49th Annual New York State Regional Graduate Mathematics Conference

Syracuse University

Date: March 23, 2024

MORNING

Time	Carnegie 100	Carnegie 119	Carnegie 120	Carnegie 200	Carnegie 219
7:00-8:30	Registration and Breakfast (Carnegie 111)				
8:40-9:00	Welcome and Opening Remarks (Carnegie 122)				
9:00-10:00	Dr. Ana Menezes (Carnegie 122) Eigenvalue problems and free boundary minimal surfaces in spherical caps				
10:10-10:40	Byeong-Ho Bahn Semilinear Eigenvalue Problem: Parametric Analyticity and the Uncertainty Quantification	Shraddha Rajpal Data Assimilation for Quantum NV Diamond Spectroscopy	JinCheng Wang Magnetic Geodesic Flows on Surfaces with Negative Curvature	Jordan Barrett Toric Varieties & Zariski-Nagata Type Theorems	Sahil Chindal Predicting Dengue Incidence In The Dominican Republic Using Climate Data
10:45-11:15	Calistus Simiyu Technology in the Mathematics Classroom	Jesse Hulse The Desingularization of the Cauchy Kernel in Bounded Convex Domains	John Carney 2-adjacent Knots	Runze Wang Generalizations of Pollard's Theorem to General Abelian Groups	Shaikh Obaidullah Computational Analysis of Polyethylene Glycol (PEG)'s Impact on Gut Microbiota
11:15-11:30	Coffee Break (Carnegie 111)				
11:30-12:00	Joseph Canavatchel & Wilber Cortez The Effect of TTX on the Recovery of Amblyopia	James Myer (Toward) An Algorithm to (Explicitly) Produce a Regular Model of a Hyperelliptic Curve in (Bad) Mixed Characteristic (0, 2)	Guesh Gebremedhin Optic B-spline collocation method For Numerical Solution of One Dimensional Heat and Advection-Diffusion Equations	Adityo Mamun Representation Stability: An Introduction to FI-modules	Fei Cao Derivation of wealth distributions from biased exchange of money
12:00-12:10	Conference Photo (Steps of Carnegie)				
12:10-1:30	Lunch (Carnegie 111)				

AFTERNOON

Time	Carnegie 100	Carnegie 119	Carnegie 120	Carnegie 200	Carnegie 219
1:30-2:30	Dr. Richard Green (Carnegie 122) Positivity properties for orthogonal sets in lattices				
2:40-3:10	Dmitrii Gudin The Dynamics of Product Adoption Through Social Networks	Reginald Verrier Modeling the effects of Amblyopia on Binocular Receptive Field Development through Hebbian Learning	Amanda Tran Polygons in Finite Field Projective Space	NO TALK	Elana Israel Maximal Regular Matroids Up to Rank 6
3:15-3:45	Esayas Weldetinsae Gebrekidan Blended Learning and Students' Mathematics Cognitive Demand in Calculus of Several Variables at Universities in Tigray, Ethiopiai	Joon Do Chang Blow-up of Derivative Nonlinear Schrodinger Equation	Abdullah Malik Weisfeiler and Lehman use Simplicial Sets: Psuedotop Vertex Neural Networks	Yashi Jain How Many Irreducible are Prime?	Emma Hoover On Compositions & Polygon Dissections
3:45-4:00	Coffee Break (Carnegie 111)				
4:00-4:30	Nicholas Ofoe	Jovan Zigic Time-Dependent Solutions to the 2D Kuramoto-Sivashinsky Equation via Pseudospectral Method on a Rectangular Domain	Eric Cochran Killing Fields on Compact m-Quasi Einstein Manifolds	Daniel Havens Practical and Heuristic Limitations of the Hardy-Littlewood Circle Method	Wisdom Attipoe Quantifying Bristle Cell Organization in Drosophila Melanogaster
4:35-5:05	Sean Ku Characterization of Essential Self-Adjointness of the Laplacian and Schrodinger Operators on Birth-Death Chains	Adam Krause Energy-minimal homeomorphisms between embedded tori	Manas Srivastava On the Geometry of a Qubit	Tony Guo Stable Module Theory and the Finitistic Dimension Conjecture	Nathaniel Smith Splitting Quantum Graphs
5:05 - 5:30	Coffee Break (Carnegie 111)				
5:30-8:00	Conference Dinner (Schine Student Center, 304 ABC)				

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1. A Letter from the President and Vice President of the MGO

Welcome and thank you for participating in the 49th ANYSRGMC. The Annual New York State Regional Graduate Mathematics Conference (ANYSRGMC) is the longest running graduate mathematics conference in the country.

We would like to thank the Graduate Student Organization, Syracuse University Mathematics Department, American Mathematical Society, and the National Science Foundation for generously supporting this conference. We would like to thank Julie O'Connor, Kimberly Canino, Kelly Jarvi, and M'Tia Williams for their help with all the conference details — both little and big. A special thanks to Jesse Hulse, Elana Israel, and Karie Schmitz for all their help with the conference organization and event planning. We would also like to give a special thanks to Professor Graham Leuschke, Professor Will Wylie, and Amy Graves for their work with the NSF Grant, in addition to their knowledge and endless patience. We would like to thank our speakers, Dr. Richard Green and Dr. Ana Menezes, for graciously accepting the invitation to speak at our conference. Finally, we would like to thank all the conference attendees for participating and giving such wonderful talks. This conference would truly be impossible without all of you.

The ANYSRGMC is a Mathematics conference dedicated to providing an opportunity for mathematics graduate students in any field to present their research or give an expository talk. The ANYSRGMC allows students from across the country an opportunity to come together and explore a wide variety of mathematical topics. Students have a unique opportunity to explore their interests, gain new insights across fields, network with their peers, and explore possible cross-disciplinary collaborative efforts. Early graduate students and advanced undergraduate students are able to present undergraduate research, experience a broad range of current mathematical research, and learn from older graduate students. Overall, it is our hope and our goal to develop careers, broaden horizons, and engage the mathematics community at large. We hope you enjoy the conference!

Henry Potts-Rubin and Michael Vance, President and Vice President

2. Funding

This conference is generously supported by the Mathematics Graduate Organization, Graduate Student Organization, Syracuse University Mathematics Department, American Mathematical Society, and the National Science Foundation.

3. Keynote Speakers

Dr. Ana Menezes, Princeton University

Ana Menezes received her PhD from the Instituto de Matemática Pura e Aplicada in 2013, advised by Harold Rosenberg. Following her PhD, she was a postdoctoral fellow at the Université Marne-la-Vallée, and she is currently an assistant professor at Princeton University. Her research interests are in differential geometry and geometric partial differential equations.

Title: Eigenvalue problems and free boundary minimal surfaces in spherical caps

Abstract: In a recent work with Vanderson Lima (UFRGS, Brazil), we introduced a family of functionals on the space of Riemannian metrics of a compact surface with boundary, defined via eigenvalues of a Steklov-type problem. In this talk we will prove that each such functional is uniformly bounded from above, and we will characterize maximizing metrics as induced by free boundary minimal immersions in some geodesic ball of a round sphere. Also, we will determine that the maximizer in the case of a disk is a spherical cap of dimension two, and we will prove rotational symmetry of free boundary minimal annuli in geodesic balls of round spheres which are immersed by first eigenfunctions.

Dr. Richard Green, University of Colorado Boulder

Richard Green received his PhD from the University of Warwick in 1995, advised by Roger Carter. He subsequently held positions at the University of Oxford and at Lancaster University, and he is currently a professor at the University of Colorado Boulder. His research interests are in algebra and combinatorics, with a focus on combinatorial problems arising from Lie theory, and he has collaborated with researchers in special functions theory and in mathematical physics.

Title: Positivity properties for orthogonal sets in lattices

Abstract: There is an extremely dense way to pack spheres in 8-dimensional Euclidean space in such a way that each sphere touches 240 others. The centers of these spheres form a discrete structure called the E_8 lattice, and the 240 nonzero vectors of minimal norm in the lattice are known as roots. This talk will explain how orthogonal bases of such roots can themselves be regarded as the elements of a discrete structure in a different vector space. We will also discuss the mysterious appearance of certain positive integers in this context, as well as analogous phenomena in other lattices.
(This talk is based on joint work with Tianyuan Xu.)

4. Talk Abstracts

4.1. **10:10-10:40 Parallel Session 1.**

Carnegie 100: Byeong-Ho Bahn, University of Massachusetts Amherst

Title: Semilinear Eigenvalue Problem: Parametric Analyticity and the Uncertainty Quantification

Abstract: In this talk, we will discuss parametric semilinear elliptic eigenvalue problem. For last few decades, parametric elliptic problem has received tremendous attentions. Even if its ubiquity, the eigenvalue problem has only studied recently. Also, the problems are only focused on linear case. In this study, to the best of our knowledge, we first attempt semilinear eigenvalue problem. A special case of our problem would be Gross Pitaevskii equation which describes super-fluidity and super-conductivity with random potential function. The main obstacle was showing analyticity of the ground state because the mixed derivative of them has no meaning without the analyticity. This obstacle is resolved by using implicit function theorem and multidimensional complex analysis. With careful analysis, we obtain the bound of mixed derivatives. With this bound, we suggest a method of uncertainty quantification for the ground state.

Carnegie 119: Shraddha Rajpal, George Mason University

Title: Data Assimilation for Quantum NV Diamond Spectroscopy

Abstract: Nitrogen-vacancy (NV) defect centers in diamond have generated much interest for their uses in quantum information and sensing. Negatively charged centers (NV-) are used for high spatial-resolution sensing (magnetometry, electrometry, thermometry, and barometry) and for quantum information (with a scalable quantum computer as the eventual goal). Despite the rapid NV applications development, our grasp of basic NV properties is incomplete, which is important to understand to fully exploit potential uses. In this work we construct a statistical model for NV spectroscopy and use it in synthetic experiments to solve inverse problems. Our principal application is to develop a primary sensor based on the NV diamond quantum optical properties. This is a significant challenge because the NV diamond structure is sensitive to temperature and pressure as well as magnetic and electric fields, including electromagnetic fields of nearby atoms and molecules. First, using the Hamiltonian for the effects of local strain and the environmental variables, we identify the observable components based on the invertibility of various observation systems. Next, we observe the influence of temperature and pressure on the NV center by solving the Schrödinger Equation and computing the theoretical spectroscopy curve. We assume that the observed photon counts are Poisson random variables with rates

proportional to the theoretical spectroscopy. Then, using the Maximum Likelihood Estimation we find the parameter values that maximize the likelihood. Last but not the least we determine the robustness of the model using sensitivity analysis.

Carnegie 120: JinCheng Wang, Tufts University

Title: Magnetic Geodesic Flows on Surfaces with Negative Curvature

Abstract: The geodesic flow, representing the free motion of particles, on surfaces with negative curvature has drawn interest from both geometers and dynamists for its rich periodic orbits as a hyperbolic system. We introduce the magnetic flow by adding an orthogonal magnetic field of constant intensity to the geodesic flow. In this talk, we will discuss its geometric and dynamical properties, such as expansivity and the measure of maximal entropy, under different magnetic intensities.

Carnegie 200: Jordan Barrett, University of Nebraska Lincoln

Title: Toric Varieties & Zariski-Nagata Type Theorems

Abstract: The Zariski-Nagata theorem is a classical result which expresses the nth symbolic power of a radical ideal I in a polynomial ring over a perfect field in terms of the nth regular powers of the maximal ideals in mSpec(I). In this talk I will discuss projective space and homogeneous coordinates and I will state a well known Zariski-Nagata type theorem for projective varieties. I will also give a brief crash course on toric varieties and generalized homogeneous coordinates and I will discuss my work on developing a Zariski-Nagata theorem for this class of varieties.

Carnegie 219: Sahil Chindal, Virginia Commonwealth University

Title: Predicting Dengue Incidence In The Dominican Republic Using Climate Data

Abstract: Dengue is a mosquito-borne disease prominent in tropical and subtropical regions of the world and has been emerging in temperate areas. Dengue is endemic to the Dominican Republic, where outbreaks have been occurring for the last four decades. Most provinces in the Dominican Republic have a tropical climate with abundant rainfall during rainy seasons, providing ample resources for mosquito proliferation and growth, which creates an environment favorable for dengue transmission. Using climate data and dengue case data, we aim to determine which climate factors are associated with dengue cases. Additionally, due to the potential lags between climate and dengue trends, we seek to characterize the lags between variables associated with climate and cases. Using machine learning methods, we analyze the temporal dynamics of dengue spread by estimating the parameters of the SIR-type model framework. We validate our model using the historical data for dengue cases in the Dominican Republic. We will use our results as part of a predictive model to forecast spread of dengue cases between various provinces of the Dominican Republic and integrate our model into an early warning system that predicts outbreaks and informs public health and mosquito control policies in the Dominican Republic.

4.2. **10:45-11:15 Parallel Session 2.**

Carnegie 100: Calistus Simiyu, Syracuse University

Title: Technology in the Mathematics Classroom

Abstract: missing

Carnegie 119: Jesse Hulse, Syracuse University

Title: The Desingularization of the Cauchy Kernel in Bounded Convex Domains

Abstract: One physical application of the Cauchy integral formula appears in fluid dynamics. However, the Cauchy kernel becomes numerically unstable near the boundary of the given domain. We will present a new technique to desingularize the Cauchy kernel for bounded convex domains which is inspired by Fokas' celebrated Unified Transform method for convex polygons. Time permitting, we will show one or two applications. This is joint work with L. Lanzani (Syracuse U./ U. of Bologna), S. Lewellyn Smith (UCSD) and E. Luca (The Cyprus Institute).

Carnegie 120: John Carney, Virginia Commonwealth University

Title: 2-adjacent knots

Abstract: An n-adjacent knot is a knot that contains some n crossings such that changing any non-empty subset of those crossings results in the unknot. This expository talk will introduce the concept of n-adjacency, discuss previous results where n is greater than 2 and show some of our results on the case of 2-adjacency. This talk will explain how the $n = 2$ case is more complicated than when $n > 2$ and ways that we can approach this case.

Carnegie 200: Runze Wang, University of Memphis

Title: Generalizations of Pollard's Theorem to General Abelian Groups

Abstract: Let $A +_t B$ denote the set of elements in $A + B$ with at least t representations in the form $a + b$, where $a \in A$ and $b \in B$. Pollard's theorem shows the bound $\sum_{i=1}^{t} |A +_i B| \geq t \cdot \min\{p, |A| + |B| - t\}$ in C_p with p prime. For general abelian groups, Grynkiewicz gave a Kneser-type theorem, which provides strong structural information when $\sum_{i=1}^{t} |A+_i B| < t|A| + t|B| - 2t^2 + 3t - 2$. Another theorem is given by Hamidoune and Serra, in which the structural result is weaker. We will also talk about a recent finding, which optimizes the coefficient of the quadratic term in Grynkiewicz's theorem.

Carnegie 219: Shaikh Obaidullah, Florida State University

Title: Computational Analysis of Polyethylene Glycol (PEG)'s Impact on Gut Microbiota

Abstract: This presentation focuses on the computational analysis of the impact of Polyethylene Glycol (PEG), a widely used osmotic laxative, on gut microbiota, particularly examining the response of two significant bacterial families, Bacteroidaceae and Muribaculaceae. The study employs a mathematical modeling approach, integrating the competitive exclusion principle to explore the dynamics of these bacterial families under varying concentrations of PEG. The models are refined and validated using advanced optimization techniques like Differential Evolution, ensuring accuracy in parameter estimation and prediction alignment with empirical data. Key observations include the resilience of Bacteroidaceae to PEG-induced osmotic stress and the vulnerability of Muribaculaceae, highlighting their distinct adaptive strategies. This research provides a deeper understanding of microbial interactions in response to osmotic challenges. It sheds light on the broader implications of PEG on gut health, offering valuable insights for future therapeutic strategies and microbiota management.

4.3. **11:30-12:00 Parallel Session 3.**

Carnegie 100: Joseph Canavatchel & Wilber Cortez, Manhattan College

Title: The Effect of TTX on the Recovery of Amblyopia

Abstract: Amblyopia is a visual disorder in which the strength of the neural connections from the eyes to the brain are not balanced, causing one eye to be stronger than the other. The current treatment in humans only works on the developmental stage, due to the strength of the neurons being able to change easier. Recent experimental results in mice and cats, however, have shown that by injecting Tetrodotoxin or TTX into the stronger of the two eyes, one is able to correct this neuron imbalance. Our research is based on modeling the results from these experiments using the BCM learning rule, a Hebbian style learning rule, used for adjusting the synaptic weights of neurons based on its activity, the stimulus input, and a dynamical activity threshold. Our simulation results suggest that (1) the effect of the TTX is to reduce the firing threshold of the neuron during recovery thereby allowing lower input level from the weak eye to still activate the neuron and help it detect stimuli (2) the effect of the TTX is to increase the firing threshold of an associated inhibitory interneurons thereby making it harder for the interneuron to inhibit the activity of the binocular neuron, so that input from the weak eye is high enough to help activate the neuron to detect stimuli.

Carnegie 119: James Myer, The CUNY Graduate Center

Title: (Toward) An Algorithm to (Explicitly) Produce a Regular Model of a Hyperelliptic Curve in (Bad) Mixed Characteristic (0, 2): A Criterion to Verify Regularity of the Normalization of a Candidate Model

Abstract: Given a hyperelliptic curve (defined over a "pleasant" field of characteristic 0 whose ring of integers is of (bad) mixed characteristic (0, 2)), we seek a regular model, i.e. a(n arithmetic) surface fibered over the (spectrum of the) ring of integers of the field whose generic fiber is the given curve, and with a special fiber: its avatar in characteristic 2. A strategy is afforded within a paper of Dino Lorenzini & Qing Liu: there exists a (regular) model of the projective line whose normalization in the function field of the given hyperelliptic curve is its sought after regular model. So, we seek such a regular model of the projective line...A candidate such model is gifted to us (explicitly) by work of Andrew Obus & Padmavathi Srinivasan. We establish a stepping stone across the river toward an algorithm to (explicitly) produce a regular model of any hyperelliptic curve in (bad) mixed characteristic (0, 2): a criterion to verify the regularity of the normalization

of a candidate model of a hyperelliptic curve (equivalently, the normalization of the candidate model of the projective line of Obus & Srinivasan in the function field of the hyperelliptic curve).

Carnegie 120: Guesh Gebremedhin, Adigrat University

Title: Optic B-spline collocation method For Numerical Solution of One Dimensional Heat and Advection-Diffusion Equations

Abstract: In this article, the optic B-spline collocation approach is implemented to obtain the approximate solution of the one-dimensional heat and advection-diffusion equations. We apply the forward difference scheme for discretizing the time derivative and the Crank-Nicolson scheme for the rest terms of the governing equation. The stability of the scheme is examined and found that the method is unconditionally stable. To test the efficiency and accuracy of the method, some numerical test problems are computed and the present work is also compared with the exact solution and others.

Carnegie 200: Adityo Mamun, Queens College

Title: Representation Stability: An Introduction to FI-modules

Abstract: Group representations over vector spaces are a foundational topic of study in many areas of mathematics. In the past several years, there has been increasing interest in the study of representation stability. The goal of studying representation stability is to better understand the underlying (algebraic) structure of *sequences* of representations (i.e., permutation representations of S_n), which occur naturally in various areas of algebraic combinatorics, algebraic geometry, and algebraic topology. Many such sequences admit a natural algebraic description as an FI-module (a functor from the category FI to a module category), and FI-modules (introduced by Church, Ellenberg, and Farb) have become a foundational tool in the field. The goal of this talk is to briefly motivate, through representation stability, the study of FI-modules and their variants.

Carnegie 219: Fei Cao, University of Massachusetts Amherst

Title: Derivation of wealth distributions from biased exchange of money

Abstract: In this talk, we will illustrate the use of kinetic theory to better understand the time evolution of wealth distribution and their large-scale behavior such as the limiting money distribution and the evolution of wealth inequality (e.g. Gini index). We investigate three types of dynamics denoted unbiased, poor-biased and rich-biased exchange models. At the individual level, one agent is picked randomly based on its wealth and one of its dollars is redistributed among the population. Proving the so-called propagation of chaos, we identify the limit of each dynamics as the number of individual approaches infinity using both coupling techniques and martingale-based approaches. Equipped with the limit equation, we identify and prove the convergence to specific equilibrium for both the unbiased and poor-biased dynamics. In the rich-biased dynamics however, we observe a more complex behavior where a dispersive wave emerges. Although the dispersive wave is vanishing in time, it's also accumulates all the wealth leading to a Gini approaching 1 (its maximum value). We characterize numerically the behavior of dispersive waves but further analytic investigation is needed to derive such dispersive waves directly from the dynamics. If time allows, we also talk about the possibility of allowing agents to be indebted where a central bank is introduced. Other models in econophysics will be briefly discussed as well.

4.4. **2:40-3:10 Parallel Session 4.**

Carnegie 100: Dmitrii Gudin, University of Maryland

Title: The Dynamics of Product Adoption Through Social Networks

Abstract: While product life cycles have been extensively documented and modelled in the scientific literature, the impact of the consumer interactions on them is not fully understood. This research project addresses this gap by constructing a mathematical model of consumer networks represented as graphs, with the edges serving as carriers of information signals. We utilize methods of Bayesian statistics, graph theory, mathematical epidemiology, and survival analysis to map the information flows originating from interactions between users of digital platforms, and we fit the model on a large dataset from a digital distribution service. We plan to release the resulting predictive model as a software package to be used by product publishers and distributors.

Carnegie 119: Reginald Verrier, Manhattan College

Title: Modeling the effects of Amblyopia on Binocular Receptive Field Development through Hebbian Learning

Abstract: Receptive fields are the medium by which sensory neurons are thought to respond to stimuli. Visual receptive fields represent the sensory stimuli that will cause a neuron to respond. It is believed that receptive fields develop over time through Hebbian learning, which claims that presynaptic cells stimulating postsynaptic cells over time increases the synaptic response between those neurons. Amblyopia is diminished vision that results from inadequate visual experience during the first years of life. There is literature on Hebbian learning as it concerns the development of binocular receptive fields. The predominant belief is that amblyopia results when there is a mismatch between the images to one eye, and one treatment in the past has been patching the normal eye in order to improve the function of the amblyopic eye. In the past, a simple Hebbian coincidence detector has been able to account for the emergence of binocular, disparity selective, receptive fields. We extend this concept to amblyopia by simulating the proposed causes during development by creating a mismatch between the images used for the development of the receptive fields. Previous models have incorporated lateral inhibition by allowing one neuron to fire for a specific presentation. We see whether this simple model can be made more plausible by the addition of a K-Winner take all firing scheme during the training of our model. Our new model reflects population characteristics of the ventral nervous system. We find that allowing multiple simulated neurons to fire in each training iteration allows for a more robust neuron

population that does not take any longer to train. In addition, when introducing image pairs designed to induce amblyopia, we find that the receptive fields generated end up causing there to be a difference in how correlated the receptive field pairs are and their development of disparity. WIP

Carnegie 120: Amanda Tran, Tufts University

Title: Polygons in Finite Field Projective Space

Abstract: Given pz, there are fifteen projective points and thirty-five projective lines. The projective line complex admissibility problem seeks to describe and generalize the underlying structures that separate admissible (linearly independent) versus inadmissible (linearly redundant) complexes. This project addresses necessary conditions that contribute to admissible and inadmissible linear structures and in particular, we are interested in generalized classes of minimally inadmissible collections of lines, their associated geometry, and its dependence on the "Even Incident Condition" (which is proven and explored in this project.)
An ongoing extension, as well, is projective space over other finite fields, and how the pz inadmissability conditions generalize.

Carnegie 200: NO TALK

Carnegie 219: Elana Israel, Syracuse University

Title: Maximal Regular Matroids Up to Rank 6

Abstract: Matrices that have all sub-determinants equal to 0, 1, or -1 are called totally unimodular. These matrices give rise to a class of vector matroids, which are called regular matroids. This talk will introduce the concepts of matroids, and discuss what work has been done so far on the classification of maximal regular matroids through rank 6.

4.5. **3:15-3:45 Parallel Session 5.**

Carnegie 100: Esayas Weldetinsae Gebrekidan, Adigrat University

Title: Blended Learning and Students' Mathematics Cognitive Demand in Calculus of Several Variables at Universities in Tigray, Ethiopiai

Abstract: The main goal of this study was to investigate how blended learning affects students' cognitive demand in learning 'Calculus of Several Variables'. The study was conducted in three public universities, guided by constructivist and cognitive load theories. A total of 67 second-year undergraduate mathematics students participated for 4 months. The study utilized a mixed research method. As a theoretical framework, it was guided by combining social constructivism and blended learning theory. Data analysis involved the use of ANCOVA procedure and thematic analysis, and the findings were discussed using both quantitative and qualitative methods. The results showed that the treatment group students' cognitive demand (treatment (TG1) (M = 70.9, SD = 10.8) and treatment (TG2) (M = 69.3, SD = 20.5)) were significantly higher than the posttest scores of students in the comparison group (CG) (M = 58.8, SD = 13.5) ($p < .05$). In conclusion, blending traditional face-to-face instruction with technology can improve the cognitive demand in mathematics. These findings suggest that policy-makers should consider implementing blended learning in higher education institutions. The observed challenges in students' technological skills indicate the need for additional training to effectively use learning platforms for future studies.

Carnegie 119: Joon Do Chang, University at Buffalo

Title: Blow-up of Derivative Nonlinear Schrodinger Equation

Abstract: During this presentation, I will talk about the current literature regarding the existence of dispersive blow-up of nonlinear schrodinger and related equations for n=1,2,3. If time permits, I will also talk about the existence of dispersive blow-up for higher order schrodinger (n>3).

Carnegie 120: Abdullah Malik, Florida State University

Title: Weisfeiler and Lehman use Simplicial Sets: Psuedotop Vertex Neural Networks

Abstract: Graph neural networks are paradigms of computation that yield powerful results for structured data based on binary relationships. However, they are limited in their expressivity by the Weisfeiler-Lehman test of for graph isomorphism. The core idea behind machine learning community's circumvention of this limitation relies on identifying (and working with) higher relationships within the data. In this talk, we put forward an architecture closely based on the identification of such higher relationships via Kan Extensions of structured data built on binary relations. We will talk about its theoretical underpinnings based on the combinatorics of simplicial sets, and based off of it, introduce the notion of a pseudotop vertex as a proxy for these higher relations. We talk about how this choice respects the variance and bias trade off necessary for generalizability of the architecture.

Carnegie 200: Yashi Jain, Johns Hopkins University

Title: How many irreducible are prime?

Abstract: Recall that a nonzero, nonunit element r of an integral domain R is irreducible, provided it has no nontrivial factorizations. It is prime if, whenever r divides a product ab, it must either divide a or b. Every prime element is irreducible, but the converse holds iff R is a principal ideal domain. In this talk, I will seek to quantify the proportion of irreducible elements that are prime, when R = oK is the ring of integers in a number field K. After defining a certain norm on number field, I will give the asymptotic of P(x)/I(x) as x goes to infinity, where P(x) counts the number of primes less than equal to x and I(x) counts the number of irreducible less than equal to x. This is a joint work with Steven Spallone.

Carnegie 219: Emma Hoover, The Pennsylvania State University

Title: On Compositions & Polygon Dissections

Abstract: In this presentation we explore two classes of combinatorial objects that are of independent interest in enumerative combinatorics. On the one hand, we consider the set of integer compositions (ordered tuples of positive integers whose parts add up to a given integer), and on the other hand we consider a certain set of polygon dissections. Specifically, we study the connection between compositions of n having k parts and (n+2)-gons with (k-1) dissecting lines. These sets are not equinumerous, so the main goal is to find a way to naturally modify them in order to achieve a bijective map that can be used to pass from one class to the other.

4.6. **4:00-4:30 Parallel Session 6.**

Carnegie 100: Nicholas Ofoe, Miami University

Title:

Abstract:

Carnegie 119: Jovan Zigic, McMaster University

Title: Time-Dependent Solutions to the 2D Kuramoto-Sivashinsky Equation via Pseudospectral Method on a Rectangular Domain

Abstract: This report provides an investigation into solving the Kuramoto-Sivashinsky equation in two spatial dimensions (2DKS) using a pseudo-spectral method on various rectangular periodic domains. The Kuramoto-Sivashinsky equation is a fluid dynamics model that exhibits dynamical features that are highly dependent on the length of the periodic domain. The goals of this report are to describe the mathematical problem; explain the details of the chosen numerical method; inspect solutions and dynamical features for varying grid sizes, step sizes, and domains; and summarize the findings.

Carnegie 120: Eric Cochran, Syracuse University

Title: Killing Fields on Compact m-Quasi Einstein Manifolds

Abstract: A Riemannian manifold (M,g) is a smooth manifold M equipped with a smoothly varying inner product g defined in each tangent space on M. This allows us to define geometric notions such as lengths, angles, geodesics, and curvature. An important class of Riemannian manifolds are called "Einstein manifolds", whose Ricci curvature at each point is proportional to the metric tensor g. A generalization of Einstein manifolds are "m-quasi Einstein manifolds", which are triples (M, g, X) (where X is a smooth vector field defined on M) satisfying a certain condition that reduces to the condition that (M, g) is Einstein when X=0. Killing fields are special vector fields which preserve the metric (i.e. the manifold "looks the same" along the flow of a Killing field K). Bahaud-Gunasekaran-Kunduri-Woolgar showed that if (M, g, X) is m-quasi Einstein, (M, g) is compact, and X is divergence free, then X must be Killing. Using this result, we show that if (M, g) has constant scalar curvature and is compact, then X must be Killing.

Carnegie 200: Daniel Havens, University of New Mexico

Title: Practical and Heuristic Limitations of the Hardy-Littlewood Circle Method

Abstract: The Hardy-Littlewood Circle method is a historical centerpiece of analytic number theory, solving such problems as Waring's problem, the weak Goldbach problem, Vinogradov's mean value theorem, and a collection of problems in the theory of partitions. However, it has many limitations, such as its parity blindness, and inability to solve many conjectures surrounding prime numbers. Here, we provide a survey of the nature of these limitations, including several of the more practical limitations given the current scope of the theory. We discuss potential ways to avoid these limitations, as well as in what ways these limitations are unavoidable.

Carnegie 219: Wisdom Attipoe, Clarkson University

Title: Quantifying Bristle Cell Organization in Drosophila Melanogaster

Abstract: Repeating patterns are important for epithelia that sense the environment. Optimizing the organization of these tissues helps them to function normally. A major challenge for researchers is the ability to quantify and classify complex cell and tissue patterns across wild type and perturbed conditions. We study this problem in the fruit fly Drosophila melanogaster, where the organization of sensory bristles on its thorax contributes to the proper function of its peripheral nervous system. A well-known perturbation in bristle cell organization is density, which has been found to increase in certain fly mutants. It is unclear if this density phenotype is shared by other mutants and whether additional pattern features beyond density exist that can be used to distinguish bristle patterns. In this study, we investigate the utility of clustering features of bristle organization in distinguishing between wildtype and perturbed patterns. The K-means algorithm is used to identify and quantify clusters. Our study finds that perturbed patterns generated through various genetic knockdowns show better organized clusters than wild type patterns.

4.7. **4:35-5:05 Parallel Session 7.**

Carnegie 100: Sean Ku, New York University

Title: Characterization of Essential Self-Adjointness of the Laplacian and Schrodinger Operators on Birth-Death Chains

Abstract: AA birth-death chain can be seen as natural numbers or whole numbers with a graph structure. By forming a measure space around this graph, we can study the Laplacian operator and the Schrodinger Operator and its essential self-adjointness, and the graph's L2 Liouville property. Specifically, it can be shown essential self-adjointness is related to the triviality of L2 eigenfunctions to the operators. In this talk, we fully characterize these properties on birth-death chains.

Carnegie 119: Adam Krause, Syracuse University

Title: Energy-minimal homeomorphisms between embedded tori

Abstract: In many cases, the energy-minimal function $h : U \to V$ is a homeomorphism. We study this question for the Dirichlet energy and when U and V are embedded tori in R^3. For the standard smooth tori U and V, the existence and global invertibility of the minimizers are obtained. Surprisingly, when V is replaced by a non-smooth torus-like target surface, injectivity of the minimizer is lost. The key tools in finding an extremal homeomorphism are the free Lagrangians. We demonstrate these ideas in the case of the Dirichlet energy and a pair of planar rectangles.

Carnegie 120: Manas Srivastava, West Virginia University

Title: On the Geometry of a Qubit

Abstract: The state space of a single qubit is given by the unit sphere $S^2 \subset \mathbb{R}^3$, namely the Bloch sphere. In this talk we use quaternions to discuss the geometry of a single qubit state of quantum computing. It is well known that the unit quaternions get mapped into the $3-$ sphere, $S^3 \subset \mathbb{R}^4$. Using this knowledge we identify S^3 with the Bloch sphere using the Hopf map. We also discuss an alternate approach to construct this Hopf map by studying the composition of the maps $S^3 \to \mathbb{C}P^1$ (the complex projective line) and $\mathbb{C}P^1 \to S^2$.

Carnegie 200: Tony Guo, Brandeis University

Title: Stable Module Theory and the Finitistic Dimension Conjecture

Abstract: An essential part in the study of rings and algebras is the study of their modules, which has motivated many definitions such as Noetherian, Artinian, and Morita-equivalence. Another important example that is of particular interest to us is the finitistic dimension findimΛ of an Artin algebra Λ, which is defined as the supremum of finite projective dimension of all finitely generated Λ-modules, and the finitistic dimension conjecture states that this number is finite. In this talk, we will cover Auslander-Bridger's foundational work in stable module theory and how their work contributes to the finitistic dimension conjecture over 50 years later.

Carnegie 219: Nathaniel Smith, Miami University

Title: Splitting Quantum Graphs

Abstract: We derive a counting formula for the eigenvalues of Schrödinger operators with self-adjoint boundary conditions on quantum star graphs. More specifically, we develop techniques using Evans functions to reduce full quantum graph eigenvalue problems into smaller subgraph eigenvalue problems. These methods provide a simple way to calculate the spectra of operators with localized potentials.