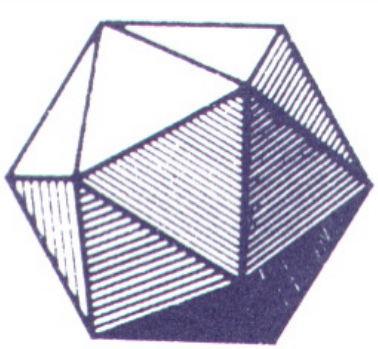
North Central Section

Mathematical Association of America



Spring Meeting • April 05-06, 2019
Augsburg University
Minneapolis, Minnesota

Friday, April 05, 2019

Student Activities

6:00 – 7:00	**Student activity**– Hagfors Center 150C Meet-and-greet, Pizza, and Interactive Fractal Activity
7:00 – 7:55	**Estimathon** – Hagfors Center 150C Team contest for students. No need for pre-arranged teams

6:00 – 8:10	**Registration** – Hagfors Center Lobby $15 (Free for Students and Invited Speakers)
7:00 – 8:00	**Book Display**, Hagfors Center 186

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Contributed Session – Hagfors Center 150AB, Presiding: John Zobitz

7:00 – 7:20 **Barry Cipra, Freelancer**,
What Goes Up Must Come Down: Reflections on the Classic Cannonball Problem

7:25 – 7:45 **Paul Zorn, Saint Olaf College,**
The Discrete Charm of the Cauchy Integral Formula

7:50 – 8:10 **Alexander Barrios, Carleton College,**
Historical Introduction to Sheaves

Invited Lecture – Sateren Auditorium, Presiding: Rebekah Dupont, Director of STEM Programs

8:20 – 9:10 **Sarah Luttman, Google**
Your Math Major in the Wild: Translating Your Degree into a Corporate Career

9:15 – 10:00 **Reception and Undergraduate Poster Session** – Hagfors Center Lobby

Saturday, April 06, 2019

8:30 – 11:00 **Registration** – Hagfors Center Lobby

8:30 – 11:00,
12:00-2:00 **Book Display** – Hagfors Center 186

Invited Lecture – Sateren Auditorium, Presiding: Suzanne Dorée

8:55 – 9:05 **Welcome:** Suzanne Dorée, Mathematics, Statistics, and Computer Science Department Chair

9:05 – 9:55 **Jenny Quinn, University of Washington, Tacoma**
Epic Math Battles: Counting vs. Matching

Morning Concurrent Session I – Hagfors Center 151, Presiding: Matt Haines

10:05 – 10:25 **Jung-Han Kimn, South Dakota State University**,
Parallel Implementation of 3D Biofilm Flow Simulation Using the Modified Cahn-Hilliard Equation

10:30 – 10:50 **Riley O'Neill, University of Saint Thomas** (Undergraduate),
Discrete Geometric Invariants for Bone Fragment Refitting

Morning Concurrent Session II – Hagfors Center 150AB, Presiding: Jody Sorensen

10:05 – 10:50 **Workshop**
Pavel Bělík, Suzanne Dorée, Jody Sorensen, John Zobitz, Augsburg University,
Applied and Active: Renovating Calculus at Augsburg

Invited Lecture – Sateren Auditorium, Presiding: John Zobitz

11:00 – 11:50 **Carlos Castillo-Chavez, Arizona State University**
Socio-Epidemiology: The Role of Social Dynamics and Behavior on the Spread of Disease

12:00 – 1:15 **Lunch** – Christensen Center, Commons Cafeteria
Tickets can be purchased for the cafeteria and a list of nearby eateries is also available.

1:15 – 1:50 **Business Meeting** – Sateren Auditorium, Presiding: Sarah Jahn, Section President

Invited Lecture – Sateren Auditorium, Presiding: Jody Sorensen

2:00 – 2:50 **Section NExT Speaker**
Lori Ziegelmeier, Macalester College
On the Data of Images

Afternoon Concurrent Session I – Hagfors Center 151, Presiding: Rich Flint

3:00 – 3:20 **Ashok Aryal, Minnesota State University-Moorhead,**
Free Boundary Problems

3:25 – 3:45 **Ioana Ghenciu, University of Wisconsin-River Falls**,
Euler's Summation Formula

3:50 – 4:10 **Bret Benesh, College of Saint Benedict and Saint John's University,**
Periodicity in Nim-Numbers of Subtraction Games

Afternoon Concurrent Session II – Hagfors Center 150AB, Presiding: Suzanne Dorée

3:00 – 3:20 **Travis Peters, College of Saint Benedict and Saint John's University,**
Transfer of Learning from Calculus to Subsequent Engineering Courses

3:25 – 3:45 **Olga Lopukhova, University of Saint Thomas**,
Should We Switch to Co-Remediation in mathematics?

3:50 – 4:10 **Suzanne Dorée, Augsburg University**,
Green Pens, Purple Paper, Whiteboards, and Other Stories: Feedback Structures that Support Student Learning.

Local Organizing Committee:
Pavel Bělík, Suzanne Dorée, Rich Flint, Matthew Haines, Billie Marget, Jody Sorensen, John Zobitz

Abstracts

Invited Addresses

Carlos Castillo-Chavez, **Arizona State University,**
Socio-Epidemiology: The Role of Social Dynamics and Behavior on the Spread of Disease

I will revisit the field of classical mathematical epidemiology, a field created by physicians. I will start by looking at the contributions of Sir Ronald Ross. Recent applications of Ross' framework and extensions will be applied in the context of the study of the spread of disease. Emphasis will be placed on the role of mobility, behavior and modes of transmission on the dynamics and control of epidemic outbreaks.

Examples will be provided from communicable and vector borne diseases under scenarios that account for the impact of mobility and behavior.

Sarah Luttman, Google,
Your Math Major in the Wild: Translating Your Degree into a Corporate Career

Math majors have clear-cut incredible job opportunities in education, academia and research. However, the wide-ranging opportunities for corporate career paths are less obvious and can seem elusive, while math skills remain in high demand. Sarah will share her experience translating her math major into a corporate career, and offer some tips and tricks for math students to explore career paths across industries.

Jenny Quinn, University of Washington, Tacoma,
Epic Math Battles: Counting vs. Matching

Positive sums count. Alternating sums match. So which is "easier" to consider mathematically? This talk is one part performance art and three parts combinatorics. The audience will judge a combinatorial competition between the competing techniques. Be prepared to explore a variety of positive and alternating sums involving binomial coefficients, Fibonacci numbers, and other beautiful combinatorial quantities. How are the terms in each sum concretely interpreted? What is being counted? What is being matched? Do alternating sums always give simpler results? You decide.

Lori Ziegelmeier, Macalester College,
On the Data of Images

Digital images can be treated as mathematical objects that can be manipulated, processed, and transformed. A data set may consist of the pixels within a single image or a set of images that each share a common trait. In this talk, we will explore the data of images and observe the structure present through a variety of lenses. This structure will be investigated by using techniques related to linear algebra, data compression, clustering, and geometry. This talk is accessible for undergraduates and could serve as a potential topic for exploration in a linear algebra course.

Workshop

Pavel Belik, Suzanne Dorée, Jody Sorensen, John Zobitz, Augsburg University,
Applied and Active: Renovating Calculus at Augsburg

In this workshop we will share the work we've been doing to renovate Calculus I and II over the past few years. This work is supported by a multi-institutional NSF I-USE grant, SUMMIT-P, which supports redesigning courses in collaboration with the partner disciplines. Our team includes a chemist and an economist. Our courses include planned active learning activities and at least one application topic every day of the semester.

In the first part of the workshop we will discuss our redesign process, including conversations with the partner disciplines and the three part structure of a typical class day. In the second part you will be able to experience the various types of active learning we incorporate into the course, including collaborative activities, problem solving at the whiteboard, and labs which focus on the transference of previously learned mathematics. (You are welcome to come to just one part.)

Contributed Talks

Ashok Aryal, Minnesota State University-Moorhead,
Free Boundary Problems

Free boundary problems deal with solving partial differential equations (PDEs) in a domain, a part of whose boundary is prior unknown; that portion of the boundary is called a free boundary. Free boundary problems are widely used in various applications. The Stefan Problem, Obstacle Problems are some notable free boundary problems. In this talk, we will discuss some examples of the free boundary problems, its geometrical aspect, and couple of key properties that are useful to understand the geometry of the free boundary problems.

Alexander Barrios, Carleton College,
Historical Introduction to Sheaves

In this talk, we trace Jean Leray's discovery of sheaves during his time as a prisoner of war during the Nazi occupation of France. Leray who specialized in fluid dynamics sought to change his research to pure mathematics and began considering equivalence relations on the complex plane. Tracing in his footsteps, we will study the equivalence relation $(f, p) \sim (g, q)$ if and only if f and g are complex differentiable functions which are equal in some open set containing $p = q$. From this equivalence relation, we will unravel the marvelous structure of a sheaf by showing how it has an algebraic, analytic, and topological structure. This talk will only assume knowledge of calculus.

Bret Benesh, College of Saint Benedict and Saint John's University, Mark Ward, Purdue University, et al.
Periodicity in Nim-Numbers of Subtraction Games

We will study the games like the following one. Imagine there are two players and a pile of 10 pennies between them. The two players take turns removing either 1 or 2 pennies from the pile until the pennies are all gone. The person who takes the last penny wins.

We will look at two versions of games like this. The first version will be very predictable, and we will present a new proof of an old result. The second one will be surprisingly chaotic.

Barry Cipra, Freelancer,
What Goes Up Must Come Down: Reflections on the Classic Cannonball Problem

Do you really need calculus to solve a max-min problem? Do you even need algebra? We'll see the answer is No.

Suzanne Dorée, Augsburg University,
Green Pens, Purple Paper, Whiteboards, and Other Stories: Feedback Structures that Support Student Learning.

How do we empower our students to include feedback in their own learning process? How do we facilitate peer feedback to encourage and include all students? How can we as instructors provide informal and formal feedback in a way that helps students learn? Throughout my career I have been developing efficient, effective, and supportive structures that provide feedback to students (and not just because I am avoiding grading). This talk will highlight some examples I have used. *Repeat of my Haimo Teaching award presentation at JMM. Thank you to the North Central Section for the nomination.*

Ioana Ghenciu, University of Wisconsin-River Falls,
Euler's Summation Formula

We will present Euler-Maclaurin's Summation Formula, a powerful tool for estimating sums by integrals, and also for evaluating integrals in terms of sums.

Jung-Han Kimn, Jeffrey Doom, Nathan McClanahan, Nicholas Stegmeier, and Rylee Sundermann**, South Dakota State University**,
Parallel Implementation of 3D Biofilm Flow Simulation Using the Modified Cahn-Hilliard Equation

We present our current numerical procedures and results of parallel 3D implementation of the modified Cahn-Hilliard equation for biofilm flow. The scaling, efficiency, and numerical accuracy of this implementation are investigated. High fidelity simulation results for several test cases of Biofilms are presented.

Olga Lopukhova, University of Saint Thomas,
Should We Switch to Co-Remediation in Mathematics?

We've considered the benefits of possible switch from traditional remediation model to co-remediation in mathematics at University of Saint Thomas (UST). We've surveyed the available information on the success of co-remediation implementation in peer institutions in United States. We've also analyzed student performance data in their mathematics remediation course(s) and their first college-credit mathematics course from 2014 through 2018 to compare the performance of traditional remediation model at UST and other schools. The Math ACT scores of UST students were also included in the analysis. The results of the survey, and the results of UST data analysis will be presented.

Riley O'Neill, University of Saint Thomas (Undergraduate)**,** Pedro Angulo-Umana, University of Minnesota, Jeff Calder, University of Minnesota, Reed Coil, Nazarbayev University, Jacob Elafandi, University of Minnesota, Bo Hessburg, University of Minnesota, Peter Olver, University of Minnesota, Cheri Shakiban, University of St. Thomas, Martha Tappen, University of Minnesota, Jacob Theis, University of St. Thomas, Anthony Yezzi, Georgia Institute of Technology, Katrina Yezzi-Woodley, University of Minnesota,

Discrete Geometric Invariants for Bone Fragment Refitting

Manual bone fragment refitting is a tedious and time-consuming task, but is critical to understanding ancient hominin behavior. To digitize and automate this process, triangulated bone surfaces were devised from CT scans and discrete geometric invariants were prepared for implementation in MATLAB. Four invariants were examined: cumulative distance histograms, area histograms, spherical volume, and principal curvature, the latter two arising from our new analytic method using the divergence theorem. Efforts are underway to pair the spherical volume invariant and principal curvatures with Dijkstra's algorithm and other methods for edge detection, face segmentation, and bone reassembly.

Travis Peters, College of Saint Benedict and Saint John's University, Craig Ogilvie, Iowa State University,

Transfer of Learning from Calculus to Subsequent Engineering Courses

In this longitudinal study, students answered a question from the Calculus Concept Inventory (CCI) pre- and post-instruction in Calculus I as well as an analogous question in the next semester framed in the context of Aerospace Engineering or Chemical Engineering. Nearly 88% of the students who answered the post-CCI question correctly answered the context question correctly, suggesting that students are able to transfer learning from Calculus I to subsequent engineering courses. Students also answered two questions from the Student Assessment of their Learning Gains instrument to assess their mathematical confidence and the degree to which they make connections between mathematics courses and other courses. Students who were more confident in their mathematical ability were more successful in transferring their understanding from the mathematics to the engineering context.

Paul Zorn, Saint Olaf College,

The Discrete Charm of the Cauchy Integral Formula

The Cauchy Integral Formula (CIF) is a key result of and resource for complex analysis. As the "I" suggests, the CIF is fundamentally about continuous objects. But the CIF has arguably simpler discrete analogues, with surprisingly powerful implications. I'll give examples.

Undergraduate Student Posters

Megan Johnson, Augsburg University,

Flowers and Research Randomness

Last semester in a Marketing Research & Analysis class, I worked on a project with a local flower shop. In the project I helped to create and distribute a survey to students at Augsburg so that the sample of students we took was randomized. After receiving 109 surveys, we analyzed the data and made suggestions to the company on how to better attract and meet the needs of students interested in buying flowers. I plan to create a poster to show our results, the importance of having a random sample, and how to know if your sample is random.

Brandon Tran, University of Saint Thomas,
Pursuit of All Composite Links

In nature there are many examples of links, such as those found in proteins. Mathematicians have classified the so-called "prime links" through 11 crossings. The non-prime links, known as composite links, have not received as much attention as prime links. Due to applications in the sciences there is an increasing need to be able to classify linking, both prime and composite, in physical systems. The goal of this project is to create a set of software tools to classify all links through 10 crossings.

John Wallace, University of Saint Thomas,
Analysis and Simulation of Knot Transitions

Knotted structures are prevalent in systems from a variety of disciplines, including biochemistry, particle physics, and fluid dynamics. While knotting and knotting transitions have been observed in these real-world systems, the scientific community does not yet know the reason or function of this behavior. Our research goal is to study knot transition processes with computational methods and analyze the intermediary knot types to give insight into and identify defining characteristics of these processes. Our recent work has focused on a simulation method based on Langevin dynamics, which has applications in the analysis of knotted DNA and proteins.

Matt Ward, University of Saint Thomas,
Using Neural Networks to Predict Knot Type

The goal of our project was to see if neural networks could classify knots. The simplest case for such an experiment was to use 6 edge equilateral knots, of which there are only three kinds of knots: the Unknot, the -Trefoil and the +Trefoil. The experiments we performed focused on determining the best way to present the knots to the neural network in order to maximize classification accuracy. The results from our experiments showed us that presenting the neural network with images of knots that have contrastingly colored edges and an orthographic projection increases knot classification accuracy. We also found that increasing the number of images of knots given to the neural network increases knot classification accuracy.