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 $G(n; a_1, a_2, \ldots, a_m) = K_{a1} \cup K_{a2} \cup \cdots \cup K_{am}$ 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 λ(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.