Fall 2023 Joint New Jersey/EPaDel Section Meeting

Hosted by Villanova University, November 11, 2023

Schedule

Time	Event
8:30-10:30	Registration: Atrium in Driscoll Hall
8:30-9:00	Light Breakfast Reception: Atrium
9:00-9:10	Welcoming Remarks: Driscoll 134
9:15-10:05	Judith Covington, Northwestern State University *Math Teachers' Circles - What, Why, When, and How?*
10:05-10:30	Coffee and Snacks Break
10:35-11:25	Kristen Hendricks, Rutgers University *A First Look at Knots and Symmetries*
11:25-11:45	Business Meeting, Awards, and Group Photo
11:45-1:00	Lunch & Table Discussions Dougherty Hall (#23 on the campus map)
1:10-2:10	Faculty and Grad Student Contributed Paper Sessions and Student Activities. Faculty Workshop led by Judith Covington.
2:20-3:20	Student Speakers
3:20-3:40	Coffee Break
3:40-4:30	Jason Rosenhouse, James Madison University *Dirichlet's Theorem and the Rise of Analytic Number Theory*
4:30-5:00	Reception & Silent Auction Winner Announcements

Math Teachers' Circles - What, Why, When, and How?

Judith Covington

Northwestern State University

Abstract: I believe that K-12 teachers are the key to our future. I also believe that in general society does not do enough to support and encourage these teachers. I have spent my career teaching mathematics to future teachers. However, as we all know, learning does not stop at graduation. In 2009 I learned about Math Teachers' Circles and immediately knew this was something that I needed to provide for my local teachers. In 2010 I created the North Louisiana Math Teachers' Circle. I will talk about what Math Teachers Circles are and why I so desperately wanted to create one. I will talk about the struggles and the successes of this endeavor and will share tips on how to start your own Math Teachers Circle. And of course, there will be some math problems to solve as well!

Judith Covington received a Bachelor of Science Degree in Mathematics Education from Northwestern State University in Natchitoches, Louisiana, her hometown. She then received a master's degree and PhD from the University of Southwestern Louisiana, now known as University of Louisiana Lafayette. While a graduate student Judith first became involved in educating future teachers. She spent 25 years at Louisiana State University in Shreveport where she taught courses for future teachers. In 2010, Judith founded the North Louisiana Math Teachers' Circle and for 8 years ran a very successful circle until she returned to teach at Northwestern State in 2018. Judith has an extensive background working with the MAA. She is an original (1994) Project NExT Red dot and served on the Project NExT leadership team from 1997 until 2014. She has also served as a MAA Governor-at- Large for teacher education as well as the Governor/Representative of the Louisiana Mississippi Section where she is currently serving as the section chair.

A First Look at Knots and Symmetries

Kristen Hendricks

Rutgers University

Abstract: A mathematical knot is a simple object -- take a piece of string, tie it up however you like, and glue the ends together so you can't untie it. But these deceptively easy objects to describe and fiddle with are key to understanding deep geometric questions, many not nearly so accessible. We'll introduce knots and consider some possible measures of how complicated a knot is, before turning our attention to one of my favorite topics, possible symmetries of knots. In the end, we'll see how different types of symmetry have wildly different relationships with how "complicated" the knots involved are.

Kristen Hendricks is a low-dimensional and symplectic topologist. Most of her work is focused on developing equivariant versions of various Floer-theoretic invariants and exploring their applications to problems of 3-manifolds and knots. She did her undergraduate degree in mathematics at Harvard, followed by doctoral work at Columbia and a postdoctoral position at UCLA. After three years as an assistant professor at Michigan State, she moved to Rutgers, where she is presently an associate professor. Her work has been recognized by an NSF CAREER grant (2018), a Sloan Research Fellowship (2019), and an AWM Birman Research Prize in Topology and Geometry (2023). When not doing mathematics, she enjoys science fiction novels and unnecessarily complicated knitting projects.

Dirichlet's Theorem and the Rise of Analytic Number Theory

Jason Rosenhouse

US Air Force Academy
James Madison University

Abstract: In 1837, Peter G. L. Dirichlet proved the following theorem: If a and d are relatively prime integers, then the arithmetic progression a, a+d, a+2d, ... contains infinitely many prime numbers. His proof ushered in a revolution in number theory because it relied in a critical way on complex analysis. The use of analytic methods to solve problems in number theory was a tremendous innovation at the time. We shall consider some of the details of Dirichlet's proof, focusing on understanding why there is a deep connection between these seemingly unrelated branches of mathematics.

Jason Rosenhouse is a professor of mathematics at James Madison University, Harrisonburg, VA. For the 2023-2024 academic year, he is the Distinguished Visiting Professor in the Department of Mathematical Sciences at the U. S. Air Force Academy, Colorado Springs, CO. He received his PhD in mathematics from Dartmouth College, Hanover, NH in 2000, specializing in number theory and combinatorics. He is the author or editor of nine books on topics such as recreational mathematics and evolution vs. creationism. Currently, he is the editor of Mathematics Magazine, published by the MAA. When not doing math, he enjoys chess, cooking, and reading locked-room mysteries.

FOOD FOR THOUGHT SERIES

(*Lunch table conversations*)

Coordinator:

Dr. Agashi P. Nwogbaga

Former Chair, Math Dept. & Professor of Mathematics & Data Science (Wesley College).

Current Affiliation: Mathematics Department, Delaware Tech, Dover, Delaware.

These lunch table conversations are intended to provide an opportunity for people to meet with other colleagues from around the region to discuss topics that interest them while they eat. Participants have the choice to self-assign themselves to topics and tables of their choice. So, those who do not wish to be involved or who want to just catch up with math friends will have plenty of opportunity to do that as well. Here is a list of the topics for this EPADEL + NJ meeting:

AWM – Supporting & Celebrating Women in Math: To discuss various current matters about women in the mathematical sciences. Possible subtopics include but are not limited to equal pay, encouraging and supporting female students to enter the profession, celebrating accomplishments of women, creating community among women in the profession, recruiting minority women into the profession, differences in teaching styles/classroom dynamics, how to deal with discrimination, and equal distribution of resources to support research. What other questions or ideas do you have for this topic?

Addressing the Nationwide Teacher Shortage: We hope to bring awareness to this crucial issue to brainstorm some ideas among the participants and share their best practices to retain their math teaching faculty in their higher education institutions. What can/should we do to help the ongoing nationwide teacher shortage in K-12 educational setting and what are the implications of this shortage for higher education institutions in NJ/PA/DE? What other questions or ideas do you have for this topic? You can ask or help answer questions from your experiences.
Moderated & Led by Dr. Sheila Tabanli, Department of Mathematics, Rutgers, The State University of New Jersey.

Zoom Teaching Tips: Although the extent to which Zoom is used vary from faculty to faculty, from semester to semester, and from one university to another, it appears that Zoom is not going away any time soon. So, how to do we promote teaching, enhance student participation, and nourish student engagement in Zoom classes of mathematics? What other practical Zoom teaching tips do you have? What other questions or ideas do you have for this topic? You can ask or help answer questions from your experiences.

Faculty/Graduate Contributed Paper Sessions
EPaDel/MAA-NJ Joint Section Meeting
11-November-2023

1:10 pm – 2:10 pm

Faculty Session 1: Driscoll 248
Speakers: Dr. James Poinsett, Alexander Furia, Yevgeniy V Galperin

Faculty Session 2: Driscoll 246
Speakers: Myung Song, Patrick Stewart, Torrey Gallagher

Faculty Session 3: Driscoll 244
Speakers: Michael Yatauro, Tom Hagedorn, Sky Pelletier Waterpeace

Faculty Session 4: Driscoll 240
Speakers: Jacob Hauser, Samantha Miller-Brown, Kenneth Gill

Faculty Session 5: Driscoll 227
Speakers: Rasha Abadir , Artur Andrade, Jeongsu Kyeong

Faculty Session 6: Driscoll 221
Speakers: Anthony Acquaviva, Ibukunoluwa Ogunjimi, Dachao Sun

Faculty/Graduate Session 1: Driscoll 248

1:10 pm, Dr. James Poinsett (Brookdale Community College)

Soccer & Color in Introductory Linear Algebra: A Couple of Simple Metaphors to Build Vector Space Structure and Computations Within

Abstract: An introductory sophomore-level linear algebra class is often a student's first real encounter with abstraction in mathematics. With such a transition from computationally-focused mathematics to structurally-focused mathematics comes hardship for many students. How can we as educators lessen that transitional burden for them? Using common metaphors through inquiry-based learning is one possible way. The game of soccer can be used to introduce the concept of vector space and printer ink cartridge sets can be used to explore the notion of basis of a finite-dimensional vector space. Soccer: If you were to explain the game of soccer to someone who has never seen the game, how would you describe it? In whatever way you explain it, your descriptions can be organized into the categories: objects, actions, and rules, much like that of a vector space. The sets are the objects, the actions are the operations, and the rules are the ten algebraic properties. Printer Ink Cartridges: HP sends the colors black, cyan, yellow, and magenta in their standard set of ink cartridges. Why do they send these four cartridges? Why don't these four cartridges come with an additional fifth cartridge of another color? Why don't they send only three of these four cartridges? Answering these questions leads to a greater understanding of linear independence, span and basis of a vector space. By linking the concepts of vector space, linear independence, span and basis to everyday life experiences, students have a familiar reference point when building these abstract concepts. Connections to student life outside the classroom such as in these soccer and printer cartridges examples can help lessen the transitional burden from computationally-focused mathematics to structurally-focused mathematics.

1:30 pm, Alexander Furia (Chestnut Hill College)

The Many Pitfalls of Computers and the Ladder of Verification

Abstract: Numerical computation power has increased drastically over the past few decades. This numerical power has resulted in many benefits for mathematicians. However, while computers do provide an amazing resource, many pitfalls exist that make numerical results difficult to obtain. In this talk we will explore the many issues that can arise when trying to obtain numerical data in a scattering problem and a present the ladder of verification used to ensure accurate results.

1:50 pm, Yevgeniy V Galperin (East Stroudsburg University of PA)

Image Processing in College Math

Abstract: We discuss the use of basic and advance image processing methods to provide meaningful context for reviewing key topics of the college mathematics curriculum, to help students gain confidence in using concepts and techniques of applied mathematics, to increase

student awareness of recent developments in mathematical sciences, and to help students prepare for graduate studies.

Faculty/Graduate Session 2: Driscoll 246

1:10 pm, Myung Song (Kutztown University of Pennsylvania)

Statistical Machine Learning to Predict the Number of Solutions for a Minimum Cardinality Set Covering Problem

Abstract: The minimum cardinality set covering problem (MCSCP) is an NP-hard combinatorial optimization problem in which a set must be covered by a minimum number of subsets selected from a specified collection of subsets of the given set. It is well documented in the literature that the MCSCP has numerous, varied, and important industrial applications. For some of these applications it would be useful to know if there are alternative optimums and the qualitative number of alternative optimums. In this presentation, statistical machine learning methods such as principal component analysis, correlation analysis, classification trees, and neural networks are employed to qualitatively predict the number of optimal solutions to a MCSCP.

1:30 pm, Patrick Stewart (Millersville)

Introducing the Law of Large Numbers to Statistics Courses Through an Interactive Programming Activity

Abstract: When students are first introduced to theoretical and empirical probability, they tend to have trouble linking the two concepts together. The Law of Large Numbers is the link between the concepts. The Law acts as the foundations for the understanding of sampling distributions, and thus enables the ability to make statistical inferences. An activity I run in my classes involves having students visualize the Law of Large Numbers through computer simulations of coin flips, die rolls, etc. What happens to the long-running probability of an outcome as the number of trials increases? Students explore the consequences of long-running empirical probabilities to make a conjecture of what happens to the empirical probability of an outcome as the number of trials keeps getting larger. In this way, students are engaged and have active participation from the beginning of the process in discerning the fundamental differences between empirical and theoretical probability.

1:50 pm, Torrey Gallagher (Monmouth University)

Equity, Inclusion, and Retention Initiatives in the Monmouth University School of Science

Abstract: In this talk, we will discuss some of the initiatives being taken to promote equity and improve retention in the School of Science at Monmouth University. Attendees will hear about several actionable goals that can be accomplished on the individual, departmental, or school-wide level. In particular, we will highlight the use of a small grant by the School of Science DEI Committee (of which the present author is a founding member) to foster school-wide growth amongst STEM faculty in the areas of equity, inclusion, and retention.

Faculty/Graduate Session 3: Driscoll 244

1:10 pm, Michael Yatauro (Penn State - Brandywine)

Integer Partitions and Representation Graphs

Abstract: Consider a partition of the integer $n \geq 1$ given by $n=a_1+a_2+\cdots+a_m$, where $1\leq a_1 \leq a_2 \leq\cdots\leq a_m$. The graph defined by $G(n; a_1, a_2, \ldots, a_m) = K_{a_1} \cup K_{a_2} \cup \cdots \cup K_{a_m}$ is called a representation graph of the partition, where K_i is the complete graph on i vertices. These graphs arise naturally when considering edge-maximal constructions with respect to certain graph parameters. In this talk, we will discuss some interesting results about representation graphs that resulted from the study of one specific graph parameter (known as component order edge connectivity). Here, we will not discuss the role of this parameter, but instead we will focus on the corresponding partitions and representation graphs.

1:30 pm, Tom Hagedorn (The College of New Jersey)

A Covering System of $\mathbb{Z}[i]$ with Minimal Modulus $\sqrt{8}$

Abstract: For covering systems of the integers, with distinct moduli, Owens (2014) constructed a covering system with minimal modulus 42, extending the work of Nielsen (2009), who constructed a covering system with minimal modulus 40. In this work, we consider covering systems of the Gaussian integers $\mathbb{Z}$ [i] with distinct moduli m_i, and seek a covering system where the minimal modulus
$| m_i |=N(m_i)^{1/2}$ is as large as possible. Jordan (1967) constructed a covering system of $\mathbb{Z}$ [i] of minimal modulus $\sqrt{2}$, and stated the existence of one of minimal modulus 2. We improve on these results and present covering systems for $\mathbb{Z}$ [i] of minimal modulus 2, $\sqrt{5}$, and $\sqrt{8}$.

1:50 pm, Sky Pelletier Waterpeace (unaffiliated)

A Novel Generalization of the Liouville Function $\lambda(n)$ *and a Convergence Result for the Associated Dirichlet Series*

Abstract: We introduce a novel arithmetic function w(n), a generalization of the Liouville function λ(n), as the coefficients of a Dirichlet series, and as a special case of a parametrized family of functions $w_m(n)$. We prove some useful special properties of these arithmetic functions and then focus on convergence of their Dirichlet series. In particular, we show that each function $w_m(n)$ injectively maps $\mathbb{N}$ into a dense subset of the unit circle in $\mathbb{C}$ and that $F_m(s)=\sum_n \frac{w_m(n)}{n^s}$

converges for all s with $\Re(s) \in \left(\frac{1}{2}, 1\right)$. Finally, we show that the family of functions $w_m(n)$ converges to $\lambda(n)$ and that $F_m(s)$ converges uniformly in m to $\sum_n \frac{\lambda(n)}{n^s}$, implying convergence of that series in the same region and thereby proving a particularly interesting property about a closely related function.

Faculty/Graduate Session 4: Driscoll 240

1:10 pm, Jacob Hauser (Lehigh University)

A Characterization of Word-Representable Apollonian Networks

Abstract: A (simple) graph, G=(V,E), is word-representable if there exists a word w over the alphabet V such that letters x and y alternate in w if and only if xy ∈ E. A current open problem in the area of word-representable graphs is to characterize specific families of word-representable graphs. In 2018, Marc Glen showed that a K_4-free plane near-triangulation is word-representable if and only if it is 3-colorable. The characterization of all word-representable plane near-triangulations (containing K_4's) is presently unknown. As progress towards solving this problem, we present a characterization of a subclass of near-triangulations called Apollonian networks, which is the class of chordal triangulations.

1:30 pm, Samantha Miller-Brown (Lehigh University)

Symmetric Compatible $\mathcal{H}_n(0)$ *Modules*

Abstract: It's well known that the Schur functions, which are a basis for the symmetric polynomials (Sym), encode the irreducible representations of the symmetric group, $\mathfrak{S}_n$, via the Frobenius characteristic map. Up until 1996, there was no defined Frobenius characteristic map on the 0-Hecke algebra, $\mathcal{H}_n(0)$, a deformation of $\mathfrak{S}_n$. Then, in 1996, Krob and Thibon defined a quasisymmetric Frobenius map on the irreducible representations of $\mathcal{H}_n(0)$, mapping them to the quasisymmetric functions (QSym). In representation theory, the relationship between Sym and QSym is well-exploited, but there is no known direct link between these two Frobenius characteristic maps and the related representations. We explore two specific situations in which a deformation of an $\mathfrak{S}_n$ action, resulting in a valid $\mathcal{H}_n(0)$ action, gives a quasisymmetric Frobenius characteristic that is equal to the symmetric Frobenius characteristic.

1:50 pm, Kenneth Gill (Penn State University)

Probabilistic automatic complexity of finite strings

Abstract: We define a new complexity measure $A_P(x)$ for finite strings *x* using probabilistic finite-state automata (PFAs), inspired by similar existing notions that use deterministic and nondeterministic automata. $A_P(x)$ is the smallest size of a PFA for which *x* is the most likely

string to be accepted among those of the same length. In this talk, we survey the results that have been obtained so far, including a complete classification of the binary strings with $A_P(x) = 2$, and discuss future directions of research.

Faculty/Graduate Session 5: Driscoll 227

1:10 pm, Rasha Abadir (Rutgers University)

A Pilot Study Exploring the Role of Collaborative Learning in promoting Conceptual Understanding while Students Working on a Calculus Optimization Problem

Abstract: In higher education, success in first-year calculus courses is considered a gateway to several STEM majors. This emphasizes the need for calculus students to learn and understand not only the mathematical ideas that produce higher-level knowledge in the study of calculus but also the applied applications of those ideas and principles. One of the primary application concepts covered in Calculus One courses involves working on solving applied optimization problems, which students are introduced to in their first year of calculus coursework. Many students find it difficult to tackle optimization problems. The students may find it challenging to use a number of mathematical ideas and calculus techniques to solve a problem that is presented in a real-world setting. When solving an applied optimization problem, students are provided with a problem-solving task that necessitates a multi-step strategy to obtain an optimal solution (an absolute maximum or minimum value within the context of the word problem) where students are expected to read and comprehend the terms and phrases in the word problem to identify what they are being asked to optimize under the given constraints. Students are expected to attempt to translate those phrases into mathematical notations to construct an equation of the objective function that represents the desired maximum or minimum quantity along with using the constraints posed in the problem to rewrite the objective function in terms of a single variable and identify a possible interval of interest (a define domain for the single variable). Additionally, students use derivative techniques to calculate the critical numbers within that interval and apply the Extreme Value Theorem to identify a solution for the word problem under the given conditions. Furthermore, students are expected to apply either the first or second derivative test to validate that they have achieved the desired optimal solution if an interval of interest was not feasible to be found under the given constraints. In an effort to obtain additional insights and explore the significance of calculus students' effectiveness in solving optimization problems at a large four-year university, the coordinator of the Calculus I course for life and social sciences stated. "Every few years I have to submit a report on the scores and grades of students on particular topics and the topics that students consistently do poorly on despite all the many revisions and additions we've made are optimization and intermediate algebra. Optimization, in particular, is really disheartening to examine because many students can't even start the problems. Like they have no idea what the goal is or what the question is asking. They have no idea how to even parse what is expected of them. In one semester (Spring 2021 I think), the average score on the optimization problem was 2/20, and the median score was 0/20." The coordinator's comments serve as a need to draw attention to the necessity for more exploration into the root causes of the student's underperformance on this specific topic. In the interest of determining whether collaborative learning may provide a suitable setting for promoting a conceptual understanding of the core ideas and mathematical concepts necessary for effectively

solving optimization problems, a pilot study was implemented in which a group of four students was invited to collaborate on solving the following optimization problem. “Tasty Soup Company is bringing its split pea soup to the market. They want to manufacture a cylindrical can that holds 475 cubic centimeters of soup. The material for the sides of the can cost 3 cents per square centimeter. The material for the top and bottom costs 8 cents per square centimeter. The manufacturing company is seeking help from calculus students to find the dimensions for the can that will minimize the cost of materials. Can you advise the Tasty Executive about the best dimensions?” a) Your group will need to use calculus knowledge to come up with the dimensions that will help the company meet the manufacturing requirement while minimizing the cost. b) Your group must present to the company a proposal for the dimensions of the soup can and the minimum cost, by providing a supporting argument for the finding to convince the company that the dimensions you came up with are what guarantee the minimum cost given the manufacturing requirement. The small-group session was videotaped, and the data are being transcribed and analyzed to investigate the contributions made by the students working together to reach a solution. Exit interviews are planned to follow up on their problem-solving activity.

1:30 pm, Artur Andrade (Temple University)

Overdetermined elliptic boundary value problems in uniformly rectifiable domains

Abstract: A number of physical phenomena are modeled by overdetermined boundary value problems, that is, boundary problems in which one imposes both Dirichlet and Neumann type boundary conditions. The subject of this talk is the analysis of over-determined boundary value problems (OBVP) for the Laplacian in non-smooth domains with boundary datum in Whitney--Lebesgue spaces. This analysis includes integral representation formulas, jump relations, existence and uniqueness of solutions for the OBVP in uniformly rectifiable domains. This is joint work with Irina Mitrea (Temple University), Dorina Mitrea and Marius Mitrea (Baylor University).

1:50 pm, Jeongsu Kyeong (Temple University)

The poly-Cauchy operator in Uniformly Rectifiable domains

Abstract: The classical Cauchy integral operator is one of the most famous and most studied singular integral operator in mathematics. In this poster, I will be presenting a higher-order analogue of the existing theory for the classical Cauchy operator, in which the salient role of the Cauchy-Riemann operator $\overline{\partial}$ is now played by natural powers of this. A central role will be played by integral representation formulas, jump relations, and higher-order Fatou-type theorems. This is joint work with Irina Mitrea (Temple University), Dorina Mitrea and Marius Mitrea (Baylor University).

Faculty/Graduate Session 6: Driscoll 221

1:10 pm, Anthony Acquaviva (Villanova University)

Environmental Impact of a U.S. Transition from an Animal-Based Diet to More Plant-Based Diets

Abstract: Numerous reports and studies tout a vegan diet's positive impact on the environment. Our study investigates the effect on the environment, particularly greenhouse gas (GHG) emissions, land use, and freshwater withdrawals, of shifting from animal-based diets to plant-based diets in the U.S. Linear regression models for prototypical omnivore, vegetarian, and vegan diets are created based on U.S. consumption data and a review of 570 life-cycle assessments of various foods. These models are used to compare future scenarios with no dietary changes to scenarios where meat-based diets are replaced by more plant-based diets. We also explore the impact of reducing the consumption of animal by-products (such as dairy and eggs) through model analysis. We find that an annual drop of 0.75% of the percentage of the U.S. omnivore population would lead to a 2-6% reduction in GHG emissions by 2030 and a 6-20% reduction by 2050. We also see a 3-6% (by 2030) and 9-21% (by 2050) reduction in land use and 1-5% (by 2030) and 3-17% (by 2050) reduction in freshwater withdrawals. The extent of the reduction depends on whether the omnivore diet is replaced by a vegetarian or vegan diet.

1:30 pm, Ibukunoluwa Ogunjimi (Villanova University)

Mathematical Model for Hair Braiding

Abstract: This mathematical model explores the relationship between time, length, number of braids, and other factors. It provides insights into hair thickness, texture of extensions, and type of braids. This model serves as a valuable tool for hairstylists, researchers, and product developers in the beauty industry, enhancing braiding techniques, precision, and design.

1:50 pm, Dachao Sun (West Chester University)

Fourier Inversion of Moment Generating Functions

Abstract: Moment generating functions (MGFs) are a insightful tool in probability theory and statistics, which shares the identical form of a two-sided Laplace transform. In a typical progression of the introduction MGFs, a look-up table is usually present in purpose of finding the corresponding probability distribution from which an MGF is calculated by summation or integration. Here, we will start from the definitions of integral transform and (exponential) Fourier transform, and delve into the general case of moment generating functions, and then perform a "Fourier inversion" to get back to the probability density function, using the Fourier transform as a wrapper tool.

Undergraduate Contributed Paper Sessions

EPaDel/MAA-NJ Joint Section Meeting
11-November-2023

2:20 pm – 3:20 pm

Undergraduate Session 1: Driscoll 221
Speakers: Aaron Kolaric, Joseph Aulenbacher, Peter de Bruin

Undergraduate Session 2: Driscoll 227
Speakers: Abdullah Alshamrani, Jerome Grant, Derek Wescoe, Rylee Barnhart, Shannon Travers, Danielle Konnick, Emily Medwid, Farhanaz Asskaryer

Undergraduate Session 3: Driscoll 240
Speakers: Eilis Casey, Juliana Pitts, Juliana Abruzzi, Alexa Fisher, Jayna Penn, Michael Fiore

Undergraduate Session 4: Driscoll 244
Speakers: Amine Boukardagha, Hung Nguyen, Iris Horng

Undergraduate Session 5: Driscoll 246
Speakers: Arwen Hertzler, Santure Chen, Xinxin Fang, Hillary Kim

Undergraduate Session 6: Driscoll 248
Speakers: John Seibert, Emily Shambaugh, Victor Greene, Christopher Heitmann

Undergraduate Session 1: Driscoll 221

2:20 pm, Aaron Kolaric (Shippensburg University)

Text Analysis of Alternative Protein Discourse

Abstract: Over the past several years, there has been an increase in discussion around genetically modified agriculture, especially on social media. X has been a prominent outlet for these discussions among users on both sides of the dialogue. In search for what discussions have been occurring, obtained were posts from 2016 to 2021 that contain certain key words that are common in the alternative protein discourse. Using the posts, can network analysis be used to see communication that is happening between users?

2:35 pm, Joseph Aulenbacher (Shippensburg University of PA)

Counting Sums of Subsets mod m

Abstract: This project was inspired by a YouTube video by 3Blue1Brown which details the solution to the question 'How many subsets of the set {1, 2, 3, …, 2000} have a sum that is divisible by 5?' That question appears very difficult at first, but the video presents an elegant solution involving a generating function and complex roots of unity. For our research, we discovered a formula for the more general case: 'How many subsets of the set {1, 2, 3, …, n} have a sum that is divisible by m where m|n?' Beyond that, an even more general case was solved, that being 'How many subsets of the set {1, 2, 3, …, n} have a sum that is congruent to r modulo m, where m|n?' Overall, this was an interesting project that combines a discrete combinatorial question with generating functions, modular arithmetic, and complex roots of unity.

2:50 pm, Peter de Bruin (Shippensburg University of PA)

9 and g-Collatz Functions

Abstract: Since the late 1930's Collatz conjecture has continued to baffle and intrigue mathematicians of all skill levels despite its apparent simplicity. I will be introducing the 9-Collatz variant of the original conjecture and describing some characteristics of the function and the sequences generated. We will also look at how these characteristics generalize across similar functions.

Undergraduate Session 2: Driscoll 227

2:20 pm, Abdullah Alshamrani, Jerome Grant (Saint Joseph's University)

Al-khwarizmi Presentation

Abstract: Discover the remarkable contributions of Al-Khwarizmi, the Persian scholar of the Islamic Golden Age. This presentation explores his enduring impact on mathematics, science, and education, as well as his legacy in shaping modern algebra and introducing the term "algorithm."

2:35 pm, Derek Wescoe, Rylee Barnhart (Saint Joseph's University)

Euler

Abstract: Euler was a Swiss mathematician and Physicist who was born in Basel, Switzerland and died in St. Petersburg Russia due to a brain hemorrhage. He contributed to the subjects of geometry, calculus, mechanics, and number theory, which is still used today in modern methods of mathematics. Euler developed the theory of trigonometric and logarithmic functions, reduced analytical operations to simpler form, and contributed to many parts of pure mathematics.

2:50 pm, Shannon Travers, Danielle Konnick (Saint Joseph's University)

Sir Isaac Newton

Abstract: We will be presenting about Isaac Newton. This includes his life and his contributions to mathematics. Our presentation will highlight Newton’s early life, the impacts this had on how he presented himself and how he worked to achieve his goals, and several of his contributions.

3:05 pm, Emily Medwid, Farhanaz Asskaryer (Saint Josephs University)

The Life and Legacy of Pythagoras

Abstract: Pythagoras was an ancient Greek mathematician and philosopher who left an enduring legacy. This presentation will delve into his remarkable journey, the development of the Pythagorean theorem, and learn how his contributions continue to shape mathematics, philosophy, and science today.

Undergraduate Session 3: Driscoll 240

2:20 pm, Eilis Casey (Villanova University)

Arithmetical Structures on Graphs

Abstract: This project focuses on the study of arithmetical structures on graphs. Given a graph, an arithmetical structure on it is an integer labeling of its vertices that satisfies some divisibility requirements. For each structure, there is an associated matrix that contains information about labels and adjacent vertices. In this talk, we will discuss two questions: 1) how many arithmetical structures exist for specific types of graphs, and 2) which structures produce matrices with the largest eigenvalues.

2:35 pm, Juliana Pitts, Juliana Abruzzi (Saint Joseph's University)

Koningsberg Bridge Problem

Abstract: There are many challenges in the world that can be left unsolved if they are not looked at in a different way. The town of Konigsberg, Russia had an issue with crossing over each of their towns bridges only one time, visiting each of the islands and coming back to your starting point. Euler studies this problem and crafts a theorem that it is impossible to cross seven bridges only passing over the same bridge once due to an odd number of bridges. During this presentation, we will discuss the troubles of the townspeople of Konigsberg, Euler's dedication to help solve the problem, and the importance of the birth of graph theory since it is a helpful tool used in the world today.

2:50 pm, Alexa Fisher, Jayna Penn (Kutztown University)

Girth of Algebraically Defined Bipartite Graphs

Abstract: This research pertains to the girth of algebraically defined bipartite graphs, which are graphs made through equations. Each node is assigned (x,y)-coordinates, and edges are only drawn if the coordinates from the two nodes, one from each partite set, satisfy a specific equation. Others had studied these types of graphs before using various fields, but not $\mathbb{Z}_n$. We investigated how changes to the modulus and changes to the equation impacted the girth of the graph.

3:05 pm, Michael Fiore (St. Joseph's University)

Chromatic Polynomials: An Algebraic Method in Graph Theory

Abstract: Graph theory has become one of the most important fields of study in discrete mathematics, giving rise to some of the most famous and elusive problems in recent history. Specifically, one very well-researched facet of graph theory is graph coloring, which has seen great use in both theoretical research and practical applications. In this talk, we will study some general properties of the polynomial, such as its relation to the chromatic number of a graph as well as an important recurrence property which finds use in this subject as well as others in graph theory. We conclude with some remarks on the computation of the chromatic polynomial by algorithm.

Undergraduate Session 4: Driscoll 244

2:20 pm, Amine Boukardagha (Swarthmore College)

Closed-Form Solution for the Heston PDE for European Put Options with Dividends

Abstract: We study Heston's PDE for European put options with dividends and prove the existence and uniqueness of solutions when asset prices and volatility are non-zero. We use a diffeomorphism to transform the PDE and boundary conditions in a simpler formulation, namely, the Laplace transform methods to transform the result. Finally, we derive a closed-form solution for the problem.

2:35 pm, Hung Nguyen (University of Pennsylvania)

Dynamics of a Vibro-Impact Energy Harvester Under Non-smooth Forcing

Abstract: We study the dynamics of a ball-and-capsule vibro-impact energy harvester (VI-EH) under triangle wave forcing to contrast with ideal models based on harmonic forcing. We obtain a comprehensive bifurcation structure of our model via simulations, a semi-analytical approach based on nonlinear maps, and linear stability analysis of the system under both the triangle wave forcing and its smooth Fourier approximations. Across a range of relevant parameters, we observe and characterize general shifts of periodic solutions and the bifurcations to smaller capsule lengths. Further analysis of these bifurcation structures also reveals novel phenomena not seen under harmonic forcing. Energy-harvesting analysis shows that low-order Fourier approximations provide an accurate estimate of the energy harvested under the non-smooth triangle wave. We find that the VI-EH is more efficient under the harmonic forcing than the triangle wave forcing in the same regime of motion, while the energy harvester generally remains in the more efficient regime of alternating periodic motion for a larger range of capsule lengths under the triangle wave forcing. This bridges the gap between previous work and experimental conditions.

2:50 pm, Iris Horng (University of Pennsylvania)

Algorithmic Generation of DNA Self-Assembly Graphs

Abstract: With recent advancements in the field of nanotechnology, there has been increasing interest in self-assembling nanostructures. These are constructed through the process of branched junction DNA molecules bonding with each other without external guidance. Using a flexible tile-based model, we represent molecules as vertices of a graph and cohesive ends of DNA strands as complementary half-edges allowing the molecules to bond with each other. Due to the unpredictability of DNA self-assembly in a laboratory setting and the risk of undesirable products being incidentally constructed, predicting what structures can be produced from a given list of components, referred to as a "pot of tiles" is useful but has been proven NP-hard. This project introduces an algorithm to computationally generate and visualize at least one valid graph and for smaller cases, all non-isomorphic graphs, given a pot of tiles. By adjusting a number of construction parameters, we can produce graphs of various orders and proportions of tiles.

Undergraduate Session 5: Driscoll 246

2:20 pm, Arwen Hertzler (Franklin & Marshall College)

Projective Geometry in Perspective Art

Abstract: A branch of theoretical mathematics, called projective geometry, provides many tools that can help artists. Projective geometry is the study of projections, or "images" and these projections are particularly applicable to perspective art. For example, though a cube is known to have six sides of equal area, when drawing a picture of a cube, only two (or possibly none) of the sides are actually shaped like a square. Projective geometry also demonstrates that math isn't all about calculations or algebra; rather, it can be a visual discipline and a unique manner in which we might approach problems. In this talk, we will present several art puzzles that we will solve with projective geometry. (No artistic experience is necessary!)

2:35 pm, Santure Chen (Franklin & Marshall College)

Same Base, Same "Parallels": Triangles on a Sphere

Abstract: An elementary fact from Euclidean geometry is that two triangles sharing the same base, say on a line *l*, will have the same area if and only if their third points lie on a line m that is parallel to *l*. However, the analogy of this relationship on the sphere seems to have been unknown until 1976, when it was asserted but not proved by David Huffman. This talk will give a proof for the following theorem using spherical trigonometry, and suggest a possible application of it in rigid origami: for spherical triangle $\triangle$ABC and spherical triangle $\triangle$DBC with non-zero overlapping area, they have the same area if and only if the midpoints of line segments AB, AC, DB, and DC are collinear, say on great circle *l*, and A and D, B and C are on two symmetric latitudes on either side of *l*, respectively.

2:50 pm, Xinxin Fang (The Episcopal Academy)

A Graphic Approach to the Frobenius Number Problem in Three Variables

Abstract: The Frobenius number for a set of relatively prime positive integers, where the smallest integer in the set is at least 2, is the largest integer that cannot be expressed as a nonnegative linear combination of those integers. We analyze the Frobenius number for three variables by analyzing the lattice points associated with the line ax+by=ab and its downward parallel translations, along with each lattice point's corresponding value ax+by. As an application of our graphic approach, we recover that key theorems such as results from Sylvester and Selmer can be reduced to a graphic problem of locating, followed by an evaluation of the linear form ax+by at, a lattice point. Therefore, an arithmetic problem of finding the Frobenius number is reduced to a visual/graphic problem of locating the lattice point, followed by an evaluation, both of which are simple tasks. We then extend our shortened proof of Selmer's explicit formula to derive relatively simple formulae for the general Frobenius number of three variables. Compared to previous works, our results are not algorithmic in nature nor complex, a significant improvement.

3:05 pm, Hillary Kim (Swarthmore College)

A Partial Resolution of Hedden's Conjecture

Abstract: Our research investigates the properties of the self-maps induced by pattern knots in solid tori on the smooth knot concordance group. We began by testing two-component links, one by one, to see which of them, if any, described patterns which induce homomorphisms on the knot concordance group. The initial goal of our research was to add small pieces of evidence to support Matthew Hedden's conjecture that the only patterns which induce homomorphism are those which induce the zero map, the identity map, or reversal. However, our goal changed somewhat as we started to recognize patterns in our findings, and we were eventually able to prove a stronger result, which resolves Hedden's conjecture for patterns of certain winding numbers. We prove that if the winding number of a pattern is even but not divisible by 8, then the corresponding map is not a homomorphism, thus partially establishing Hedden's conjecture. This is the first result to obstruct all patterns of a given winding number from inducing homomorphisms.

Undergraduate Session 6: Driscoll 248

2:20 pm, John Seibert (Bloomsburg University of Pennsylvania)

Evaluating the Cost of an Integer using Primitive Recursive Functions

Abstract: In 2020, Max Norfolk defined the cost of an integer relative to S, denoted C_S, a finite set of binary operations. Here, we will present an approach to constructing C_S by expanding the scope of S to sets of primitive recursive functions. $C_S(n)$ is defined as the minimum of n or the sum of the cost of a primitive recursive function, f: $N^k \to N$, in S and the cost of the argument, x, where f(x) = n. We will discuss the definition of C_S, the computability of C_S , and several theorems and open questions.

2:35 pm, Emily Shambaugh (Dickinson College)

Ghost series and a motivated proof of the Bressoud-Göllnitz-Gordon identities

Abstract: We present what we call a "motivated proof" of the Bressoud-Göllnitz-Gordon partition identities. Similar "motivated proofs" have been given by Andrews and Baxter for the Rogers-Ramanujan identities and by Lepowsky and Zhu for Gordon's identities. Additionally, "motivated proofs" have also been given for the Andrews-Bressoud partition identities by Kanade, Lepowsky, Russell, and Sills and for the Göllnitz-Gordon-Andrews identities by Coulson, Kanade, Lepowsky, McRae, Qi, Russell, and the third author. Our proof borrows both the use of "ghost series" from the "motivated proof" of the Andrews-Bressoud identities and uses recursions similar to those found in the "motivated proof" of the Göllnitz-Gordon-Andrews identities. We anticipate that this "motivated proof" of the Bressoud-Göllnitz-Gordon identities will illuminate certain twisted vertex-algebraic constructions.

2:50 pm, Victor Greene (Gettysburg College)

An Investigation of Exact h-Spanning Sets of Cyclic Groups

Abstract: Let n ∈ ℕ, and consider the Abelian group G= $\mathbb{N}_n$. For a subset $\{a_1, a_2\}$ ⊆ G, we define the h-fold signed sumset of $\{a_1, a_2\}$ to be

$$h_{\pm}\{a_1,a_2\} = \{\lambda_1 a_1 + \lambda_2 a_2 \mid |\lambda_1| + |\lambda_2| = h\}$$

We say that $\{a_1, a_2\}$ h-spans G if $h_{\pm}\{a_1, a_2\}$ = G. We are interested in finding groups G and positive integers h for which $\{a_1, a_2\}$ h-spans G. We'll present a result for when G is a group of odd order and h
is even.

3:05 pm, Christopher Heitmann (Temple University)

New Examples of Fixed Point Free and Contractive Maps

In my talk, I first prove a general theorem that once a map is fixed-point-free (fpf) and contractive on an appropriate domain, previously established series technique will always produce a fpf and contractive map. I also use a known fixed point free and non-expansive map TΔ, inspired by Alspach's famous example, to construct a new fixed-point-free and contractive map.

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