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.

Pi Mu Epsilon

Pi Mu Epsilon is a national mathematics honor society with 371 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. Pi Mu Epsilon encourages scholarly activity in its chapters with grants to support mathematics contests and regional meetings established by the chapters and through its Lectureship program that funds Councillors to visit 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

Unless otherwise noted, all events are held at the Connecticut Convention Center.

Please note that there are no MAA Sessions #11-14, or 23-26 and there are no PME Sessions #7-10.

Wednesday, July 31

Time:	**Event:**	**Location:**
2:00 pm - 4:00 pm	CUSAC Meeting	Marriott, Conference Room 7
4:30 pm - 5:30 pm	MAA/PME Student Reception	Ballroom A
5:30 pm - 6:15 pm	Math Jeopardy	Ballroom A

Thursday, August 1

Time:	**Event:**	**Location:**
8:30 am - 11:30 am	PME Council Meeting	Room 17
8:30 am - 10:25 am	MAA Session #1	Theater 115: Room 11
8:30 am - 10:25 am	MAA Session #2	Theater 115: Room 12
8:30 am - 10:25 am	MAA Session #3	Theater 115: Room 13
8:30 am - 10:25 am	MAA Session #4	Theater 115: Room 21
8:30 am - 10:25 am	MAA Session #5	Theater 115: Room 22
8:30 am - 10:25 am	MAA Session #6	Theater 115: Room 23
9:00 am - 5:00 pm	Student Hospitality Center	Ballroom C (Exhibit Hall)
1:00 pm - 1:50 pm	MAA Lecture for Students	Ballroom B
2:00 pm - 3:55 pm	MAA Session #7	Theater 115: Room 11
2:00 pm - 3:55 pm	MAA Session #8	Theater 115: Room 12
2:00 pm - 3:55 pm	MAA Session #9	Theater 115: Room 13
2:00 pm - 3:55 pm	MAA Session #10	Theater 115: Room 21
2:00 pm - 3:55 pm	PME Session #1	Theater 115: Room 22
2:00 pm - 3:55 pm	PME Session #2	Theater 115: Room 23
2:30 pm - 4:00 pm	Opportunities in the Actuarial Profession	Marriott, Ballroom E
4:00 pm - 6:15 pm	PME Session #3	Theater 115: Room 22
4:00 pm - 6:15 pm	PME Session #4	Theater 115: Room 23

Friday, August 2

Time:	Event:	Location:
7:30 am - 8:30 am	PME Advisor Breakfast Meeting	Room 25
8:30 am - 11:45 am	MAA Session #15	Theater 115: Room 11
8:30 am - 11:45 am	MAA Session #16	Theater 115: Room 12
8:30 am - 11:45 am	MAA Session #17	Theater 115: Room 13
8:30 am - 11:45 am	MAA Session #18	Theater 115: Room 21
9:00 am - 5:00 pm	Student Hospitality Center	Ballroom C (Exhibit Hall)
10:00 am - 11:55 am	PME Session #5	Theater 115: Room 22
10:00 am - 11:55 am	PME Session #6	Theater 115: Room 23
1:00 pm - 1:50 pm	MAA Student Activity: Mathematician & Environmental Scientist	Marriott, Ballroom C
1:00 pm - 1:50 pm	MAA Student Activities Session: Exhilaration & Consternation	Marriott, Ballroom E
2:00 pm - 3:55 pm	MAA Session #19	Theater 115: Room 11
2:00 pm - 3:55 pm	MAA Session #20	Theater 115: Room 12
2:00 pm - 3:55 pm	MAA Session #21	Theater 115: Room 13
2:00 pm - 3:55 pm	MAA Session #22	Theater 115: Room 21
2:35 pm - 3:55 pm	Non-Academic Career Paths Panel	Marriott, Ballroom D
6:00 pm - 7:45 pm	PME Banquet and Awards Ceremony	Marriott, Ballroom C
8:00 pm - 8:50 pm	J. Sutherland Frame Lecture	Ballroom B
9:00 pm - 10:00 pm	MAA Ice Cream Social and Awards	Pre-Function

Saturday, August 3

Time:	Event:	Location:
9:00 am - 1:30 pm	Student Hospitality Center	Ballroom C (Exhibit Hall)
9:00 am - 10:30 am	MAA Modeling (MCM) Winners	Room 17
1:00 pm - 2:15 pm	Student Problem Solving Competition	Room 17
2:00 pm - 3:15 pm	Speed Interviewing Marathon for Students	Marriott, Ballroom E

J. Sutherland Frame Lecture

MATRICES I ADMIRE

Gilbert Strang
Massachusetts Institute of Technology

I will start with my absolute favorite among all matrices. It has 2's down the main diagonal and -1's on the diagonals just above and just below. It is a Toeplitz matrix (constant diagonals), a second difference matrix (because of -1, 2, -1), and a highpass filter. The matrix is tridiagonal and positive definite and you see it all over pure mathematics too. Its determinant is $n + 1$, and most important are its eigenvectors which are pure sines.

Recently I came back to this well-loved matrix, realizing that I didn't know its symmetric square root, its exponential or its cosine. Those are all badly needed for the heat equation and wave equation. They are not tridiagonal but still amazing. I will speak about another matrix too (the graph Laplacian) as well as the combination of differential equations and linear algebra.

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 Lecture for Students

OPTIMAL PENTAGONAL TILINGS

Frank Morgan
Williams College

Hales proved that the least-perimeter way to tile the plane with unit areas is by regular hexagons. What is the least-perimeter way to tile the plane with unit-area pentagons? We will discuss some new results, examples, and open questions, including work by undergraduates.

MAA Undergraduate Student Activities Sessions

A Mathematician and an Environmental Scientist Walk into a Bar

Thomas J. Pfaff and Jason Hamilton
Department of Mathematics and Department of Environmental Sciences and Studies
Ithaca College

Ballroom C

Come and engage in the conversation that ensues and see how interacting with scientists is good for both the mathematician and the scientist. The conversation will provide some useful intellectual tools related to the role of mathematics in society. In the end you will be armed with at least one answer to the questions of who cares about math and where does it get used.

Exhilaration and Consternation: Adventures in Conducting Undergraduate Research

Robin Blankenship
Morehead State University

Ballroom E

One day you are sitting in your office, chipping away at your responsibilities: preparing for class, grading papers, producing paperwork for committees, creating workshops for teachers, or whatever it is that you are doing to find and maintain your niche. There comes a knock at your door, and for the first time in your life you hear the words, “Are you willing to be my research advisor?” Ah, the excitement, and...the fear. I will relate my personal story of entering this endeavor: the trials and tribulations, the excitement and revelations, as I carry you through the results my students have produced over the past few years and provide you with materials to explore topics in graph theory and knot theory as the story progresses!

MAA Student Speakers

Name	School	MAA Session
Christopher Abriola	Marist College	20
Alec Arana	Yale University	4
Jordan Awan	Clarion University	19
Rob R. A. Baello	Montclair State University	19
Lisa Bendall	Brigham Young University	8
Andrew Best	Williams College	15
Beth Bjorkman	Grand Valley State University	4
Su Lin Blodgett	Wellesley College	6
Zeyad Boodoo	Montclair State University	19
Michael Boyle	University of Houston	7
Francisc Bozgan	UCLA	7
Madeline Brandt	Reed College	1
Matthew Brown	Brigham Young University	8
William P. Burke	Montclair State University	19
Shelby Burnett	Cal Poly San Luis Obispo	9
Orsola Capovilla-Searle	Bryn Mawr College	5
David Cervantes Nava	SUNY Potsdam	9
Xinwei Chen	Benedictine University	18
Alex Chin	North Carolina State University	9
Natanya Clark	Arkansas State University	20
Andrew Clemens	Goshen College	4
Jonathan D. Cohen	Duquesne University	21
Daniel Condon	Georgia Institute of Technology	9
Austin Conner	Vanderbilt University	22
Gregory Convertito	Trinity College	10
Nathan Cordner	Brigham Young University	8
Craig Corsi	Williams College	6
Christopher Cox	Iowa State University	3
Aglika Darakchieva	Fairfield University	20
Robert Dolan	Western Connecticut State University	17
Hannah Louise Dorman	Valparaiso University	16
Shawn Doyle	Youngstown State University	17
Peter Draznik	Augustana College	9
Andrea Ekey	Howard University	15
Rebecca Etnyre	Cal State Fullerton	16
Travis Fillmore	Brigham Young University	20
Claire Frechette	Brown University	19
Jesse Freeman	Williams College	5
Ehtan Fricker	University of Wisconsin	6
Paul Frigge	Northwestern University	7
Paul Gallagher	University of Pennsylvania	1
Ryan Gallagher	University of Connecticut	18
Michael Garn	Yale University	4

MAA Student Speakers (Continued)

Name	School	MAA Session
Erika Gerhold	Salisbury University	10
Claire Gibbons	Morningside College	3
Sheridan Grant	Pomona College	8
Sean Gravelle	Xavier University	4
James Emil-Maxum Grenier	Radford University	22
Kimberly Grimmer	Augustana College	16
Allison Grossman	Fordham University	7
Michal Gudejko	Minot State University	17
Pamela Guerron	Montclair State University	19
Caitlyn Hannum	Quinnipiac University	15
Daniel Harris	Sam Houston State University	18
Daniel Helkey	Emmanuel College	17
Tyler Hills	Brigham Young University	6
Amanda Hoisington	University of California Riverside	21
David Hu	Georgetown University	1
Ashley Huhman	East Central University	4
Jennifer Hults	SUNY Potsdam	6
Daniel Irvine	University of Notre Dame	5
Vladimir Ivanov	Fairfield University	6
Fulton Jackson	Metropolitan State University of Denver	18
Sarah Jermeland	Simpson College	15
Peihong Jiang	University of Rochester	8
Leah Kaisler	Franciscan University of Steubenville	4
HeeChan Kang	Augsburg College	17
Rachel Katz	University of Chicago	9
Harold Westin King	Baylor University	21
Anna Kirkpatrick	University of South Carolina	8
Benjamin Knapper	Augustana College	6
Sylvanna Krawczyk	California State University - Sacramento	7
Logan Kruse	Augustana College	6
Sanjay Kumar	University of Iowa	7
Seung Hyun Lee	Yale University	4
Brian Lei	Yale University	4
Kari Lemelin	Unity College	2
Cale Lewis	Sam Houston State University	18
Yumi Li	Willamette University	19
Gerard Lisella	Quinnipiac University	3
Sander Mack-Crane	Case Western Reserve University	8
Kellie MacPhee	Dartmouth College	9
Kathryn Marie Merkling	Valparaiso University	16
Brice Merwine	Long Island University Brooklyn	7

MAA Student Speakers (Continued)

Name	School	MAA Session
Margaret Mikus	Michigan State University	6
Maggie Hall Miller	University of Texas at Austin	1
Shaun Miller	Winona State University	17
Natawut Monaikul	University of Illinois at Urbana-Champaign	18
Aaron Morse	SUNY Potsdam	3
Kiran Munir	Benedictine University	2
Taliha Nadeem	Benedictine University	2
Lisa Naples	Fairfield University	7
Christopher Negron	SUNY Potsdam	3
Rachel Nicinski	Benedictine University	2
Byron Perpetua	Williams College	1
Samantha Petti	Williams College	5
Cameron Pombert	Benedictine University	2
Robert Jordan Porter	Brigham Young University	6
Rebecca Post	Augustana College	6
Greg Pritchard	Sam Houston State University	18
Anita Kummamuri Rao	Texas Academy of Math & Science	5
Erika Refsland	Mills College	10
Samuel Reid	University of Calgary	1
Robert Rennie	Reed College	10
Wonho Rhee	Brown University	15
Alex Safsten	Brigham Young University	20
Anthony Sanchez	Arizona State University	7
Matthew Schmidt	SUNY at Buffalo	10
Peter Schrock	Goshen College	4
Melissa Sherman-Bennett	Bard College at Simon’s Rock	7
Clarissa Sirmons	Sam Houston State University	5
Hanson Smith	Colorado College	1
Leah Stamer	Cal Poly San Luis Obispo	9
David Stevens	Williams College	7
Katelyn Stoll	Quinnipiac University	15
Tim Tarver	Bethune-Cookman University	21
Michael Terhaar	St. John’s University	19
George Ison Thekkedath	Trinity College	22
Daniel Thompson	Pomona College	15
Michelle Tiffany Tin	University of Notre Dame	2
Robert B. Torrence	The College of William and Mary	3
Christina Tran	California State University, Fullerton	16

MAA Student Speakers (Continued)

Name	School	MAA Session
Samuel Tripp	Williams College	8
Abigail Turner	University of Illinois at Urbana-Champaign	18
Austin Tuttle	University of the Pacific (California)	7
Austin Unsicker	Brigham Young University	6
Charles Vincent	Lafayette College	9
Omar de la Cruz Vite	Universidad Autonoma del Estad de Hidalgo	3
Daniel Vitek	Duke University	5
Rachel Volkert	University of Northern Iowa	3
Tyler Wales	Louisiana State University	20
Andrew Walsh	Augsburg College	17
Jane Wang	Princeton University	7
Ashley Weber	University of Michigan-Ann Arbor	5
David Wegscheid	Michigan State University	18
Haining Wei	Knox College	15
Ilan Weinschelbaum	Wesleyan University	7
Jakob Weisblat	Kent State University	4
Michael Weselcouch	Assumption College	9
Samuel Whitfield	McDaniel College	10
Doug Wickingson	St. Norbert College	16
Emma Winegar	Augsburg College	17
Carrie Winterer	St. Mary's College of Maryland	16
Sicong Zhang	Columbia University	5
Siqi Zheng	Macalester College	9

Pi Mu Epsilon Speakers

Name	School	Chapter	PME Session
Camron Bagheri	Youngstown State University	OH Xi	2
Michael Baker	Youngstown State University	OH Xi	3
Matthew Barry	Texas A&M University	TX Eta	4
Lisa Borum	Randolph-Macon College	VA Iota	6
Joshua Brakensiek	High School (Homeschool)	VA Iota	6
Daniel Catello	Youngstown State University	OH Xi	5
Calvin Cochran	Hendrix College	AR Beta	6
Heather Cook	Roanoke College	VA Delta	1
Kim Do	Youngstown State University	OH Xi	5
Wes Galbraith	Gettysburg College	PA Alpha Alpha	4
Nicole Gardner	Texas A&M	TX Eta	3
Karenna Genzlinger	Gettysburg College	PA Alpha Alpha	6
Dorothy Klein	Kent State University	OH Alpha	1
Kristen Knight	Austin Peay State University	TN Epsilon	1
Alex Leitheiser	St. Norbert College	WI Delta	4
Jonathan Marino	Roanoke College	VA Delta	6
Ryan Matzke	Gettysburg College	PA Alpha Alpha	6
Daniel Miller	Texas A&M University	TX Eta	3
Jeremy Moody	Worcester Polytechnic Institute	MA Alpha	2
James Munyon	Youngstown State University	OH Xi	2
Yvette Niyomugaba	Southwestern University	TX Pi	1
Ashley Orr	Youngstown State University	OH Xi	5
Blain Patterson	Youngstown State University	OH Xi	5
Daniel Persia	Denison University	OH Iota	1
Kathleen Perzanowski	Sacred Heart University	CT Zeta	4
Matthew Pierson	Youngstown State University	OH Xi	2
Sarah Ritchey	Youngstown State University	OH Xi	3
Eric Shehadi	Youngstown State University	OH Xi	2
Zachary Silbernick	Saint John's University	MN Delta	4
Marissa Sileo	University of Maryland	MD Alpha	3
Aleksandra Sobieska	Kent State University	OH Alpha	3
Laura Staver	St Norbert College	WI Delta	5
Sarah Stiemke	St. Norbert College	WI Delta	4
Laura Tobak	Marist College	NY Alpha Pi	3
Ananya Uppal	UI - Urbana Champaign	IL Alpha	5
Rashida Washington	McNeese State University	LA Epsilon	1
Victoria Zimbro	Randolph-Macon College	VA Iota	2

Delegates

Name	School	Chapter
Madison Cole	SUNY Fredonia	NY Pi
Michael McAllister	Austin Peay State University	TN Eta

MAA Session #1

Theater 115: CCC Room 11 **8:30A.M. – 10:25A.M.**

8:30–8:45

Tiling Space with n-Hedra

Byron Perpetua
Williams College

What is the least-perimeter way to tile space with n-hedra for small n?

8:50–9:05

Tilings with Nonconvex Pentagons

Maggie Hall Miller
University of Texas at Austin

We study tilings of the plane by unit-area pentagons. Could mixtures of nonconvex and regular pentagons can have less perimeter than convex irregular pentagons?

9:10–9:25

Isoperimetry in Surfaces with Density

Paul Gallagher
University of Pennsylvania

We study the isoperimetric problem in some simple surfaces with density. The isoperimetric problem seeks to enclose prescribed area with minimum perimeter. In the Euclidean plane, the answer is the circle.

9:30–9:45

Isoperimetry in the Plane with Density e^{r^a}

David Hu
Georgetown University

We study the isoperimetric problem in the plane with density e^{r^a}. Sometimes, as in the Euclidean plane, the solution is a circle about the origin, sometimes not.

9:50–10:05

Equal Circle Packing on Flat Tori

Madeline Brandt and Hanson Smith
Reed College and Colorado College

The study of maximally dense packings of disjoint equal circles in different types of containers is a problem in Discrete Geometry that has developed over the past forty years. The optimal densities and arrangements are known for 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 called a flat torus. Using numerous figures we will introduce the basic concepts (including the notion of a flat torus, an optimal packing and the graph of a packing), demonstrate many maximally dense arrangements for four equal circles, and outline a proof of their optimality. This research was conducted as part of the 2013 REU program at Grand Valley State University.

10:10–10:25

Contact Graphs of Unit Sphere Packings

Samuel Reid
University of Calgary

The contact graph of an arbitrary finite packing of unit balls in Euclidean 3-space is the (simple) graph whose vertices correspond to the packing elements and whose two vertices are connected by an edge if the corresponding two packing elements touch each other. One of the most basic questions on contact graphs is to find the maximum number of edges that a contact graph of a packing of n unit balls can have. In this paper, improving earlier estimates, we prove that the number of touching pairs in an arbitrary packing of n unit balls in $\mathbb{E}^3$ is always less than $6n - 0.926n^{\frac{2}{3}}$. Moreover, as a natural extension of the above problem, we propose to study the maximum number of touching triplets (resp., quadruples) in an arbitrary packing of n unit balls in Euclidean 3-space. In particular, we prove that the number of touching triplets (resp., quadruples) in an arbitrary packing of n unit balls in $\mathbb{E}^3$ is at most $\frac{25}{3}n$ (resp., $\frac{11}{4}n$).

MAA Session #2

Theater 115: CCC Room 12 **8:30A.M. – 10:25A.M.**

8:30–8:45

An Epidemic Model with Different Susceptibility Classes

Taliha Nadeem
Benedictine University

Although diseases such as the common cold and flu can be caught by anyone, certain people are more susceptible than others. This means, not only are they more likely to become infected, but they are also a likely source to spread the infection. This begs the question: If we could somehow vaccinate or quarantine that highly susceptible group, will that cause the disease to die off for the entire population?

This talk concerns setting up and analyzing a system of differential equations describing this situation with an emphasis on what is necessary to eliminate the disease from the population.

8:50–9:05

An Integrated Pest Management Model with Ivlev-Type Functional Response and a Prey Specific Disease

Cameron Pombert
Benedictine University

We present a model for integrated pest management. The model incorporates an Ivlev-type functional response for predation and a prey-specific disease with a nonlinear saturation incidence rate. Additionally new predators and infected prey are introduced into the population and pesticide is sprayed periodically. We show that there is a periodic pest eradication solution that is locally asymptotically stable and a globally asymptotically stable. We also show the existence of a permanent solution.

9:10–9:25

The Effects of Vaccination/Quarantine on an Epidemic with Different Susceptibility Classes

Rachel Nicinski
Benedictine University

Although diseases such as the common cold and flu can be caught by anyone, certain people are more susceptible than others. This means, not only are they more likely to become infected, but they are also a likely source to spread the infection. Certainly, vaccinating and/or quarantining those that are highly susceptible should have an impact on the disease spread, but are there better ways to vaccinate/quarantine than others? That is, should we continuously vaccinate/quarantine over a period of time, or should it be done in one shot?

This talk concerns setting up and analyzing a system of differential equations describing this situation with an emphasis on different ways of vaccinating and/or quarantining highly susceptible people and what best eliminates the disease.

9:30–9:45

An Analysis of Neural Spike Trains

Michelle Tiffany Tin
University of Notre Dame

Spike trains encode a vast amount of information. The analysis of spike trains is useful for the understanding of communication between excitable cells. The interspike interval, or the time in between spikes, is a critical facet of spike trains that plays an important role in encoding information. From the interspike interval, the frequency of cell firing can be determined. Using Monte Carlo simulations, bifurcation analysis, and stability theory with the Morris-Lecar model, type I and type II membrane excitability were analyzed. A bifurcation refers to a point of qualitative change in a system, in this case, a change in stability. Stability analysis showed that the type I system has three equilibrium points, which give rise to a saddle-node bifurcation and a Hopf bifurcation. The single equilibrium point in the type II system is stable and marks a Hopf bifurcation. Critical bifurcation values of the primary parameter, applied current, were found for both systems.

9:50–10:05

The Effect of Repeated Vaccination Cycles on an Epidemic Model with a Multi-Stage Vaccine

Kiran Munir
Benedictine University

In epidemiology, some diseases require multiple shots with pre-determined times between them in order to be fully effective. In such a case, modeling the effectiveness of such a vaccine in a given population saves resources while helping strategize the best usage of the limited vaccines. In this presentation, we will present a model and results for disease spread with a multi-stage vaccine repeatedly administered, in a cyclic pattern, with an incorporated grace period.

10:10–10:25

Mathematical Modeling of the Zombie Outbreak at Unity College

Kari Lemelin
Unity College

On Sunday October 21, 2012, a zombie outbreak that came to be known as Humans vs. Zombies (HvZ) appeared at Unity College, endangering the lives of over 70 students. Events like this one have occurred in the past, but this was the first time at Unity College that data was collected for analysis. In just 72 hours a total of 55 students had become infected. To reduce the affect of future attacks by zombie hordes we must first understand how the disease is transmitted. The data collected throughout the game indicated that zombie-human relationships are parallel to predator-prey interactions. By including the Lotka-Volterra equation within a simple SIR disease model, predictions of zombie population growth rates were created more accurately. These predictions can be used to aid the human resistance during the next outbreak of HvZ at Unity College in October 2013. Together we can stop zombies for good.

MAA Session #3

Theater 115: CCC Room 13 **8:30A.M. – 10:25A.M.**

8:30–8:45

Playing *Lights Out* on Petersen Graphs

Robert B. Torrence

The College of William and Mary

Lights Out is a game traditionally played on a 5 by 5 grid-graph of two-state vertices, in which a button press on a vertex changes its state and the states of all neighboring vertices. Given an initial configuration of lit vertices, the goal of the game is to turn all of the lights out. While the mathematics behind the *Lights Out* (or σ^+) game on grids has been well researched, the game has not been studied on the generalized Petersen graphs. We introduce strategies to solve these games and discuss various other phenomena.

8:50–9:05

Using Graph Theory to Prove Newton's Identities

Gerard Lisella

Quinnipiac University

Newton's Identities, a powerful tool in the setting of symmetric polynomials, function to express the relation between the elementary and the power sum bases for the symmetric polynomials. Since their discovery in the late 17th century, these identities have appeared frequently in the literature in connection with various other fields of mathematics. Our research is focused on presenting a proof of Newton's Identities in the setting of graph theory.

9:10–9:25

Isospectral Drums and Cospectral Graphs

Christopher Cox

Iowa State University

In the 1960s, Mark Kac asked a question that would give birth to the field of inverse spectral geometry: "Can one hear the shape of a drum?" By this, he was asking whether or not the shape of a drum could be reconstructed solely through its Laplacian spectrum. This question remained unanswered until Gordon, Web, and Wolpert constructed the first set of isospectral drums, i.e. drums of different shapes that sound the same, thus answering Kac's question in the negative. Soon after this, a method known as transplantation was developed specifically for the purpose of showing isospectrality between non-congruent regions. Through transplantation and the Sunada theory, a number of isospectral pairs of drums were discovered, but currently there are only finitely many known. In this presentation, we use the transplantation method to show a connection between isospectral drums and cospectral weighted graphs. Through this connection, we provide a method to construct an infinite number of isospectral pairs of drums by making use of a partitioning method. In doing this, we reach a number of interesting conclusions pertaining to the structure of these isospectral drums.

9:30–9:45

Equivalences of Dessins D'Enfants

Rachel Volkert
University of Northern Iowa

Dessins d'enfants are bipartite graphs with a cyclic ordering given to the set of edges that meet at each vertex. Merling and Perlis presented a method by which to construct pairs of dessins d'enfants using the permutations induced by the action of a finite group on the cosets of two locally conjugate subgroups of that group. They called these pairs of dessins Gassmann equivalent and investigated some of their properties. First, we discuss several properties of pairs of dessins that imply Gassmann equivalence. Then, using elementwise conjugate subgroups, we introduce and investigate a weaker type of equivalence of dessins, which we refer to as Kronecker equivalence.

9:50–10:05

Flatness of the total graph of a graph, Part I

Omar de la Cruz Vite and Claire Gibbons
Universidad Autonoma del Estad de Hidalgo and Morningside College

Recall that a graph G has a flat spatial embedding, provided there is an embedding of G for which every cycle bounds a disk with interior disjoint from G. There are several indications that flatness is analogous to planarity (in particular, the Colin de Verdiere parameter).

Given a graph G, the total graph $T(G)$ is the graph with vertex set equal to the vertex set of G union with the edges of G, with two vertices of $T(G)$ adjacent whenever they are neighbors in G. The associated line graph, $L(G)$ is defined as follows: vertices of $L(G)$ correspond to edges of G and two vertices of $L(G)$ are adjacent whenever their corresponding edges in G are. Note that $T(G)$ contains both G and $L(G)$ as induced subgraphs. Chartrand, Geller and Hedetniemi and Behzad showed the following are equivalent for a given graph G:

a. The line graph $L(G)$ is outerplanar

b. The maximum degree is less than or equal 3 and every vertex of degree 3 is a cutpoint

c. The total graph $T(G)$ is planar

In these talks, we will discuss whether (a) is equivalent to (c) with "outerplanar" replaced by "planar," and "planar" replaced by "has a flat embedding", and whether there is an analog of (b) in this case.

10:10–10:25

Flatness of the Total Graph of a Graph, Part II

Aaron Morse and Christopher Negron
SUNY Potsdam

Recall that a graph G has a flat spatial embedding, provided there is an embedding of G for which every cycle bounds a disk with interior disjoint from G. There are several indications that flatness is analogous to planarity (in particular, the Colin de Verdiere parameter).

Given a graph G, the total graph $T(G)$ is the graph with vertex set equal to the vertex set of G union with the edges of G, with two vertices of $T(G)$ adjacent whenever they are neighbors in G. The associated line graph, $L(G)$ is defined as follows: vertices of $L(G)$ correspond to edges of G and two vertices of $L(G)$ are adjacent whenever their corresponding edges in G are. Note that $T(G)$ contains both G and $L(G)$ as induced subgraphs. Chartrand, Geller and Hedetniemi and Behzad showed the following are equivalent for a given graph G:

a. The line graph $L(G)$ is outerplanar

b. The maximum degree is less than or equal 3 and every vertex of degree 3 is a cutpoint

c. The total graph $T(G)$ is planar

In these talks, we will discuss whether a is equivalent to c with "outerplanar" replaced by "planar," and "planar" replaced by "has a flat embedding", and whether there is an analog of b in this case.

MAA Session #4

Theater 115: CCC Room 21 **8:30A.M. – 10:25A.M.**

8:30–8:45

Some Fibonacci-type Polynomials and their Properties

Ashley Huhman and Leah Kaisler
East Central University and Franciscan University of Steubenville

Several studies about the roots of Fibonacci-type polynomials focus when k is a positive integer. In this talk we will explore the properties of a a Fibonacci-type polynomial sequence given by $F_1(x) = -a$, $F_2(x) = x - a$, and $F_n(x) = x^k F_{n-1}(x) + F_{n-2}(x)$. Here a is positive integer and k is a real number between 0 and 2. We will characterize the nature of the roots of F_n and present analytic and numerical results on the behavior of the maximum real roots.

8:50–9:05

Strategy Evolution for Cooperation Games

Andrew Clemens
Goshen College

The world is full of many different kinds of conflict, which vary in many ways. A common type of conflict occurs when two or more participants have their own best interests in mind, but must work together, at a cost, to achieve those interests. In game theory, this is known as the prisoners dilemma. The most basic form of this is when two players can either cooperate, which would help the opponent but hurt the cooperator by a smaller amount, or defect, which has no effect on either player. No matter what the other player does, each player always does better by defecting; however, each player does better when both cooperate than when both defect. This dilemma can be resolved with both players choosing to cooperate when the game is played in multiple rounds. This project examines what happens when there are more than two players, communication errors may occur, and opportunities for punishment of defectors are made available. Stable strategies are found using a process of evolution: different strategies play each other, the weaker ones die off, and the stronger ones remain and possibly "mutate" into new strategies, until the strongest strategies dominate over all the others.

9:10–9:25

Princess and Monster Game

Jakob Weisblat
Kent State University

This talk will consider a game in which two players (a monster and a princess) move in a finite graph or space. The monster can travel at a fixed rate and tries to 'catch' the princess (come within a certain relatively small distance of her) as fast as possible. The princess can move freely and tries to maximize the expected amount of time until she is caught. Neither player receives any feedback until the game ends (that is, neither player knows the others actions). We will discuss the game and the players optimal strategies in various spaces. Additionally, we will discuss a probabilistic extension of the game.

9:30–9:45

The Effects of Bloc Formation on Relative Power in Weighted Voting Games

Peter Schrock
Goshen College

In a nine person committee where every member has one vote and a majority, or five votes, is required to reach a consensus, five members would stand to increase their power by agreeing to form a bloc. By secretly voting before meeting as a whole committee, the five could come to a consensus by majority and then all agree to vote the same way in front of the full committee. Because the bloc effectively controls the committee, each member would have one fifth of the full committees power, instead of the one ninth they would receive without the bloc. Three particularly Machiavellian members of the five could then theoretically form a bloc within the bloc of five and control the whole committee. If the full committee required unanimity instead of a majority, forming blocs that require a majority decreases the power of individual voters. Members of such a bloc would lose their ability to single handedly veto a proposal and thus would lose power. The aim of this paper is to characterize games and groups of players within those games for which voting power would be increased by forming blocs.

9:50–10:05

Developing a Theory of Bidding Chess

Brian Lei, Seung Hyun Lee, Alec Arana and Michael Garn
Yale University

Chess is an example of a combinatorial game; players take turns to move and have perfect information. However, bidding chess adds a layer of complexity by incorporating elements from classical game theory and auction theory, namely that players must bid for the right to move. After the closed bidding, the larger bid wins the right to move at the cost of handing over the chips to the opposing player.

In our research, we have laid the groundwork for developing a full-fledged theory of bidding chess. In the initial stages, we have delved into openings using probability analysis from random-turn chess and have solved multiple simple endgame positions. In addition, we have created a computer program in Python that allows for human vs. human bidding chess play. We aim to develop our understanding of the game to the point that we may be able to look at any given position and systematically calculate the following: the ideal next bid; the ideal next move for either player given the previous move; and the chip ratio required for guaranteed victory. Our ability to construct insight problems and various theorems on winning strategies will enable us to construct a global portrait of the game. The study of bidding chess, given the complexity of the game, can be viewed as a source of insights and intuition for the bidding game world, with the potential for application in finance and economics. Furthermore, bidding chess is an entertaining way to bring fresh air to a centuries-old game.

10:10–10:25

Graph Theoretic Models of Interdependent Preferences in Referendum Elections

Beth Bjorkman and Sean Gravelle

Grand Valley State University and Xavier University

In referendum elections, voters are frequently required to cast votes simultaneously on multiple questions or proposals. The separability problem occurs when a voter's preferences on the outcome of one or more proposals depend on the predicted outcomes of other proposals. These kinds of interdependencies cannot be fully expressed in a simultaneous election. When voters are forced to separate issues that may be linked in their minds, the resulting election outcomes can be unsatisfactory or even paradoxical. In this talk, we will use graph theoretic models to characterize, construct, and better understand interdependent voter preferences in referendum elections. We will also explore connections between these models and prior research on the structure of interdependent multidimensional preferences. This work was completed as part of the Grand Valley State University Summer Mathematics REU.

MAA Session #5

Theater 115: CCC Room 22 **8:30A.M. – 10:25A.M.**

8:30–8:45

The Quintuple Crossing Number of Knots

Orsola Capovilla-Searle and Jesse Freeman
Bryn Mawr College and Williams College

A quintuple crossing in a knot projection is a crossing with exactly five strands of the knot passing straight through it. The quintuple crossing number of a knot is the least number of quintuple crossings in a projection with only quintuple crossings. We relate quintuple crossing number to the span of the bracket polynomial to determine bounds on quintuple crossing number for certain families of knots.

8:50–9:05

Ubercrossing Number of Knots

Daniel Irvine
University of Notre Dame

A multi-crossing is a crossing in a projection of a knot with n strands of the knot passing straight through it. We consider projections with just one multi-crossing. It is known that every knot has such a projection, called an ubercrossing projection, and therefore a well-defined ubercrossing number, which is the minimum n for such a projection. We investigate the ubercrossing number and how it relates to other knot invariants.

9:10–9:25

The Spectrum of Crossing Numbers for Knots

Daniel Vitek and Ashley Weber
Duke University and University of Michigan-Ann Arbor

Traditionally, knots have been ordered according to their crossing number, which is the least number of crossings in any projection of the knot. But recently, these traditional crossings have been extended to allow more than two strands of the knot to cross. Hence, we have triple crossing number, quadruple crossing number, etc. Hence every knot has a spectrum of crossing numbers associated to it. We will discuss how these numbers behave for various knots.

9:30–9:45

Petal Number of Knots

Samantha Petti and Sicong Zhang
Williams College and Columbia University

A multi-crossing is a crossing in a projection of a knot with n strands of the knot passing straight through it. We consider projections with just one multi-crossing such that none of the loops coming out of the crossing are nested. In other words, the projection resembles a daisy. It is known that every knot possesses such a petal projection. We investigate the petal number and how it relates to other knot invariants.

9:50–10:05

Some Fibered Twisted Torus Knots

Clarissa Sirmons
Sam Houston State University

Knot Theory is a relatively new mathematical topic and many of the questions about knots have not yet been answered. A twisted torus knot is a knot that lies on the surface of a genus 2 surface and a knot is fibered if its complement is a surface bundle over S^1. Little research has been done to ascertain which twisted torus knots are fibered and which are not, and no general classification has been completed. In our research, we began with simple twisted torus knots and worked our way up in order to attempt to form a theorem stating that twisted torus knots of the form $K(p, q, r, -n)$— where p is the number of total strands, q is the number of twists on p strands, and $1 < r < p$ is the number of strands to be twisted $n > 0$ full times— are fibered under certain conditions.

10:10–10:25

Modular Flows are in the Complement of the Trefoil Knot

Anita Kummamuri Rao
Texas Academy of Math & Science

We examine the connections between knot theory and the dynamical systems called as modular flows which describe orbits in the space of lattices. Using Eisenstein series from the theory of elliptic functions, a special modular function called the j invariant is expressed, and a mapping defined between the quotient space $SL(2, R)/SL(2, Z)$ and the three-sphere $S3$. The space of all lattices is identified with the collection of pairs (a, b) of complex numbers that satisfy $\Delta(a, b) \neq 0$ via the map

$$L \mapsto (E_4(L), E_6(L))$$

. We will show that the fibers of the j-invariant map are equivalent to trefoil knots in $S3$.

MAA Session #6

Theater 115: CCC Room 23 **8:30A.M. – 10:25A.M.**

8:30–8:45

Paper Folding 101

Benjamin Knapper, Rebecca Post and Logan Kruse
Augustana College

A favorite classroom past-time is closely examined using graph theory. Basic graph theory ideas such as colorability and Euler circuits are related to the folds that can be made on a piece of paper. An algorithm is created that shows how to fold a piece of paper to contain an Euler circuit. Suggestions for further exploration are offered.

8:50–9:05

Proving the Rigid Reachability of a Four-Valent Vertex

Tyler Hills
Brigham Young University

The four-valent vertex appears in many rigid origami designs. Developing a method to prove the rigid reachability of a single, four-valent vertex can be helpful in nding a method to prove the rigid reachability of a multi-vertex crease pattern. Using transformation matrices, we have developed a Matrix Model to prove the rigid reachability of a single, four-valent vertex crease pattern.

9:10–9:25

Proving Rigid Reachability for the Pseudo-Square Twist

Austin Unsicker
Brigham Young University

The pseudo-square twist has folding pattern similar to the classic square twist, the difference being the parity of some of the folds. We will prove that the pseudo-square twist is rigid reachable (i.e. rigid foldable).

9:30–9:45

Origami Math and Foldable Solar Arrays

Robert Jordan Porter
Brigham Young University

An important application of origami is the design of deployable, foldable solar arrays. We will analyze the rigid **reachability** of a given solar array folding pattern. This is an important problem in order to determine whether any given solar array folding pattern is, indeed, rigid **reachable**. Knowing whether a pattern will be rigid **reachable** will allow engineers to optimize the surface area of solar panels in a solar array while maintaining a structure with minimal stress exerted on solar panels throughout deployment.

9:50–10:05

On the Roots of a Generalized Fibonacci Polynomial Sequence

Ehtan Fricker and Margaret Mikus

University of Wisconsin and Michigan State University

Several asymptotic results are known for the the maximum real roots of a Fibonacci-type polynomial sequence given by $F_1(x) = a$, $F_2(x) = x + b$, and $F_n(x) = x^k F_{n-1}(x) + F_{n-2}(x)$. Here a and b are negative integers and k is a positive integer. In this talk we will present a method to characterize all the roots of such polynomials. We will also explore the nature of the roots of another generalized sequence given by $F_1(x) = a$, $F_2(x) = x + b$, and $F_n(x) = x^{2k} F_{n-1}(x) + F_{n-2}(x)$.

10:10–10:25

Associate Primes of Powers of the Cover Ideal

Craig Corsi, Vladimir Ivanov, Jennifer Hults and Su Lin Blodgett

Williams College, Fairfield University, SUNY Potsdam and Wellesley College

In this paper we study the associated primes of power of ideals related to graphs.

PME Session #1

Theater 115: CCC Room 22 **2:00P.M. – 3:55P.M.**

2:00–2:15

The Walking Dice: An Optimal Play Strategy

Heather Cook
Roanoke College

We will discuss the game of "Zombie Dice," published by Steve Jackson Games. Game play will be explained, and then we will investigate a model for deciding whether or not to continue rolling if given the opportunity. Examples will be shown to highlight the game and its strategy.

2:20–2:35

How to Estimate the Size of a Polynomial

Dorothy Klein
Kent State University

It is theoretically and practically important to be able to estimate how big polynomial values can be on domains of interest. Exact computations of polynomial maxima are difficult or even impossible for high degree polynomials. However, for many purposes, a close approximation is good enough.

2:40–2:55

Statistical Goodness of Fit Methods Used to Analyze Data

Kristen Knight
Austin Peay State University

Statistical methods which are used to study populations of interest often require a goodness of fit test. The distribution from which the inferences are drawn must accurately model the data at hand. A variety of methods may be utilized, including Chi Square, Akaike's Information Criterion, Bayesian Information Criterion, Kolmogorov-Smirnov, and Monte Carlo simulation. Recent literature suggests that traditional methods do not always provide the most accurate measurement for the fit of a distribution to a data set. In this study, each of the methods mentioned is applied to three different data sets and the results are compared.

3:00–3:15

Recycle Plastic to Save our Planet!!

Yvette Niyomugaba
Southwestern University

As the world population increases significantly, recycling is one of the effective ways to conserve energy and natural resources. In addition, recycling reduces landfill use and the environmental damage from pollutants and greenhouse gas emissions. Plastic is one of the most consumed products worldwide, and this research will focus on modeling plastic recycling and landfill usage in Bangladesh and the United States. We develop a Markov chain model in which state diagrams show the flow of plastic in a recycling system. Linear, exponential, and logistic functions are used to describe the amount of plastic at different stages, including virgin plastic and landfill. In addition, the relationship between landfill growth and plastic consumption are modeled using various mathematical procedures.

3:20–3:35

Modeling NBA Player Value from Box Score Data

Daniel Persia

Denison University

Recent findings in basketball analytics reveal the importance of five-man units in modeling player interactions on the court. In a synergistic environment, how much is a shot worth? How much should we value an assist? A turnover? A block? In this session we'll explore how box score data can be used to evaluate NBA player performance. We introduce an adjusted plus-minus statistic, generated for NBA players across five seasons, and regress against linear and non-linear variations of the box score. We consider models to predict future performance, with an eye toward determining which player types play well together, producing synergistic effects. Can a reasonable definition of player value be determined?

3:40–3:55

An Application of the Hotelling's T^2 Statistic

Rashida Washington

McNeese State University

The Hotellings T^2 statistic charts as a single variable, yet contains information from all of the variables in a multivariate process. Extending the theory of Shewhart charting, I will describe and present an application of the multivariate T^2 statistic that demonstrates the ability to identify the variable or variables causing the signal.

PME Session #2

Theater 115: CCC Room 23 **2:00P.M. – 3:55P.M.**

2:00–2:15

Applications of Linear Algebra to the Fibonacci Sequence

Camron Bagheri
Youngstown State University

From its mysterious mathematical properties to its intriguing recurrence as a basic pattern in nature, the seemingly simple Fibonacci Sequence has dazzled the world's greatest thinkers for more than 800 years. History credits Jacques Philippe Marie Binet, an accomplished French mathematician and physicist, as having created the first explicit expression for this recursively-defined sequence. This presentation will derive the aptly-named "Binet's Formula" using the basic principles of Matrix Diagonalization and Eigen-Characteristics from Linear Algebra.

2:20–2:35

Efficient Methods for Calculating Equivalent Resistance Between Nodes of a Highly Symmetric Resistor Network

Jeremy Moody
Worcester Polytechnic Institute

Kirchhoff methods for solving resistor network problems rapidly become unwieldy as network size grows. We describe a method for efficiently calculating the effective resistance between nodes of any resistor network with a large number of automorphisms. We demonstrate this method for semiregular polyhedra, 4-dimensional polytopes, and N-dimensional hypercubes.

2:40–2:55

Ranking the 2012 NFL Teams

James Munyon
Youngstown State University

Ranking methods from the book "Who's #1?" were used to rank all teams from the National Football League during the 17 weeks of the regular 2012-2013 season. Several methods using linear algebra, systems of equations, and matrices were used, including notable methods like the Colley, Keener, and Massey methods. Rankings were then compared to see which teams consistently ranked high, and whether or not these teams actually experienced regular season, as well as post-season, success.

3:00–3:15

A Characterization of Dihedral and Generalized Quaternion Groups

Matthew Pierson
Youngstown State University

In this talk, we will analyze and give a classification of dihedral and generalized quaternion groups. Namely, we will prove that a group G, with a cyclic subgroup C of index 2, is dihedral if and only if every element of $G-C$ has order 2, and G is generalized quaternion if and only if every element of $G-C$ has order 4. From this, we will prove two further results.

3:20–3:35

Prioritizing Vacant Residential Properties for Demolition in Youngstown, Ohio

Eric Shehadi
Youngstown State University

A January 2013 article in the Youngstown Vindicator noted that the city of Youngstown, Ohio has historically taken a "scattershot approach" to identifying and razing vacant homes. This research focuses on creating and applying a mathematical model to prioritize vacant homes for demolition. It relies on variables including property condition, neighborhood, and also through geographical analysis of the surrounding area and homes. The model utilizes data collected by organizations within the city to assign scores to vacant properties and weigh these scores to ultimately rank vacant homes for demolition. By identifying priority demolitions, it is hoped that the model will maximize the impact of demolition funds to benefit the community and the city

3:40–3:55

The Geometry of Partitions of Euclidean Space

Victoria Zimbro
Randolph-Macon College

The problem of rotating one linear subspace into another is an old problem. We investigate a generalization involving partitions of space into three or more components instead of just two. A generalization of the CS (cosine-sine) matrix decomposition is key.

MAA Session #7

Theater 115: CCC Room 11 **2:00P.M. – 3:55P.M.**

2:00–2:15

Some Remarks on a Generalized Quasi Fibonacci-type Polynomials

Brice Merwine and Ilan Weinschelbaum

Long Island University Brooklyn and Wesleyan University

In recent years, analytic and numerical properties of quasi-Fibonacci-type polynomials, defined by $F_0(x) = -1,\ F_1(x) = x - 1$, $F_n(x) = F_{n-1}(x) + xF_{n-2}(x),\ n \geq 2$, have been studied. In particular it is known that the maximum real roots of F_n converge to 2. In this talk we present analytic and numerical results about the nature of the roots of generalized quasi Fibonacci-type polynomials given by $F_0(x) = -1,\ F_1(x) = x - 1$, $F_n(x) = F_{n-1}(x) + x^2F_{n-2}(x),\ n \geq 2$

2:20–2:35

Extended Outer Billiard Map in the Hyperbolic Plane

Sanjay Kumar and Austin Tuttle

University of Iowa and University of the Pacific (California)

Outer (Dual) polygonal billiards is a simple plane based dynamical system on a convex polygon. In this work we analyze the extended outer polygonal billiard map in the hyperbolic plane, we explore rational and irrational rotation numbers and periodic orbits of this special circle map with respect to polygonal tables. This research was conducted as part of the 2013 REU program at Grand Valley State University.

2:40–2:55

Mixing Notions and Examples

Francisc Bozgan and Jane Wang

University of California, Los Angeles and Princeton University

We study various mixing notions for infinite measure-preserving and nonsingular transformations and consider examples and implications of the various properties.

3:00–3:15

Notions of Sensitivity and Randomness in Ergodic Theory

Anthony Sanchez and David Stevens

Arizona State University and Williams College

Using metrics on standard spaces, we study notions of sensitivity in the presence of other ergodic properties.

3:20–3:35

Escape Rates in Open and Slowly Mixing Dynamical Systems

Michael Boyle, Paul Frigge, Allison Grossman and Lisa Naples

University of Houston, Northwestern University, Fordham University and Fairfield University

This presentation will introduce basic questions regarding the study of open dynamical systems in which mass or energy is allowed to escape through a "hole" in the system. We will begin by presenting definitions of several types of invariant and conditionally invariant objects which are important for the study of such systems. We will then describe different behaviors observed in slowly and quickly mixing dynamical systems.

3:40–3:55

Mathematics Research with a 3D Printer

Sylvanna Krawczyk and Melissa Sherman-Bennett
California State University - Sacramento and Bard College at Simon's Rock

In this talk, we will describe our research applying mathematical concepts to create new objects with a 3D printer. Using a Makerbot Replicator 2, we created interesting shapes using a variety of mathematical tools. 3D printing is sometimes called "additive manufacturing technology". This research was conducted during the 2013 REU program at Grand Valley State University, under the mentorship of Prof. Ed Aboufadel.

MAA Session #8

Theater 115: CCC Room 12 **2:00P.M. – 3:55P.M.**

2:00–2:15

Characterizations of the Maximal Symmetry Group

Nathan Cordner
Brigham Young University

I will discuss approaches to characterizing the maximal Abelian symmetry group of homogenous and other polynomials. Currently these symmetry groups are understood well for a special class of polynomials called invertible polynomials, but they are not as well understood for noninvertible polynomials. I will describe new algebraic and geometric characterizations of the maximal symmetry group for both invertible and noninvertible polynomials. These problems arise in the context of geometry and physics and have important implications for mirror symmetry, but these polynomials and their symmetry groups are also interesting in their own right.

2:20–2:35

Correspondence Between Symmetry Groups and Monomials for Polynomials

Lisa Bendall
Brigham Young University

I will discuss results related to the characterization of groups of symmetries of certain polynomials. For certain types of these polynomials, called invertible, the corresponding group is well-understood, but the group is less clear for other polynomials. Adding certain monomials to invertible polynomials will yield a noninvertible polynomial whose automorphism group is a subgroup of the original group. I will discuss the effects of adding different monomials on the group and the correspondence between monomials and subgroups. This has applications in the conjectured Landau-Ginzberg mirror symmetry of theoretical physics, but one need not know the physics to appreciate the interesting mathematical results about groups and polynomials.

2:40–2:55

Symmetry Groups of Homogeneous and Other Polynomials

Matthew Brown
Brigham Young University

I will discuss the maximal Abelian symmetry group of homogeneous and other polynomials. These groups are comprised of all diagonal linear transformations that preserve the polynomial. For a certain class of polynomial, called invertible, the maximal groups are fairly well understood, but finding all of the possible groups that could occur for other polynomials is problematic. In my presentation, I will discuss under what circumstances adding a monomial to a polynomial decreases the order of the maximal symmetry group. These polynomials and corresponding groups are of interest because of their relation to problems that arise in physics, notably in Landau-Ginzburg theories, but they are also interesting for their own sake.

3:00–3:15

Polynomial Rings and Power Series Rings

Peihong Jiang and Samuel Tripp
University of Rochester and Williams College

We first define a metric on a polynomial ring and present interesting properties of the metric. Completing this metric space gives formal power series rings. We will present new results relating Polynomial rings to their power series ring completions.

3:20–3:35

Local Rings and Completions

Sander Mack-Crane and Anna Kirkpatrick
Case Western Reserve University and University of South Carolina

One can define a distance function on a local ring that turns out to be a metric. After defining this metric, we discuss the completion of this metric space, and some of its surprising properties. Finally, we present new results which relate prime ideals of a local ring to prime ideals of its completion.

3:40–3:55

Approximating Amoebae Using Archimedean Tropical Varieties

Sheridan Grant
Pomona College

For a complex polynomial f, the amoeba of f is the image of the complex roots of f under coordinate-wise absolute value log. The Archimedean tropical variety has been proposed as a means of approximating the amoeba of f, and there are now explicit bounds on the Hausdorff distance between the two sets. We illustrate a randomized algorithm, based on this distance bound, to approximate ball-amoeba intersections in polynomial time. The relaxation to intersections with balls of a suitable size is necessary, as deciding point membership for amoebae is in fact NP-hard.

MAA Session #9

Theater 115: CCC Room 13 **2:00P.M. – 3:55P.M.**

2:00–2:15

Necessary and Sufficient Conditions for Benford Sequences

Siqi Zheng
Macalester College

What makes a sequence of real numbers a Benford sequence? It turns out that a lot of sequences growing exponentially or faster are Benford sequences. However, being exponential is not sufficient to prove that the sequence is Benford. Therefore, more general sufficient conditions for Benford sequences are needed. In this paper we will explore some sufficient and necessary conditions for Benford sequences. Specifically, for any sequence $\{a_n\}$, we will explore the limit $\lim_{n\to\infty} \log_{10} \frac{a_{n+1}}{a_n}$. We will show how this limit assists us in determining the Benfordness of $\{a_n\}$.

2:20–2:35

Subgraphs of Every Tournament

Peter Draznik
Augustana College

A tournament is a directed graph with exactly one directed edge between each pair of vertices. A spanning path is a directed path containing all the vertices of the tournament. There is a spanning path in every tournament. We will build upon the spanning path to construct other graphs that are subgraphs of every tournament.

2:40–2:55

True Intercepts on Lattice Paths

Michael Weselcouch
Assumption College

This presentation introduces a new statistic on lattice paths in the plane: the "true intercept" count. I construct several formulas for calculating the total true intercept count for a family of lattice paths, thus answering a question of Ruehr: to show that 5 certain binomial sums are equal. I conclude by introducing a generalization of this statistic, the "fake intercept" count, and give analogs of these summation identities as well as open problems.

3:00–3:15

Numerical Ranges of Keystone Matrices

Shelby Burnett and Leah Stamer
Cal Poly San Luis Obispo

The numerical range of an $n \times n$ matrix A is a subset of the complex plane denoted $W(A)$. The set $W(A)$ consists of all quadratic forms $\langle Ax, x\rangle$ for unit vectors x in $\mathbb{C}^n$. It is well-known that the numerical range is always a convex set and the definition shows that the numerical range is invariant under unitary similarity. Previous work has shown that any matrix with rows that are a certain permutation of the rows of a diagonal matrix has numerical range with a special type of symmetry about the origin. We will discuss the numerical ranges of a certain family of 4×4 matrices. The matrices in this family are not unitarily similar to any of the "row-swap" matrices but their numerical ranges have the same type of symmetry. The family is a generalization of one previously known example.

3:20–3:35

The Colored Cubes Problem

David Cervantes Nava, Daniel Condon and Rachel Katz
SUNY Potsdam, Georgia Institute of Technology and University of Chicago

Start with a collection of cubes and a palette of six colors. We paint the cubes so that each cube face is one color, and all six colors appear in some order on every cube. It is easy to show that there are 30 distinct cubes colored in this way. It's harder to show that if you take 27 cubes from this set, allowing for multiple copies of the same cube, it's always possible to assemble those cubes into a $3 \times 3 \times 3$ cubes where each face is a single color. In this talk, we will discuss some recent results related to the problem of assembling bigger colored cubes from smaller ones.

3:40–3:55

Bounding Zeroes and Coefficients of Graph Polynomials

Alex Chin, Kellie MacPhee and Charles Vincent
North Carolina State University, Dartmouth College and Lafayette College

Several polynomials associated with trees, rooted graphs and rooted digraphs carry combinatorial information about the graph. These include the subtree polynomial of a tree, the leaf polynomial, and versions of these polynomials for rooted trees. We discuss the zeroes and coefficients of several of these polynomials, and include some open questions.

MAA Session #10

Theater 115: CCC Room 21 **2:00P.M. – 3:55P.M.**

2:00–2:15

p-adic Analysis and L-functions via Explicit Methods

Matthew Schmidt
SUNY at Buffalo

Given a 1-variable polynomial $f(x) = x^d + ax^s$ for $d > s > 1$, $\gcd(d, s) = 1$ and rational a, we compute explicit original computations for the case $d = 5$ that will lead to generic properties of the L-function of the exponential sum of $f(x) \bmod p$ for large enough prime p (relative only to d and s). For this purpose we first review standard and not-so standard p-adic analysis, including fundamental materials leading to Dwork theory. We compute the p-adic valuation of the truncated determinant of the Dwork operator for $f(x) = x^5 + ax^s \bmod p$ for p large enough. We prove that for p large enough in a residue class of $p \bmod d$, the aforementioned p-adic valuation achieves its minimum for all p if and only if a is nonzero. We list all such minimum valuations.

2:20–2:35

Waring's Problem over Quaternions Algebras

Samuel Whitfield
McDaniel College

Generalizations of Waring's problem – that for every natural number k there exists an integer $g(k)$ such that every natural number is the sum of at most $g(k)$ k^{th} powers – have been studied in a variety of contexts, from algebraic number fields to non-commutative groups. We study Waring's problem in the setting of quaternion algebras, and explore the complications and simplifications that arise.

2:40–2:55

Rationality of Calculus Optimization Problems

Gregory Convertito
Trinity College

Beginning with the generalization of a basic optimization problem from Calculus I, we attempted to find all possible rational solutions assuming integer initial conditions. The original problem reduced to finding solutions to solving a Pythagorean-like Diophantine equation $a^2 + 3b^2 = c^2$. We solved this by generalizing a classical method of generating Pythagorean triples, producing four cases involving the parity of a, b, and c.

3:00–3:15

On Algorithms for Determining Zero Set Topologies

Erika Refsland and Robert Rennie
Mills College and Reed College

Given an honest, real n-variate $(n+2)$-nomial f, we propose a new algorithm to determine the topological type of the set $Z_+(f)$ of roots of f in the positive orthant. We show that by checking the sign of a linear combination of logs, we can determine, in polynomial-time, a quadratic hypersurface isotopic to $Z_+(f)$. Furthermore, we show that if Baker's refinement of the abc-conjecture is true then our algorithm has complexity polynomial in n as well.

3:20–3:35

The Group of Units of $Z_p[x]/\langle f(x)\rangle$ when $f(x)$ is a Reducible Polynomial

Erika Gerhold
Salisbury University

In every introductory ring theory class, one studies factor rings of the form $Z_p[x]/\langle f(x)\rangle$, with p prime and $f(x)$ irreducible in $Z_p[x]$. These types of factor rings yield a field with cyclic multiplicative group structure of its nonzero elements. One obvious question is ″What happens when $f(x)$ is reducible?″ Of course, $Z_p[x]/\langle f(x)\rangle$ is no longer an integral domain, hence it is not a field, but more can be said about the multiplicative group of units. It is well-known that if $g(x)$ and $h(x)$ are relatively prime then $Z_p[x]/\langle g(x)h(x)\rangle \cong Z_p[x]/\langle g(x)\rangle \times Z_p[x]/\langle h(x)\rangle$. With this reduction we needed only to categorize the multiplicative group decomposition for rings of the form $Z_p[x]/\langle f^n(x)\rangle$ when $f(x)$ is irreducible. In our research we developed a concise formula for determining the cyclic group decomposition of the multiplicative group structure for $Z_p[x]/\langle f^n(x)\rangle$ that is dependent only on n and the degree of $f(x)$.

PME Session #3

Theater 115: CCC Room 22 **4:00P.M. – 6:15P.M.**

4:00–4:15

A Study of Optical Gain in Three-Component Multilayered Films

Michael Baker

Youngstown State University

Using transfer matrices, we compute the optical gain in tri-layered nanostructured films. Different layering combinations are compared with the goal of determining which structure allows for the most desirable laser behavior. Among the structures compared are various Distributed Feedback Laser (DFB) and Distributed Bragg Reflector (DBR) Laser combinations.

4:20–4:35

Climate Change in the Florida Everglades

Nicole Gardner

Texas A&M

The impacts of sea level rise and salt water intrusion have already been felt in the water supplies and ecosystems of the Florida Everglades. We will analyze historical trends in temperature and rainfall for the region and perform statistical downscaling from the coarse model resolution to a regional scale. Once the historical period has been assessed, the same procedure with be applied to projected climate changes using a representative future emissions scenario.

4:40–4:55

Powering Your Water Heater with Solar Energy

Daniel Miller

Texas A&M University

Solar water heaters are used to supplement or replace standard water heaters, reducing homeowners electrical bills. I developed a mathematical model of a solar water heater, and designed and implemented a control scheme to maximize the heaters efficiency. I am currently researching predictive control methods to further optimize the system.

5:00–5:15

Residue Number System Algorithms for Signed Numbers

Sarah Ritchey

Youngstown State University

Modern applications of mathematics, such as cryptography, increasingly require the storage and mathematical manipulation of extremely large numbers. While it is theoretically feasible to use standard algorithms for arithmetic calculations on large integers, in practice such computations are not spatially or time efficient. Instead, storage of these numbers and subsequent calculations can be carried out using a Residue Number System (RNS). Such a system uses the remainders of the large integers, modulo a set of relatively prime numbers. Several issues, however, arise when using an RNS. For example, new methods for parity checking, sign detection, magnitude comparisons, and detecting overflow errors become necessary since only the residues have been stored. Techniques for overcoming these difficulties will be presented as well as recent advances that require less storage and are more time efficient than current algorithms. An implementation of these methods to sets of signed integers will also be explored.

5:20–5:35

Design and Optimization of a Microphone-Phased Array for Flight Testing

Marissa Sileo
University of Maryland

We describe the steps taken to optimize the performance of a multi-element microphone phased array to be deployed at the NASA Wallops Flight Facility in 2014. Using standard beamforming methods (based on spatio-temporal filtering) the goal is to achieve better low frequency performance and to minimize peak sidelobe levels relative to the central beamform peak. Some of the steps taken include analytically computing the theoretical beamform response for various array patterns and computing both the width of the central peak and the maximum peak to sidelobe ratio as a function of frequency.

5:40–5:55

Edge Ideals of Graphs and Minimal Free Resolutions

Aleksandra Sobieska
Kent State University

For a graph G with vertices $v_1, \ldots, v_n$ and field k, define the *edge ideal* $I(g)$ to be the ideal of the polynomial ring $k[x_1, \ldots, x_n]$ generated by all monomials $x_i x_j$ where $v_i v_j$ is an edge of G. How is the combinatorial structure of G expressed in algebraic properties of $I(G)$?

6:00–6:15

Underwater Acoustic Interface Waves

Laura Tobak
Marist College

Sound waves can travel much farther than any other type of wave in the ocean, making them useful for studying marine life, submarine communication and seafloor topography. Interface waves, also called Rayleigh waves, can occur on a boundary between any water-sediment or sediment–sediment interface and contribute to the underwater acoustic field. Rayleigh waves require simultaneous incidence of both compressional waves, in which the particles travel parallel to the wave, and shear waves, in which particles travel perpendicular to the wave. This talk will focus on interface waves at the water–sediment interface in an environment with one elastic layer underneath a water layer. We will use the rotated variable elastic parabolic method to create models and then compare the interface wave amplitudes to theoretical results.

PME Session #4

Theater 115: CCC Room 23 **4:00P.M. – 6:15P.M.**

4:00–4:15

When Things Don't Quite Add Up: Bounding Minimum Restricted Sumset Size in Non-cyclic Abelian Groups

Wes Galbraith
Gettysburg College

Given a subset A of an abelian group, the h-fold restricted sumset of A is the set containing sums of h distinct elements of A. Here we present a method of obtaining upper bounds on minimum 2-fold restricted sumset size in non-cyclic abelian groups of rank two.

4:20–4:35

On the Atomisticity of Supercharacter Theorattices of Cyclic Groupsy l

Alex Leitheiser
St. Norbert College

The set $\mathrm{Sup}(C_n)$ of supercharacter theories of a finite cyclic group C_n forms a lattice, whose properties depend on n. Necessary and sufficient conditions on n are already known for upper semimodularity, lower semimodularity, and coatomisticity of $\mathrm{Sup}(C_n)$, but not yet for atomisticity. We present results leading towards the complete characterization of atomistic supercharacter theory lattices of cyclic groups.

4:40–4:55

Game Theory of Chinese Checkers

Kathleen Perzanowski
Sacred Heart University

Game theory is a branch of mathematics that looks into strategies for maximizing gains and minimizing loses within given restrictions. The game of Chinese checkers originated in the late 1800s and can be played with two to six players. We will overview the game itself as well as the shortest possible game with regards to game theory. In order to understand the shortest possible game we must look into distances. We will be discussing how the distance between two board locations is equal to the norm of the difference of the coordinates. We can also find the distance between two armies, where an army is defined as the set of men, or marbles, that belongs to the specific player. We will also discuss and prove the theorem for the least amount of moves, or the lowest bound for a standard game. However, this lower bound is not possible for a two-player game, but only for a solitary game.

5:00–5:15

A Winning Strategy for Antonim

Zachary Silbernick
Saint John's University

The game of Antonim is a Nim variant with the additional rule that heaps are not allowed to be the same size. A winning strategy for three heap Antonim has been solved. We will discuss the solution to three-heap Antonim and generalize this theory to an arbitrary number of heaps of any size.

5:20–5:35

Helping the Environment through Strategic Placing of Power Plants

Sarah Stiemke

St. Norbert College

This work is inspired by an article by Christopher Schaufele and Nancy Zumoff in the MAA publication Environmental Mathematics in the Classroom. This presentation examines the effects a coal burning power plant has on water and the organisms that use the water. This talk attempts to find the height and location of the smokestacks that would result in the smallest effect on the environment.

5:40–5:55

MathLex: A Web-Based Mathematical Entry System

Matthew Barry

Texas A&M University

Mathematical formulas are easy to convey in handwritten media, but how should they be represented in electronic format? Unfortunately, mathematical content has not been as well-implemented on the Web as images and video. There are two sides to this problem: display and input. The former has been solved in multiple ways by representing formulas as images, MathML, or LaTeX(via MathJax). Representing math input is much more difficult and is the subject of this presentation. The goal is to enable users to enter complex formulas using a syntax which is as close as possible to normal handwritten math but is unambiguous in its mathematical meaning. Unfortunately, existing enrty systems either (1) use a language (MathML, LaTeX, computer algebra) which is too complex for an average user (difficult to learn and/or read), (2) only work in a particular environment (they have system and browser compatibility issues; java or flash), or lack certain math concepts. Some (e.g. LaTeX) do not even retain mathematical meaning. This thesis presents MathLex, an intuitive, easy-to-type, unambiguous, mathematically faithful input language and processing system intended for representing math input (and potentially display) on the web. It aims to mimic handwritten math as much as possible while maintaining semantic meaning.

MAA Session #15

Theater 115: CCC Room 11 **8:30A.M. – 11:45A.M.**

8:30–8:45

Time Series of Implied Density

Wonho Rhee
Brown University

In this ongoing and rapidly expanding age of computers, the sheer amount of data that can be recorded and analyzed through methods of applied mathematics provides challenges addressed by new financial models. This data often comes in the form of prices of various financial instruments traded in the market. Some of the most popular financial instruments are the European type options (call and put) written on some underlying. The information contained in the market prices of such options is represented via the implied density, which is a market prediction of the distribution of the future value of the underlying. For problems involving risk management, pricing, and hedging, constructing a model for future implied density itself is important. Using multivariate time series methods, we model the vector of the values of the implied density at certain points while maintaining consistency with historical and current observations. By treating implied density as an element of the space of integrable functions (or sequences), we decompose each implied density into a linear combination of basis functions using Fourier series expansion. Then, we apply principal component analysis, a highly popular and traditional time series model, to forecast the time evolution of the coefficients of this decomposition. Such information is instrumental when applied to financial decision-making.

8:50–9:05

Risk Management in Banking

Haining Wei
Knox College

It has been said 'to finance is to create'. From the boom of the railroads to the advent of the Internet, the financial markets have manifested the authenticity of this proverb for centuries. But it seems more reasonable to substitute this saying with 'to finance is to destroy' after such events as the financial crisis in 2007 caused by mortgage loan mismanagement. Bankers misunderstood and misused the Gaussian copula function created by David Li to model credit risk so that they allowed themselves to be exposed to the dangers of risky loan portfolios. The talk will study this formula, and illustrate its potential dangers.

9:10–9:25

Model for Beer Fermentation Under Aerobic and Anaerobic Conditions

Caitlyn Hannum
Quinnipiac University

A novel model for fermentation in beer production is presented. The model incorporates interactions between glucose, ethanol, oxygen and yeast over time, accounting for both aerobic and anaerobic conditions. Literature values were used for model parameters when available and simulations were performed under various initial conditions.

9:30–9:45

Michaelis-Menten Dynamics of Gluten Proteolysis in Beer Production Under Varying pH and Temperature Conditions

Katelyn Stoll
Quinnipiac University

Barley, one of the traditional beer substrates, contains a gluten protein called hordein that causes an adverse reaction for people who have a gluten intolerance or sensitivity. One can reduce the amount of gluten in beer to an acceptable level through the addition of an enzyme, prolyl endopeptidase, which breaks down the offending protein. We create a model, using Michaelis-Menten dynamics, for the behavior of the enzyme under varying pH and temperature conditions. We then add noise to create simulated data and perform an inverse problem to estimate the model parameters.

9:50–10:05

Abstract of Protein-protein Interaction Detection Using Mixed Models

Andrew Best, Andrea Ekey and Sarah Jermeland
Williams College, Howard University and Simpson College

Membrane protein-protein interaction (PPI) plays an important role in biological processes; however, knowledge about membrane proteins is limited. Mating-based Split Ubiquitin System (mbSUS) is a technique used to investigate interactions between proteins by utilizing yeast as a heterologous system. The observed fluorescence scores are a result of PPI. We propose a statistic mixed model to improve the modeling of yeast growth, which provides a more accurate detection of the PPI. Our mixed model considers several factors that affect the observed fluorescence of the yeast, including test versus positive controls, variation due to individual plates, and PPI effects. The proposed model is applied to detect interactions between thousands of Arabidopsis membrane proteins.

10:10–10:25

On the Properties of a Quasi-Fibonacci Polynomial Sequence

Daniel Thompson
Pomona College

Properties of several Fibonacci type polynomial sequences have been explored, especially the asymptotic behavior of the maximum roots. In this talk we will be exploring the properties of a quasi-Fibonacci polynomial sequence defined by the recursion $F_1(x) = a$, $F_2(x) = x + b$, and $F_n(x) = F_{n-1}(x) + xF_{n-2}(x)$. Analytic as well as numerical results will be presented. This work will extend known results when $a = b = -1$.

MAA Session #16

Theater 115: CCC Room 12 **8:30A.M. – 11:45A.M.**

8:30–8:45

Muskrat Multiplication

Kimberly Grimmer
Augustana College

Muskrat Multiplication is a multiplication trick that elementary school teachers use to help teach their students to multiply the numbers six through nine. I will explain the muskrat multiplication trick, show why it works, and consider the trick in bases other than base ten.

8:50–9:05

Women in Science House (WiSH)

Carrie Winterer
St. Mary's College of Maryland

Women in Science House (WiSH), is a living learning community at St. Marys College of Maryland (SMCM). WiSH is a specialty community for women interested in science, the language of science, and women in science. WiSH acts as a supportive community for women interested in science, technology, engineering, and mathematics (STEM) that also performs outreach to the campus and local communities. The goal of WiSH is to encourage younger women to follow their interest in STEM. WiSH engages with elementary school girls and middle school girls in the local community. A second goal of WiSH is to empress upon the campus and local community the importance of women in STEM. We present the positive impact of WiSH on participants' lives and scholarship as well as on the community. We also evaluate the accomplishment of program outcomes.

9:10–9:25

Analysis of Student Performance in Mathematics Courses

Hannah Louise Dorman and Kathryn Marie Merkling
Valparaiso University

Assessment is currently a topic of much interest in the higher education community, but one of the challenges of assessment is obtaining adequate data in order to make meaningful conclusions about student learning. This talk will examine trends relating to student performance in mathematics courses resulting from analysis of a large data set acquired from the Valparaiso University Registrar. Some questions that were investigated are as follows: How does Advanced Placement (AP) credit affect student performance in mathematics courses?, How do students majors affect their performance in mathematics courses?, Does the Valparaiso University math placement score give valuable information that cannot be deduced from high school GPA and standardized test scores?, Does student performance vary between online mathematics course and traditional mathematics courses? This analysis provides insight into the performance of students in mathematics courses at Valparaiso University, and possibly suggests trends at other universities and colleges. This insight could help mathematics departments to design and implement curriculum and policies to maximize student success and learning.

9:30–9:45

Which Algebra Problems Are Suitable for Highly Gifted Students in Grades 5-6?

Christina Tran and Rebecca Etnyre

California State University, Fullerton and Cal State Fullerton

Over one hundred years, European programs such as Abacus International Challenge in Hungary and Gazeta Matematica in Romania addressed problems in number theory, combinatorics and other topics in algebra to middle school students. We adapted a few of these ideas in our work with the Fullerton Mathematical Circle. In our talk, we will present a few of these themes and we will share our experiences.

9:50–10:05

An Economic Approach to Environmental Sustainability of Public Beaches, Oceans and Waterways

Doug Wickingson

St. Norbert College

This talk tackles two environmental considerations by employing the economics associated with both cost-benefit and marginal analysis in simple ways. It will discuss the reduction of pollution on public beaches with a focus on costs, benefits, and efficiency. It will also discuss the conservation of water resources that have free public access. The work is inspired by an article by Ginger Holmes Rowell in the MAA publication, Environmental Mathematics in the Classroom. This talk attempts to quantify the sustainable use of free access beaches, ocean, and waterways from both environmental and economic vantage points. It uses the analysis of hypothetical data sets to better understand the complex, interconnected relationship that exists between the public and our natural resources.

MAA Session #17

Theater 15: CCC Room 13 **8:30A.M. – 11:45A.M.**

8:30–8:45

Newton's Series for π

Shawn Doyle
Youngstown State University

We will discuss the historical background and derivation of Newton's obscure infinite series for π. Any student who has taken a Calculus II class, or an equivalent course that involves sequences and series, will have the background knowledge necessary to understand the material.

8:50–9:05

Determining Future Genotype Proportions

Shaun Miller
Winona State University

Given the current proportion of genotype distribution in a given population, we can use linear algebra and Markov chains to predict the genotype proportions in future generations. Genes are passed on from parent to offspring in many different ways; our research includes how to predict the future genotype makeup of a given population when genes are passed on through autosomal inheritance or X-linked inheritance in particular. This research has great practical importance for scientists and researchers who want to limit undesired genes, or increase beneficial genes in future generations. For example, these methods could be used to limit the occurrence of certain genes associated with diseases in future generations of a given population; or they could be used to increase genes in livestock and crops that would help maximize food production.

9:10–9:25

Numerical Solution of Heat Equation by Spectral Method

Michal Gudejko
Minot State University

Spectral method is used to solve the homogeneous and non-homogeneous heat equations numerically. Orthogonal basis are used to establish computational algorithm. Numerical results are presented. The accuracy and efficiency of the proposed model are discussed.

9:30–9:45

M-Band Wavelet-Based Audio Watermarking Algorithm

Robert Dolan

Western Connecticut State University

As digital music has become increasingly popular, there is a great need to further develop a method that could be used to enhance copyright protection in the music industry. This paper addresses this problem by providing a way to protect against unauthorized copying of digital music by inserting a watermark in the audio le through the use of discrete wavelet transforms and other statistical means. The proposed watermark algorithm will achieve two goals: (1) The embedded watermark will not affect the quality of the audio in any way; (2) The watermark should be able to prevent common attacks that could remove or destroy the watermark, such as re-sampling, compression, amplitude scaling, and time scaling.

9:50–10:05

Analysis of Laguerre's Method Applied to Find the Roots of Unity

Emma Winegar, HeeChan Kang and Andrew Walsh

Augsburg College

Previous analyses have provided results on the convergence and properties of Laguerre's method when applied to the polynomials $p_n(z) = z^n - 1$, $n \in \mathbb{N}$. While the analyses for $p_n(z)$ appear to provide a fairly complete picture, careful study of the results reveals that more can be said. We provide additional analytical, computational, and graphical results, insights, and details. We also raise and summarize questions that still need to be answered.

10:10–10:25

Efficiently Boarding an Airplane: A Modeling Based Approach

Daniel Helkey

Emmanuel College

The airline boarding problem involves minimizing the time it takes to load passengers onto an airplane. Reduced boarding time can allow airlines to operate more flights and have more profitable day-to-day operations. Various academic and industrial researchers have developed improved boarding schemes over the traditional method of boarding the airplane from back to front. While there are multiple studies considering this problem, few studies incorporate a model for time and spatial location involved in stowing luggage in overhead bins. We investigate luggage interferences, which occur when a passenger is unable to stow baggage at their seat due to a full overhead bin. A model is developed for the expected number of luggage interferences for a plane of arbitrary size. We also investigate how various boarding strategies perform differently in the presence of a spatial model for luggage.

MAA Session #18

Theater 15: CCC Room 21 **8:30A.M. – 11:45A.M.**

8:30–8:45

Do Numbers Play Dice? Visualizing Order and Chaos in Number Theory Through Random Walks

Natawut Monaikul
University of Illinois at Urbana-Champaign

Many properties of the natural numbers can be encoded as sequences of 1's and -1's. On the surface, such sequences often show no obvious pattern and indeed seem to behave much like randomly generated sequences. In order to gain a deeper understanding of the "random-like" behavior of such sequences, we construct certain "random walks" in the plane formed with these sequences. These random walks provide a natural way to visualize the degree of randomness inherent in a sequence and to detect, and possibly explain, hidden patterns, but they can also open up new mysteries that defy explanation.

In this presentation, we report on the research we performed at the Illinois Geometry Lab (IGL) aimed at better understanding these number-theoretic random walks and unraveling some of their mysteries.

This is a joint work with Yiwang Chen, Wenmian Hua, and Tong Zhang.

8:50–9:05

Harmonic Functions and Random Walks on Spheres

Ryan Gallagher and David Wegscheid
University of Connecticut and Michigan State University

We are examining a classical Kakutani result on the relationship between Brownian motion, a form of random movement, and harmonic functions, which are solutions to the Laplace equation. Kakutanis theorem is a generalization of the mean value property of harmonic functions. We will use this result to solve the diffusion equation in various regions with certain boundary conditions.

Random Walks on Spheres (RWoS) can be used to estimate the temperature (or population density, concentration) at any point in a region. We will discuss the distribution of the point of first encounter with the boundary of several regions in different dimensions. We will also consider the rate of convergence of the Brownian motion to the boundary as well as the overall computational effort needed to estimate values of the harmonic function using the Monte Carlo algorithm.

9:10–9:25

Intersecting Cylinders: From Archimedes and Zu Chongzhi to Steinmetz and Beyond

Abigail Turner

University of Illinois at Urbana-Champaign

If two cylinders of radius 1 intersect at right angle, what is the volume of the region common to both cylinders? This problem goes back more than two thousand years to Archimedes and the Chinese mathematician Zu Chongzhi, who solved it using an ingenious geometric argument. In the early 20th century, Charles Steinmetz, a famous engineer of his time, studied this problem and also the analogous problem involving three perpendicular cylinders, and the regions of intersection of the cylinders have since been referred to as ”Steinmetz solids”. More recently, the problem has been popularized by Martin Gardner in his books and Scientific American articles, and by Steven Strogatz in his New York Times column. In this presentation, we report on research performed at the Illinois Geometry Lab (IGL), in which we considered higher-dimensional versions of the Steinmetz solids.

9:30–9:45

Discrete Morse Theory and Persistence of Critical Points

Daniel Harris, Cale Lewis and Greg Pritchard

Sam Houston State University

Discrete Morse theory has been shown to be a useful tool in the identification of those cells in a complex that are deemed critical to the topology of the complex. A discrete version of the Laplacian can also be used to identify these critical cells. An algorithm was recently found to determine those cells that are persistent among a sequence of different cellular decompositions of the same complex. The relationship between this algorithm and the discrete Laplacian will be discussed.

9:50–10:05

The Geometry of Quasigroups

Xinwei Chen

Benedictine University

A quasigroup is a binary operation whose multiplication table is a Latin square. Quasigroups have recently been used in the field of cryptography to create new codes and ciphers. In this talk we will discuss properties of quasigroups that can be seen by studying graphs related to these structures. We will illustrate how these graphs can be used to study the security of cryptographic schemes based on quasigroups.

10:10–10:25

Classifying the Astroid Curve

Fulton Jackson
Metropolitan State University of Denver

A plane algebraic curve is the set of points on the Euclidean plane whose coordinates are zeros of some polynomial in two variables. Some algebraic curves have interesting symmetries. For instance, the Lemniscate of Bernoulli is shaped like the infinity symbol. It turns out that the symmetries of the Lemniscate are isomorphic to the rotational symmetries of an Octahedron. In order to establish this conclusion it is necessary to discuss the topics of points at infinity, genus, singularities, and complex roots. Once these properties are understood we can then form connections between the Lemniscate and the Octahedron. The talk begins with a summary of some results by Langer and Singer in "When is a Curve an Octahedron? (The American Mathematical Monthly, December 2010). We extend the results of this paper through an investigation of the Astroid curve. Through our identification and classification of the curves singularities and calculating of the curves genus, we note similarities between the properties of the Astroid curve and the Dodecahedron. We explore the characteristics of the Astroid and conclude with a conjecture about the symmetry group of this curve.

PME Session #5

Theater 115: CCC Room 22 **10:00A.M. – 11:55A.M.**

10:00–10:15

Managing Risk through Linear Techniques

Daniel Catello

Youngstown State University

Risk management contains many techniques to analyze risk exposures and rein in the unpredictable and uncertain future. Several methods of managing risk that rely on linear algebra techniques are compared to empirical evidence in the stock market to better illustrate and explore the use of these methods as a financial and economic tool.

10:20–10:35

Introduction to Combinatorial Game Theory and What Lies Underneath

Kim Do

Youngstown State University

We discuss the basic theory of impartial combinatorial games on directed graphs. The structures of directed graphs with no cycles are used to find winning strategies for games. Wythoff's game is introduced and some remarkable fractal patterns of its solution are considered.

10:40–10:55

Fourier and Wavelet Analysis: Extracting the Business Cycle

Ashley Orr

Youngstown State University

Fourier analysis and wavelet theory are two increasingly popular extracting techniques to analyze economic time series. Business cycles, which are periodic over time, occur due to fluctuations in the economy. The growth and decay patterns of a business cycle make Fourier analysis an adept representation of these sinusoidal like economic fluctuations. This talk highlights the foundations of Fourier analysis and wavelet-based-time-frequency representations that are used in signal processing and then applies these methods to economic data. The analysis shows how well these techniques represent the business cycle and its frequency and amplitude shifts.

11:00–11:15

Isometries as Reflections

Blain Patterson

Youngstown State University

We will take a look at representing geometric isometries as well as compositions of isometries as a series of reflections. One can start with a variety of rotations, reflections, and translations, and simplify this to reflections. This process can be done with even the most complicated isometries. Once we reach a series of reflections, this can be simplified even more, often to a single isometry.

11:20–11:35

Zero Forcing for Lattices

Laura Staver
St. Norbert College

The minimum rank of a simple graph G is defined to be the smallest possible rank of any symmetric real matrix whose non-zero entries correspond to the edges in G, with no restriction on the main diagonal. The minimum rank of a graph can be bounded by a combinatorial property of the graph, the zero forcing number of G, $Z(G)$, and we will describe $Z(G)$ and calculate it for square lattices of size m by n.

11:40–11:55

Random Points, Broken Sticks, and Triangles

Ananya Uppal
University of Illinois at Urbana Champaign

If a stick is broken up at two randomly chosen points, what is the probability that the three pieces form a triangle? This question first appeared about 150 years ago in an examination at Cambridge University.

It attracted the interest of 19th century French probabilists, and more recently was popularized by Martin Gardner. The problem gives rise to the "broken stick model", an important probabilistic model that arises in areas ranging from biology to finance. The model has been shown to be a good match for a variety of real-world data sets, including intervals between twin births reported in the Champaign-Urbana, intervals between rainy days reported at the airport in North Bay, Ontario, Canada, and intervals between aircraft crashes of U.S. Carriers.

In this presentation, we report an research performed at the Illinois Geometry Lab (IGL), in which we considered generalizations of the original broken stick problem.

PME Session #6

Theater 115: CCC Room 23 **10:00A.M. – 11:55A.M.**

10:00–10:15

Pebbling Chessboard and Samurai Sudoku Graphs

Lisa Borum
Randolph-Macon College

A pebbling move is defined as removing two pebbles from a vertex and placing one pebble on an adjacent vertex. The pebbling number of a graph is defined to be the smallest number of pebbles such that when placed in any configuration there is a sequence of pebbling moves available to get to any empty vertex. Two classes of graphs are defined, Samurai Sudoku and Chessboard, and lower bounds are presented for pebbling numbers of variations of these graphs.

10:20–10:35

Bounds on MSNs Accepting Directed Trees

Joshua Brakensiek
High School (Homeschool)

We prove bounds on the size of sound monotone switching networks accepting permutations sets of directed trees. This corresponds to proving almost tight bounds on the monotone memory efficiency of the directed ST-connectivity problem when the input graph is guaranteed to be disconnected or isomorphic to a specific directed tree.

10:40–10:55

Shuffle Posets and Their Hasse Diagrams

Calvin Cochran
Hendrix College

Shuffle posets are poset variations which contain listings of elements of ordered alphabets A and/or B such that the listings preserve the order of the alphabets within their structures. This project uses combinatorics and abstract algebra to inspect the Hasse diagrams of shuffle posets for partial order and group-like qualities.

11:00–11:15

Minimum Sumset Size

Karenna Genzlinger
Gettysburg College

We are interested in finding the minimum possible size of an h-fold restricted sumset of an m-element subset of $\mathbb{Z}_n$, denoted by $\rho\hat{}(n, m, h) = min\{|h\hat{}A| \mid |A| = m\}$. A good upper bound for $\rho\hat{}(n, m, h)$ is $u\hat{}(n, m, h)$, which is found by comparing a few strategically chosen m-subsets of $\mathbb{Z}_n$.

11:20–11:35

GraphTheory in 140 Characters or Less: An Analysis of Directed Social Networks

Jonathan Marino
Roanoke College

Social media outlets like Facebook and Twitter allow individuals to post their thoughts in real time and "follow" others. However, each network behaves differently. We used graph theory to visualize and measure the difference between several social networks as well as quantify how information is dispersed throughout a given network.

11:40–11:55

Subtraction Adds Nothing: Calculating the Minimum Size of h-fold Unrestricted Signed Sumsets of m-sized Subsets of Cyclic Groups

Ryan Matzke
Gettysburg College

The minimum size of an h-fold unrestricted sumset of an m-sized subset of a cyclic group is known, along with a method to find the ideal subset. By taking advantage of the group being cyclic and the inverse property, we find the same size for a signed sumset.

MAA Session #19

Theater 115: CCC Room 11 **2:00P.M. – 3:55P.M.**

2:00–2:15

Colored Independence on Cycle Graphs and Finite Grids

Michael Terhaar

St. John's University

In colored independence, we consider a storage/scheduling problem. In addition to the standard restriction involving pairs of elements that cannot be placed together, we will consider pairs of elements that must be placed together. A set S is a colored-independent set if, for each color class V_i, $S \cap V_i = V_i$ or $S \cap V_i = \emptyset$. Suppose we have a partition $F = \{V_1, V_2, \ldots, V_t\}$ on a graph G. The F-independence number of G is the maximum cardinality of an independent set $S \subseteq V(G)$ denoted $\beta(G; F)$. Note that if any two vertices in V_i are adjacent, then one must have $S \cap V_i = \emptyset$. The independence-partition number of a graph G is $\beta_{PRT}(G) = min\{\beta(G; F) : F\ is\ a\ partition\ of\ V(G)\ into\ independent\ sets\}$. The coupled-independence number is defined to be $\beta_{cpl}(G) = min\{\beta(G; F) : F\ is\ a\ partition\ of\ V(G)\ into\ independent\ sets\ with\ each\ |V_i| \leq 2\}$. We will take the ideas of colored independence, independence-partition number, and coupled-independence number and apply them to cycle graphs as well as finite grids.

2:20–2:35

Geometry and Other Mathematics in the Card Game SET

Jordan Awan, Claire Frechette and Yumi Li

Clarion University, Brown University and Willamette University

The card game SET serves as an excellent model for the finite geometry $AG(4; 3)$. Using that visualization, previous researchers have found partitions of $AG(4; 3)$ into 4 disjoint maximal caps (collections of points with no lines; in this case, collections of cards with no sets) along with a distinguished point/card. We will present results about these partitions and other interesting mathematics that have arisen from the visualization provided by the game of SET

2:40–2:55

Graph Connectivity Indices of Octagonal Systems

William P. Burke and Rob R. A. Baello

Montclair State University

In this presentation we will report the results from our research project on Randi Connectivity Indices (RCI) of certain graphs derived from chemistry and biology problems. Special focus is on octagonal systems. Formulas for RCI values are given for all those graphs without interior vertices and for a special type of graph called Lake Graph. We further identify the graphs with maximum or minimum RCI value among these graphs. As one of the most successful molecular descriptors for structural-property and structural-activity relationship studies, the RCI values may reveal connectivities and related properties of the considered graphs. This research is funded by NSA (grant H98230-13-1-0270) and NSF (grant DMS-1156582) through MAA NREUP.

3:00–3:15

Applications of Graph Connectivity Indices in DNA Data Analysis

Pamela Guerron and Zeyad Boodoo
Montclair State University

Using graph index techniques to analyze DNA data has become a new method in recent years. Our research applies the *Randić Connectivity Index*, together with various generalized forms of it, to analyze DNA sequence data of Chagas disease obtained from biology research. It aims to better understand the evolutionary relationships of the insect vectors. We apply the graph index method on converted DNA line graphs, perform normalization and principle component analysis on them, and build phylogenetic trees from the data in order to answer scientific questions about the disease. In this presentation we will report the results from this on-going research. This research is funded by NSA (grant H98230-13-1-0270) and NSF (grant DMS-1156582) through MAA NREUP.

MAA Session #20

Theater 115: CCC Room 12 **2:00P.M. – 3:55P.M.**

2:00–2:15

The Vibration Spectrum of Two Euler-Bernoulli Beams Coupled Via a Dissipative Joint

Christopher Abriola, Aglika Darakchieva and Tyler Wales
Marist College, Fairfield University and Louisiana State University

We present analytical/asymptotic results for the vibration spectrum of two identical Euler-Bernoulli beams coupled by way of each of the four standard types of dissipative joint conditions. We do so for all cases of energy-conserving end conditions - clamped, pinned, roller supported and free - and we categorize the results based on which configurations are asymptotically equivalent, with regard to vibration frequencies and damping rates.

2:20–2:35

Numerical Approaches to Thermoelastic Rods with Dynamic Contact

Natanya Clark
Arkansas State University

In this work, we study mathematical tools and numerical schemes for solving a system of partial differential equations that describes the displacement and temperature of a thermoelastic rod. When the rod touches a deformable obstacle, the normal compliance is considered as a contact condition. We set up numerical formulations using time descretization and a hybrid of the midpoint rule and the implicit Euler method. The boundedness of the energy function over each time step ensures numerical stability. The Finite Element Method is also applied to set up the fully discrete numerical formulation. Numerical results and simulations are presented.

2:40–2:55

Numeric and Analytic Solutions to Extreme Deflection Problems

Alex Safsten
Brigham Young University

We examine the shape of a paper sheet as it undergoes large deflections. We hypothesize that paper assumes a minimal energy shape subject to boundary conditions imposed by the deflection, and that the energy stored in each unit of arc length is proportional to the curvature of the paper squared. Using this model we have applied variational calculus and evolutionary algorithms in order to find analytic and numeric solutions to the shape of deflected paper.

3:00–3:15

Modeling Properties of Compliant Mechanisms

Travis Fillmore
Brigham Young University

Objects folded from a material that has some flexibility can have motions that are not possible with stiffer materials. In such cases there are regions of stability. One example is a kaleidocycle, which is a closed ring composed of at least 6 tetrahedra that has the ability to rotate continuously. Based on numerical evaluations there are regions where the kaleidocycle appears to be monostable, bistable, tristable, and quadstable. The aim of this research is to model such behaviors mathematically.

MAA Session #21

Theater 115: CCC Room 13 **2:00P.M. – 3:55P.M.**

2:00–2:15

Hilbert's Space-Filling Curve

Tim Tarver

Bethune-Cookman University

This paper introduces the notion of a certain type of space-filling curve. We will be talking about how a one-dimensional curve can be called space-filling. The curve will begin at a one-dimensional unit interval and be mapped onto a unit square by a certain correspondence. This correspondence is said to have a one-to-one correspondence. This correspondence will be denoted as a function later on in this paper. There are different kinds of space-filling curves such as the Lebesque Curve, the Peano Curve, the Sierpinski Curve, and the Recursive space-filling curve. This amazing finding was first brought to everyone's attention by Henri Lebesque. He explained this finding geometrically and analytically in this paper as a function of "t". We will discuss a specific type of curve called the "Hilbert's Space-Filling Curve" by David Hilbert and how it is NOT one-to-one.

2:20–2:35

Pointwise Besov Space Smoothing of Images

Jonathan D. Cohen

Duquesne University

Recently, fast algorithms for minimizing the Total Variation (TV) of an image have been proposed for solving the image denoising problem. TV-based denoising, however, creates a 'staircasing effect' which poorly represents smoothly changing regions of the underlying clean image. An alternative is to use Besov spaces, which have a mechanism similar to TV to measure the smoothness of an image. We propose a generalization of the TV-based approaches to Besov spaces, which allows for smoothly changing regions to be maintained in the cleaned image. We also propose a saddle-point formulation of the Besov denoising model, forming a convex optimization problem, which may be efficiently solved using state-of-the-art primal-dual methods.

2:40–2:55

Anderson (de)localization on the Sierpinski Gasket

Harold Westin King and Amanda Hoisington

Baylor University and University of California Riverside

The question of Anderson localization, suggested in 1958, examines whether an initially localized state in a random medium will remain bounded in space or evolve into a scattering state.

This phenomenon has been studied for many underlying geometries. We apply recently developed numerical methods to the Sierpinski gasket to investigate the presence or absence of Anderson localization.

MAA Session #22

Theater 115: CCC Room 21 **2:00P.M. – 3:55P.M.**

2:00–2:15

Taxicab Geometry and Mass Transit Distance

George Ison Thekkedath
Trinity College

In this presentation, I will cover the basic ideas behind taxicab geometry. We will explore how shapes change due to the constraints of the taxicab metric and how these ideas differ from Euclidean geometry. We will also explore mass-transit distance and understand how adding a subway into taxicab geometry can change the distance between points. To put the idea to perspective, we will investigate how traffic density within an area can affect the mass-transit distance as well.

2:20–2:35

An Expository Proof of Bezout's Theorem

James Emil-Maxum Grenier
Radford University

Bezout's Theorem gives a relation between the degrees of two curves and the number of intersection points in projective space. In this paper we briefly outline the history leading to the discovery and proof of the theorem; we explain the importance of Bezout's Theorem and illustrate this with several applications; then we present an expository proof of the theorem designed to be comprehensible at the undergraduate level. The proof is based on the outline given by Rational Points on an Elliptic Curve by Silverman and Tate.

2:40–2:55

Coxeter Group Fundamentals with Purely Algebraic Arguments

Austin Conner
Vanderbilt University

Coxeter groups geometrically represent symmetry groups generated by reflections. Naturally, many classical arguments for elementary Coxeter group theorems appeal to this interpretation, relying on results of linear algebra and root systems. However, the Coxeter groups can also be defined purely algebraically as a class of group presentations. When thought of this way, it is instructive and clear to have the basic theorems proved using purely algebraic arguments. The fact that subgroups generated by a subset of the Coxeter generators are themselves Coxeter groups is an important classical result for which no purely algebraic argument exists. We provide such a proof for this theorem using the algebraic method of Dehn diagrams, relying on no geometrical facts.

J. Sutherland Frame Lectures

2013	Gilbert Strang	*Matrices I Admire*
2012	Melanie Matchett Wood	*The Chemistry of Primes*
2011	Margaret H. Wright	*You Can't Top This: Making Things Better with Mathematics*
2010	Nathaniel Dean	*Incomprehensibility*
2009	Persi Diaconis	*The Mathematics of Perfect Shuffles*
2008	John H. Conway	*The Symmetries of Things*
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, the American Statistical Association, the Committee for Undergraduate Research, the Society for Industrial and Applied Mathematics, Budapest Semesters in 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 subsistence grants to Pi Mu Epsilon speakers.

MAA Lectures for Students

2013	Frank Morgan	*Optimal Pentagonal Tilings*
2012	Ivars Peterson	*Geometreks*
2011	Roger Nelson	*Math Icons*
2010	Sommer Gentry	*Faster, Safer, Healthier with Operations Research*
2009	Colm Mulcahy	*Mathemagic with a Deck of Cards on the Interval Between 5.700439718 and 80658175170943878571660636856403766975289505440883277824000000000000*
2008	Laura Taalman	*Sudoku: Questions, Variations and Research*
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*

In Memory of

Dr. J. Douglas Faires

Youngstown State University

J. Douglas Faires, longtime MAA member and PME leader passed away on Friday, December 21, 2012. Doug leaves behind his wife Barbara (currently Secretary of the MAA and retired professor) and his daughter Erika. Doug and Barbara have both held a variety of leadership positions in MAA over the years, and are members of the Icosahedron Society.

Doug graduated from Youngstown State University in 1963 and, after earning his Ph.D. from University of South Carolina in 1969, returned to YSU as a faculty member until his retirement in 2006 – the same year he was instrumental in establishing the Center for Undergraduate Research at YSU.

A tireless champion of undergraduate research in mathematics, Doug was a driving force behind the establishment, in 2006, of the Center for Undergraduate Research in Mathematics at Youngstown State. After his retirement, he continued to serve as chair of the Oversight Committee.

Doug served as President of the Ohio Section of MAA in 1981-82, and represented the Section on the Board of Governors from 1997-2000. He was awarded the Section Teaching Award in 1996. In addition to his deep involvement with MAA, Doug was a leader in Pi Mu Epsilon, serving as a member of the Council from 1987 to 2005, including a term as President from 1999 to 2002. He was awarded the MacDuffee Award by Pi Mu Epsilon for lifetime service in 2005.

Doug's publication list was long, and includes several editions of the classic *Numerical Analysis*, with Richard Burden. More recently, he wrote the best-selling book *First Steps for Math Olympians: Using the American Mathematics Competitions* (MAA, 2006).

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