be prepared in the event that an outbreak occurs. In this presentation, I use a logistic function to analyze the spread of the infection and determine an approximate time to get to safety.

3:40–3:55

A Complex History

Stefanie Meyer
Sam Houston State University, Texas Epsilon

We will explore the evolution of the number i. The discovery of the square root of negative one had repercussions on many aspects of mathematics. We will discuss some interesting facts and applications of this fascinating number.

4:00–4:15

When does a complex function equal it's own derivative?

Lea Cluff
Youngstown State University, Ohio Xi

In this talk, we present some unique properties of the complex exponential function.

4:20–4:35

Representations of Complex Numbers

Tara Cruickshank
Youngstown State University, Ohio Xi

In this talk, we consider alternative methods of representing complex numbers. We will look at representations in linear algebra and abstract algebra.

4:40–4:55

The Effect of Branch Cuts on Integral Representations

Kensey Foushee
Meredith College, North Carolina Mu

Computer algebra systems perform integration using complex numbers, and branch cuts are necessary to carry out integration for certain classes of real valued functions. However, different branch cuts can lead to apparently different forms for even standard integrals. The purpose of this talk is to explore this relationship in depth.

MAA Session #11

Fairfield **2:00P.M. – 5:00P.M.**

2:00–2:15

Statistical analyses of long range weather trends

Rachel Bayless and Katelyn Chabot
Wheaton College

As part of a project-based course at Wheaton College (Norton, MA), a team of four students worked on a forecasting project from the National Weather Service. The goal was to better understand and to develop a model for long range weather trends in New England based on four oceanic and atmospheric indices. In this talk, we introduce the problem, discuss the accompanying data and present graphical and regression analyses used to address the questions of interest.

2:20–2:35

An ARIMA model for Weather trends in New England

Alexander Shvonski and Victoria Bennett
Wheaton College

As part of a project-based course at Wheaton College (Norton, MA), a team of four students worked on a forecasting project from the National Weather Service. The goal was to better understand and to develop a model for long range weather trends in New England based on four oceanic and atmospheric indices. In this talk, we will discuss the time series analysis and autoregressive model we developed to explore the relationships between these indices and the New England weather trends over a 30 year period.

2:40–2:55

Coliform levels in Peconic Bay estuaries

Trisha Carr and Coriann Lanni
Wheaton College

A team of four students from Wheaton College (Norton, MA) worked on a project for a division of Battelle Memorial Institute in Duxbury, Massachusetts, carrying out statistical analyses for the water quality related to the shellfish harvesting in Peconic Bay estuaries of New York state. Our team computed confidence intervals for the 90th percentile and the geometric mean of the most recent 30 water quality samples. These statistics are used to determine whether the estuary should be open to shellfish harvesting. In this talk, we explain insights provided by these confidence intervals in the water quality analysis.

3:00–3:15

Confidence Intervals For Coliform In NY Estuaries

Nicholas apRoberts-Warren and Dale Bowring
Wheaton College

A team of four students from Wheaton College (Norton, MA) worked on a project for a division of Battelle Memorial Institute in Duxbury, Massachusetts, to analyze data the quality of shellfish harvest waters in Peconic Bay estuaries of New York state. Primary indicators for determining water quality are the 90th percentile and the geometric mean of fecal coliform. When either of these statistics exceed a preset threshold, the area is closed to shellfishing. In this talk, we explain how our team computed confidence intervals for these statistics, yielding a greater sense of the variability inherent in these quantities.

3:20–3:35

Exact solutions to the Korteweg-de Vries equation

Danielle Williams and Antonio Lopez
University of Texas Arlington

We present certain exact solutions to the Korteweg-de Vries (KdV) equation, a nonlinear partial differential equation used in modeling of surface water waves in canals and various other waves in nonlinear media. Our solutions are explicitly expressed in terms of trigonometric, exponential, and polynomial functions of the spatial and temporal variables. The research presented is based on the 2007 NREUP at the University of Texas at Arlington sponsored by the MAA.

3:40–3:55

Korteweg-de Vries equation: solutions and animations

Antonio Lopez
University of Texas Arlington

Certain exact solutions to the Korteweg-de Vries equation are constructed explicitly in terms of matrix exponentials. We present some Mathematica programs to produce, display, and animate such solutions. The research presented is based on the 2007 MAA NREUP at University of Texas at Arlington.

4:00–4:15

Using Gradient to Construct a Solar Electric Array

Chad Griffith
Sonoma State University

In the process of designing a solar electric array, the gradient vector was very useful in calculating the slope of the land and as an aid in completing the design process. This paper shows the details of these calculations.

4:20–4:35

Modeling of Fuel Consumption

Gregory Shinault
California State University Bakersfield

Conventional approaches to the problem of finding an energy flight (a flight path minimizing the fuel consumption of an aircraft) raise huge mathematical and numerical challenges which involve a complex system of differential equations. A new approach to the problem is attempted. The theory of calculus of variations was tested in solving the problem of modeling the flight path of an aircraft that minimizes fuel consumption. The approach yields a boundary value problem (BVP) for a system of ordinary differential equations (ODE) called the Euler-Lagrange equations. The numerical result matches physical intuition and general characteristics of commercial air flight.

MAA Session #12

Glen Ellen **2:00P.M. – 5:00P.M.**

2:00–2:15

On Torus Knots and Their Properties

Tirasan Khandhawit
Duke University

Torus knots are in a special class of knots obtained by embedding an unknot on a torus without crossings. It is one of a few infinite classes of knots which are well understood. We will discuss classic invariants of torus knots and possible methods to find new invariants of them

2:20–2:35

Regular Conformation Bounds of $(2n, 2)$-Torus Links

Hunan Chaudhry
Benedictine University

An α-regular conformation of a knot (or link) K is a polygonal embedding of K in space such that all edges have the same length and all angles between adjacent edges are equal to α. The α-regular stick number of K is the minimum number of sticks required to construct an α-regular conformation of K. We construct α-regular conformations of $(2n, 2)$-torus links, where $\alpha = \cos^{-1}(-1/3)$. These conformations provide good upper bounds for α-regular stick numbers and, in some cases, realize α-regular stick numbers.

2:40–2:55

Alpha Regular Stick Knots

Mary Wootters
Swarthmore College

Stick knots, knotted embeddings of polygons in $\mathbb{R}^3$, have recently been useful in chemistry as models for certain macro-molecules. We examine the stick number, and in particular the α-regular stick number, and we answer some questions about these knot invariants.

3:00–3:15

Applications of Supercrossing Numbers of Knots

Rachel Allen
Williams College

Here we will generalize the knot invariant of crossing index to its “super” analogue: supercrossing index. We will discuss bounds on the supercrossing index and we will use the crossing map to better understand its properties.

3:20–3:35

Generalisations of the Bridge Number of Knots

Nikhil Agarwal
Brandeis University

Determining the stick number of knots has been remarkably hard and is known for surprisingly few knots. The super bridge number of knots, a hard to calculate generalization of the traditional bridge number, has proved useful in calculating bounds on the stick number of knots. We will define and explore the planar-super bridge number, an invariant that proves to be relatively easy to calculate. The invariant is useful in calculating new bounds on stick numbers of knots.

3:40–3:55

Symmetries of Knots

Jonathan Schneider
University of Illinois Chicago

An object in 3-dimensional space may is characterized by a set of symmetries that form a group, called a point group. For example, a regular octahedron has the same symmetry group as a cube, with order 48. Knot embeddings are 3-dimensional objects and therefore are characterized by point groups. An abstract knot can be embedded in space in different ways that may have different symmetries; the symmetries attainable by a nontrivial knot form a finite list. For example, a trefoil knot can have dihedral D_3 symmetry, dihedral D_2 symmetry, or any subgroup of D_3 or D_2.

4:00–4:15

Rational Tangles and Continued Fractions

Chris Tou
Augustana College

We will talk about various definitions important to knot theory and introduce examples of knot invariants. We will mention a few notations for identifying knots, but will focus on Conway's notation for rational tangles. We will explain tangles and the very interesting relationship between them and their associated continued fractions. Finally, we will look at a computer program that draws any given rational tangle.

J. Sutherland Frame Lectures

2007	Donald E. Knuth	*Negafibonacci Numbers and the Hyperbolic Plane*
2006	Donald Saari	*Ellipses and Circles? To Understand Voting Problems??!*
2005	Arthur T. Benjamin	*Proofs that Really Count: The Art of Combinatorial Proof*
2004	Joan P. Hutchinson	*When Five Colors Suffice*
2003	Robert L. Devaney	*Chaos Games and Fractal Images*
2002	Frank Morgan	*Soap Bubbles: Open Problems*
2001	Thomas F. Banchoff	*Twice as Old, Again, and Other Found Problems*
2000	John H. Ewing	*The Mathematics of Computers*
1999	V. Frederick Rickey	*The Creation of the Calculus: Who, What, When, Where, Why*
1998	Joseph A. Gallian	*Breaking Drivers' License Codes*
1997	Philip D. Straffin, Jr.	*Excursions in the Geometry of Voting*
1996	J. Kevin Colligan	*Webs, Sieves and Money*
1995	Marjorie Senechal	*Tilings as Differential Gratings*
1994	Colin Adams	*Cheating Your Way to the Knot Merit Badge*
1993	George Andrews	*Ramanujan for Students*
1992	Underwood Dudley	*Angle Trisectors*
1991	Henry Pollack	*Some Mathematics of Baseball*
1990	Ronald L. Graham	*Combinatorics and Computers*
1989	Jean Cronin Scanlon	*Entrainment of Frequency*
1988	Doris Schattschneider	*You Too Can Tile the Conway Way*
1987	Clayton W. Dodge	*Reflections of a Problems Editor*
1986	Paul Halmos	*Problems I Cannot Solve*
1985	Ernst Snapper	*The Philosophy of Mathematics*
1984	John L. Kelley	*The Concept of Plane Area*
1983	Henry Alder	*How to Discover and Prove Theorems*
1982	Israel Halperin	*The Changing Face of Mathematics*
1981	E. P. Miles, Jr.	*The Beauties of Mathematics*
1980	Richard P. Askey	*Ramanujan and Some Extensions of the Gamma and Beta Functions*
1979	H. Jerome Keisler	*Infinitesimals: Where They Come From and What They Can Do*
1978	Herbert E. Robbins	*The Statistics of Incidents and Accidents*
1977	Ivan Niven	*Techniques of Solving Extremal Problems*
1976	H. S. M. Coxeter	*The Pappus Configuration and Its Groups*
1975	J. Sutherland Frame	*Matrix Functions: A Powerful Tool*

Pi Mu Epsilon would like to express its appreciation to the American Mathematical Society and to the Committee for Undergraduate Research, the Society for Industrial and Applied Mathematics, the SIGMAA-Environmental Mathematics and BioSIGMAA for the sponsorship of the Awards for Outstanding Presentations. It would additionally like to thank the National Security Agency for its continued support of the student program by providing subsistent grants to Pi Mu Epsilon speakers.

MAA Student Lectures

2007	Francis Edward Su	*Splitting the Rent: Fairness Problems, Fixed Points, and Fragmented Polytopes*
2006	Richard Tapia	*Math at Top Speed: Exploring and Breaking Myths in Drag Racing Folklore*
2005	Annalisa Crannell & Marc Frantz	*Lights, Camera, Freeze!*
2004	Mario Martelli	*The Secret of Brunelleschi's Cupola*
2004	Mark Meerschaert	*Fractional Calculus with Applications*
2003	Arthur T. Benjamin	*The Art of Mental Calculation*
2003	Donna L. Beers	*What Drives Mathematics and Where is Mathematics Driving Innovation?*
2002	Colin Adams	*"Blown Away: What Knot to do When Sailing" by Sir Randolph "Skipper" Bacon III*
2002	M. Elisabeth Pate-Cornell	*Finding and Fixing Systems' Weaknesses: The Art and Science of Engineering Risk Analysis*
2001	Rhonda Hatcher	*Ranking College Football Teams*
2001	Ralph Keeney	*Building and Using Mathematical Models to Guide Decision Making*
2000	Michael O'Fallon	*Attributable Risk Estimation: A Tale of Mathematical/Statistical Modeling*
2000	Thomas Banchoff	*Interactive Geometry on the Internet*
1999	Edward G. Dunne	*Pianos and Continued Fractions*
1999	Dan Kalman	*A Square Pie for the Simpsons and Other Mathematical Diversions*
1998	Ross Honsberger	*Some Mathematical Morsels*
1998	Roger Howe	*Some New and Old Results in Euclidean Geometry*
1997	Aparna Higgins	*Demonic Graphs and Undergraduate Research*
1997	Edward Schaefer	*When is an Integer the Product of Two and Three Consecutive Integers?*
1996	Kenneth Ross	*The Mathematics of Card Shuffling*
1996	Richard Tapia	*Mathematics Education and National Concerns*
1995	David Bressoud	*Cauchy, Abel, Dirichlet and the Birth of Real Analysis*
1995	William Dunham	*Newton's (Original) Method - or - Though This Be Method, Yet There is Madness*
1994	Gail Nelson	*What is Really in the Cantor Set?*
1994	Brent Morris	*Magic Tricks, Card Shuffling and Dynamic Computer Memories*
1993	Richard Guy	*The Unity of Combinatorics*
1993	Joseph Gallian	*Touring a Torus*
1992	Peter Hilton	*Another Look at Fibonacci and Lucas Numbers*
1992	Caroline Mahoney	*Contemporary Problems in Graph Theory*
1991	Lester Lange	*Desirable Scientific Habits of Mind Learned from George Polya*