



MAA Metropolitan New York
Annual Meeting
May 2, 2026



The MAA Metropolitan New York Section Annual Meeting 2026

Dear MAA Metro New York Conference Participants,

It is both a privilege and an honor to welcome you to the annual meeting of the Mathematical Association of America's Metropolitan New York Section (Metro New York)!

We hope that the program will introduce you to some new ideas and deepen your existing knowledge. We are excited to hear the Editor Lecture by Dr. Tamara Lakins and the Pólya Lecture by Dr. Po-Shen Loh as well as all of the contributed talks in our Applied Mathematics/Data Science, Miscellaneous, Pedagogy/Math Education, Pure Mathematics, and Student sessions and to see the posters in our contributed poster session. We also have workshops on using PreTeXt to improve accessibility, integrating projects into your teaching, getting started with mathematical outreach, and running a math circle.

We are also very pleased to welcome the INTEGRATE participants in our section, both teachers and students, for the first time. We are excited to see the projects ranging from poetry to posters that they will share with us in the INTEGRATE Math Fair.

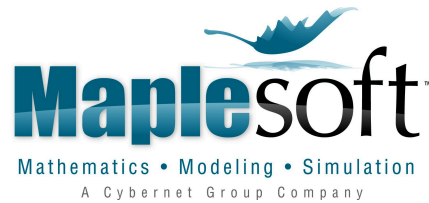
I hope you'll join me in thanking everyone who has made this meeting possible, particularly the committee members who have planned the program so carefully and our colleagues at St. Thomas Aquinas College who have helped with everything from room reservations to registration to the book exhibits.

We are also deeply grateful to our sponsors—Cengage, Coaching Actuaries, Maplesoft, and Wiley—for their continued support and for the valuable educational resources they provide.

We truly appreciate your presence and engagement today, and we warmly invite you to become more involved in our vibrant MAA Metro New York community. Thank you again for joining us.

Warmly,
Johanna Franklin
MAA Metro New York Section, Chair
on behalf of the MAA Metro New York Section

METROPOLITAN NEW YORK SECTION SPONSORS



LOCAL ORGANIZERS

Meghan DeWitt, with Steve Burns and Ellen Loftus

CONFERENCE ORGANIZERS

Emad Alfar, Bora Ferlengez, Johanna Franklin (Section Chair), Benjamin Gaines, Shamita Dutta Gupta, Richard Gustavson, Ezra Halleck, Sandie Han, Mónica Morales-Hernandez, Joshua Hiller, Andrew Lee, Lauren Rose, Eric Rowland, and Satyanand Singh

CONTRIBUTED PAPER AND POSTER SESSIONS ORGANIZING COMMITTEE

Shamita Dutta Gupta, Bora Ferlengez, and Mónica Morales-Hernandez

The MAA Metro New York Annual Meeting Agenda

May 2, 2026

- 10:00–10:10 AM **Official Welcome:** Aquinas Hall Gym
Dr. Steve Burns, Interim Dean of the School of STEM, St. Thomas Aquinas College
Dr. Johanna Franklin, MAA Metro New York Section, Chair
- 10:10–11:10 AM **Pólya Lecture:** Aquinas Hall Gym
Dr. Po-Shen Loh, Professor, Carnegie Mellon University
- 11:15 AM–noon **Contributed talks**
Applied Mathematics/Data Science Session: Maguire 126 (Presider: Ezra Halleck)
Miscellaneous Session: Maguire 122 (Presider: Satyanand Singh)
Pedagogy/Math Education Session 1: Costello 103 (Presider: Lauren Rose)
Pure Mathematics Session 1: Maguire 118 (Presider: Eric Rowland)
Student Session 1: Costello 104 (Presider: Emad Alfar)
- 11:15 AM–noon **INTEGRATE Math Fair:** Library Reading Room
- noon–1:15 PM **Lunch:** Aquinas Hall Gym
Poster Session: Aquinas Hall Gym (Presider: Richard Gustavson)
- 1:15–2:15 PM **Editor Lecture:** Aquinas Hall Gym
Dr. Tamara Lakins, Professor, Allegheny College
- 2:15–2:45 PM **Awards Ceremony:** Aquinas Hall Gym
- 2:50–3:35 PM **Contributed talks**
Pedagogy/Math Education 2: Costello 103 (Presider: Emad Alfar)
Pedagogy/Math Education 3: Maguire 122 (Presider: Satyanand Singh)
Pure Mathematics Session 2: Maguire 118 (Presider: Ezra Halleck)
Pure Mathematics Session 3: Maguire 126 (Presider: Eric Rowland)
Student Session 2: Costello 104 (Presider: Lauren Rose)
- 2:50–3:35 PM **INTEGRATE Math Fair:** Library Reading Room
- 3:40–4:25 PM **Workshops**
MAA Metro NExT Workshop: Students as Partners: Making an Impact by Learning with Students: Costello 103
INTEGRATE Handbook Round Table: Costello 104
Mathematical Outreach that YOU Can Do!: Maguire 126
Use of Accessible PreTeXt-Based OER for Student Centered Learning: Maguire 118
- 4:30–5:00 PM **Business Meeting:** Aquinas Hall Gym (Presider: Johanna Franklin, MAA Metro New York Section, Chair)

Dr. Tamara Lakins, *Allegheny College*

A journey with *The College Mathematics Journal*

Abstract: The MAA journals (*The College Mathematics Journal*, *Mathematics Magazine*, and *The American Mathematical Monthly*) offer a wealth of mathematics for college faculty and their students. We begin with a quick introduction to *CMJ* and the particular fun found in *CMJ*'s Proofs Without Words. We then describe how MAA journal articles were used in an upper level course dedicated to helping majors learn to read mathematics more independently, give a sampling of recently published *CMJ* papers appropriate for an undergraduate audience, and include tips for those interested in publishing in *CMJ*.



Bio: Tamara Lakins is Editor of MAA's *The College Mathematics Journal* and Professor Emeritus of Mathematics at Allegheny College, a small liberal arts college located in northwest Pennsylvania. After 28 years at Allegheny, she retired in 2023. Tami was a 1995–96 Project NExT Fellow and has been active in the MAA at both the section and national level, serving as Chair, Governor, and Treasurer of the Allegheny Mountain Section, co-coordinator of the Allegheny Mountain Section NExT, and Associate Editor on the MAA Classroom Resource Materials Editorial Board. Her book, *The Tools of Mathematical Reasoning* (AMS Pure and Applied Undergraduate Texts

26), was published by the American Mathematical Society in 2016. Tami's term as Editor of *CMJ* runs from 2024 to 2028.

PÓLYA LECTURE

Dr. Po-Shen Loh, *Carnegie Mellon University*

Using math to invent win-win solutions for large-scale human problems, just in time to survive AI

Abstract: "Why are we learning this?" — the dreaded question often received by mathematics educators

The speaker will share his story, which starts with a math degree and the International Mathematical Olympiad (where he was the USA national coach for 10 years). Now he travels to 100+ cities per year, observing the human condition firsthand, and then uses his combinatorics and problem-solving background to devise new solutions to practical problems that affect our whole society: disease control, education, and more generally, the survival of human civilization. The mathematical areas of graph theory and game theory feature as inspirations in his work.

He has been working for a decade at the intersection of education and technology. His latest creation there is a new, highly-scalable ecosystem for teaching secondary school students how to invent their own solutions to unfamiliar (math) problems, powered by a unique incentive alignment structure that involves professionally trained actors and comedians collaborating with math stars. This comes just in time, as the rise of AI necessitates more advanced skills. Along the way, it also presents a novel solution to the bigger question of how to reasonably organize society in the post-AI age.

This talk will be accessible to people across all career stages. Mathematicians will notice several key places where mathematical insights played a major role in unlocking solutions.



Bio: Prof. Loh is a social entrepreneur and inventor. He combines math, science, and technology with firsthand exploration of the human condition. Across the global landscape of work, AI, and education. Major newspapers have covered his diverse innovations. His latest initiative unites math stars and actors to transform education. He won silver for Team USA at the 1999 International Math Olympiad, and served a decade as National Coach. He is a Hertz Fellow — in a community of broadly innovative scientists with roots in the Manhattan Project and Space Race.

He personally speaks in an unprecedented 100+ cities per year on education-after-AI. Conferences. Substitute-teaching in K–12 classrooms. Visiting companies and labs. Public lectures. Learning while sharing ideas with students, parents, researchers, and policymakers. All while teaching at one of the world's foremost universities in AI (Carnegie Mellon) and running his own EdTech social enterprise.

INTEGRATE MATH FAIR

11:15 AM–noon and 2:50–3:35 PM

MAA INTEGRATE is a new MAA initiative that fosters collaboration across K-12 and higher education communities. Its activities support a systemic approach to expanding access to high-quality mathematics education and enrichment opportunities for all students. Through a focus on building local programs and communities, MAA INTEGRATE supports students' mathematical development, strengthens positive mathematical identities, and builds students' sense of belonging in mathematics. MAA INTEGRATE programs, resources, and networks further expand the value of MAA membership for K-12 teachers and MAA members who work with or have an interest in working with K-12 educators, students, and families.

The MAA INTEGRATE Math Fair showcases fun and engaging projects, games, and activities that make a great addition to math enrichment programs. The student presenters, from middle schools and Boys and Girls Club programs across New York City, have been part of a pilot program for MAA INTEGRATE's Math Club Handbook (to be launched at 2026 MAA MathFest). They are excited to share some of their favorite activities through presentations, demonstrations, and opportunities for you to try them for yourself. If you currently run a math club or enrichment program, or you would like to do so in the future, come check out all the MAA INTEGRATE Math Club Handbook has to offer and hear directly from students and teachers about the best ways to create fun, challenging mathematical experiences for students of all ages.

WORKSHOPS

3:40–4:25 PM

Mathematical Outreach that YOU Can Do!

Meghan De Witt (St. Thomas Aquinas College), Brett Karopczyc (St. Thomas Aquinas College), Bob Vermilyer (St. Thomas Aquinas College), Heather Rave (St. Thomas Aquinas College), Jonathan Leal (St. Thomas Aquinas College)

Ever wanted to do mathematical outreach, but you don't know where to start, or think you don't have the time? We will help you discover ways to start outreach with low barriers to entry that anyone can do for minimal time commitments and yet they can still have a great impact on the participants. Outreach doesn't have to be hard!

MAA Metro NExT Workshop: Students as Partners: Making an Impact by Learning with Students

Angel Pineda (Hofstra University)

As teachers and scholars, supporting and having a positive impact on students is something that we all strive for. In my experience, this happens most naturally when faculty work with students in activities that they are passionate about rather than doing something for them. Trying to find the intersection of one's research interests and the student's background knowledge leads to a collaborative as well as a mentoring relationship. Using projects in courses leads to students teaching us and the rest of the class what they find interesting, as well as adding lines to their resume which help when looking for internships. When possible, including students in volunteering benefits the project and adds a mentoring aspect. In all of these, it is also helpful to look for external sources of support, especially for under-represented students. In this talk, I will share my experiences trying to support students by partnering and learning from them and invite you to find your own way through interactive and sharing activities.

INTEGRATE Handbook Round Table

Alpha Recio

The MAA INTEGRATE project's purpose is to assist teachers in establishing and improving their math clubs. Math clubs exist as a transformative tool that academic communities can use in order to create an ecosystem of positive math identities. Last year, this project was piloted with teachers across New York City in order to "integrate" their experiences, resources, and feedback into a math club handbook such that other teachers across the country can use this resource. This round table will dissect this handbook; We will hear from teachers who have participated in this pilot, teachers who have been recently introduced with it, and teachers who assisted in the development of this project. Further, we will discuss the math club as a community space and how impactful that has been for students.

Use of Accessible PreTeXt-Based OER for Student Centered Learning

Marina Dedlovskaya (CUNY LaGuardia Community College), Bukurie Gjoci (CUNY LaGuardia Community College), Shenglan Yuan (CUNY LaGuardia Community College)

This introductory workshop demonstrates the PROWESS Classrooms pedagogy and its integration with Open Educational Resources (OER), with emphasis on those developed using PreTeXt. It showcases how accessible, student-centered materials enhance engagement and equity, with examples of implementation and strategies for continuous improvement. The workshop will explore available PreTeXt-based OER and learn about resources that support content development. Using examples from the Discrete Mathematics course worksheet(s) originally developed in LaTeX, we will walk through the conversion process step by step. Participants will gain practical insight into structuring content in PreTeXt and learn strategies for developing accessible online workbooks.

CONTRIBUTED PAPER SESSIONS
11:15 AM–noon

Applied Mathematics and Data Science Session

Maguire 126, Presider: Ezra Halleck

11:15 AM

Lanchester Combat Model with One-Sided Information

Charles Li (Mercy University)

The Lanchester combat model (Lanchester square law) is analyzed from the perspective of limited information from just one side of the battle. We tackle this matter theoretically and then test it in practice with real combat data from the Battle of Iwo Jima. A recurrence relation is developed which theoretically enables the battle outcome and intensity of the battle to be deduced from knowing one side's force levels at three moments in time, without any knowledge of the other side's force levels. Furthermore, it is not necessary to know the attrition rates as is usual with the Lanchester model. This analysis with limited one-sided information can be thought of as a formal mathematical model exploring the effects of a fog of war on the Lanchester combat model. Our one-sided combat model is tested with data from the Battle of Iwo Jima and is shown to be successful at making short-term predictions of friendly force levels, but not long-term predictions.

11:30 AM

Collective Synchronization on Cayley Graphs

Richard Gustavson* (Farmingdale State College), Lawrence Udeigwe (Manhattan University)

Collective synchronization is a phenomenon in which a large system of oscillators spontaneously obtain a common frequency. This behavior is observed in such biological examples as pacemaker cells in the heart, synchronous firefly flashes, and chirping crickets. An important question related to collective synchronization is how the arrangement of the oscillators affects the common, steady-state frequency. In this talk we discuss synchronization of oscillators arranged in the form of a Cayley graph of a group, and examine how the symmetries of the group affect the properties of the oscillators.

11:45 AM

Symbolic Logistic Regression for Interval-Valued Predictors: A Simulation Study and Application to Health Data

Soad Abdullah (Northern Illinois University)

Adviser: Duchwan Ryu (Northern Illinois University)

This study investigates symbolic logistic regression for interval-valued predictors through simulation studies and a real health data application. Classical logistic regression assumes exact predictor values, whereas in many practical settings variables are available only in interval form due to coarsening or reporting uncertainty. Two simulation studies are conducted to examine the impact of interval uncertainty under asymmetric intervals and measurement error. Symbolic models based on midpoint and midpoint-plus-width representations are compared with the classical approach. Results show that midpoint modeling captures the general relationship but introduces bias under asymmetry, while incorporating width reduces this distortion. Under measurement error, classical logistic regression exhibits attenuation bias, whereas symbolic models remain comparatively stable. The methodology is applied to NHANES data using grouped age intervals, where symbolic midpoint regression preserves the overall relationship with only minor loss of precision. Overall, symbolic logistic regression provides a stable and interpretable approach when predictors are available in interval form.

Miscellaneous Session

Maguire 122, Presider: Satyanand Singh

11:15 AM

Michaelis-Menten Kinetics in Hydrangea Macrophyllas in Correspondence to Soil pH

Yoseni Chen (Centereach High School)

Adviser: Vera Hu (SUNY Suffolk County Community College)

The Michaelis-Menten Equation is a mathematical model used in biochemistry to determine the reaction rate of an enzyme at a given substrate concentration: $v_0 = \frac{V_{max}[S]}{K_m + [S]}$. This study uses this equation to determine the relationship between soil pH and the kinetics of an enzyme and how it connects to the coloration of the sepals in Hydrangea Macrophyllas. In acidic soils, the sepals appear to be blue, whereas in basic soils, the sepals appear to be pink. This is due to the aluminum ion concentration ($[Al^{3+}]$) in soil, which is toxic to the plant. In lower pHs, the $[Al^{3+}]$ increases, and the hydrangea releases citric acid to detoxify the aluminum ions. This further consists of the enzyme Chalcone synthase and the substrate p-coumaroyl-CoA, which initiates the production of the anthocyanin delphinidin-3-O-glucoside with the purpose of binding with the product of the citric acid and aluminum ions. Using a constant K_m value of 0.6 μM , a normalized V_{max} value of one and a range of different substrate concentrations from 0.1M to 10.0M, increasing by 0.3 with

each calculation to simulate varying environmental conditions, the activity of the enzyme increased as the concentration did as well. These results suggest that the relationship between pH and enzyme kinetics is that at lower pHs, the activity of Chalcone synthase is higher than at higher pHs. This then corresponds to more vibrancy in the blue pigment being produced at more acidic pHs.

11:30 AM

Lonely Distancing Dance Graphs: An Undergraduate Research Project

Angelina Chirichella (Marist University), Matthew Glomski* (Marist University), K. Peter Krog (Marist University), Elizabeth Reid (Marist University)

People can crave company while simultaneously seeking to avoid too much of it. Elaborating on this goal of “lonely distancing” we construct a scenario in which k players on an $n \times n$ grid jockey to occupy space next to a single companion while maintaining at least a minimum distance from everyone else. The tension behind these conflicting needs—companionship versus isolation—induces a dynamical system on the grid we model with directed graphs. Depending on k and n , players are likely to redistribute themselves into one or more equilibrium states. In very special cases no such resolution is possible, and the players enter a cycle of perpetual redistribution in what we call a never-ending lonely distancing dance.

Pedagogy/Math Education Session 1

Costello 103, Presider: Lauren Rose

11:15 AM

Experiential Learning and Mathematics

Shamita Dutta Gupta (Pace University)

Competence in mathematics is a journey for the individual. However, bringing in a community to help develop strong and confident mathematically sound individuals with analytic capabilities for logical reasoning has led me down the path of community based Experiential Learning. I have made the connection of Math for my students with industries exploring topics and writing projects, producing portfolios in my Writing Enhanced Statistics Course. It gives meaningful exposure to industries that apply math. I have made the connection of Math to service in my service-learning course where I have connected my students to high school students to tutor them. My philosophy that when you teach you have an obligation to learn and deliver correct knowledge has helped my students to take ownership of their high school math knowledge which in turn made them stronger college math students and they gained valuable exposure to teaching experiences. Now further along in my journey, exploring with my Experiential Learning course, I choose to connect mathematics to the world around my students. By visiting museums with their multiple displays on STEM

topics, it serves as a trigger for understanding Mathematics. First, the students are exposed to a guided exploration to observe the world around them through a veil of Mathematics and then they are left to explore on their own and explain their findings with mathematics. The project presentation days are thrilling when the students share their unexpected connections with Mathematics.

11:30 AM

Integrating Social Justice Projects in Differential Equations to Foster Belonging and Broaden Participation in STEM

Mónica Morales-Hernandez* (Adelphi University), Sherli Koshy-Chenthittayil (Touro University Nevada)

Courses in differential equations are frequently viewed by students as highly theoretical and detached from real world contexts. This presentation describes an instructional approach that incorporates project based learning centered on socially relevant issues within an introductory ordinary differential equations course. Students develop mathematical models related to topics such as health inequities, environmental challenges, and other societal systems. Through these projects, students apply differential equations, data analysis, and computational tools while examining how mathematical methods can help investigate complex social phenomena. This framework is designed to enhance student engagement, cultivate a stronger sense of belonging in mathematics, and motivate students from historically underrepresented backgrounds to continue in STEM pathways. The talk will include examples of student work as well as practical strategies for incorporating socially meaningful modeling projects into differential equations curricula.

Pure Mathematics Session 1

Maguire 118, Presider: Eric Rowland

11:15 AM

Powers, Primes, and Pascal's Triangle

Eric Rowland (Hofstra University), Allison R. Siegel* (Hofstra University)

Pascal's triangle has been a source of mathematical insight for over a thousand years. For our purposes, we are interested in the many number theoretic properties of Pascal's triangle. For example, consider the 5th row on Pascal's triangle, which is $(1, 5, 10, 10, 5, 1)$, and consider the prime 2. The exponent to which 2 divides each entry is $(0, 0, 1, 1, 0, 0)$. In particular, 4 of the 6 entries are not divisible by 2, resulting in 0's. These 0's represent 2^0 . The remaining 2 entries are 1's, which represent divisibility by 2^1 but not 2^2 . We count entries on the n th row of Pascal's triangle by how many times a fixed prime divides them. We present a new proof of

a theorem of the first-named author that describes the structure of this enumeration. This new proof will generalize more easily to other sequences.

11:30 AM

Random Boolean Restriction for Infinite Logical Formulas

Cade Ferguson* (Hofstra University), Johanna Franklin (Hofstra University), Dan Turetsky (Victoria University of Wellington)

Intuitively, one may be able to examine a logical formula and classify it as either random or nonrandom by noticing patterns or relationships between clauses (or a lack thereof). But how is randomness formally defined in these contexts, and how is the definition of randomness altered for infinite formulas? Classical answers such as Martin-Löf randomness, Kolmogorov complexity, and martingales involve algorithmic complexity and predictability. Our approach involves random Boolean restriction, a method from computational complexity theory.

We consider a conjunctive normal form logical formula φ with fixed clause size and number of clauses n . Fixing p as the probability of leaving a variable unassigned and $\frac{1-p}{2}$ as the probability of assigning a variable to a value of true or false, a random restriction is applied to increasingly long prefixes of φ . After restricting φ , we can measure key complexity measures of the formula, such as remaining clause width, surviving variables, and metrics of compression.

We observe the convergence of these measurements as prefix length increases for varying values of $p \geq \frac{1}{2}$. Our findings reveal potential for quantifying bounds on length after compression and predicting ratios of collapsed clauses. Formalization of these observations could allow for the development of criteria to describe randomness of logical formulas.

Student Session 1

Costello 104, Presider: Emad Alfar

11:15 AM

Applying the Matrix Riccati Equation to Optimal Control

Mason Matheus* (Marist University), Malick Ndiaye (Marist University)

The Matrix Riccati Equation (MRE), named after the Italian mathematician Jacopo Francesco Riccati, plays a central role in connecting linear dynamical systems with optimal control theory. In particular, it is fundamental to solving the Linear Quadratic Regulator (LQR) problem, where the objective is to minimize a quadratic cost function subject to linear system dynamics. Despite its broad applicability across applied mathematics, the MRE does not yet admit a general analytic solution. While the scalar Riccati equation (SRE) has been extensively studied and well understood, the matrix case—of which the scalar form is a special instance—remains relatively uninvestigated. This presentation provides an overview of the MRE, highlighting its structure and significance while building on solution methods of the SRE to use as a conceptual and computational blueprint for addressing cases of the MRE. Applications to optimal control frameworks, specifically in the context of the LQR, are demonstrated.

11:30 AM

Starling: A Proof Assistant for Everybody

Ender Minyard (New York University)

Adviser: Michael Norrish (Australian National University)

A proof assistant is a programming language and/or user interface that enables the creation of computer-aided proofs. Proof assistants are interactive theorem provers. Starling is a proof assistant designed for ease of use by novices.

CONTRIBUTED PAPER SESSIONS
2:50–3:35 PM

Pedagogy/Math Education Session 2

Costello 103, Presider: Emad Alfar

2:50 PM

Conceptual Misunderstandings in Undergraduate Calculus: An Analysis Through the Lens of Mathematical Thinking

Yonghong L. McDowell (CUNY York College)

Mathematical skills in interpretation, representation, and application are essential for effective problem solving. Mathematical thinking enables students to connect ideas, interpret concepts, represent their work appropriately, and apply logical reasoning to real world situations. For college educators, understanding how mathematical thinking supports error detection and correction is critical for designing research based practices in undergraduate Science, Technology, Engineering, and Mathematics (STEM) education. This study aims to investigate the issues and address the challenges students experience in problem solving from psychological and pedagogical perspectives. Furthermore, the study seeks to examine how mathematical thinking—guided by Tall’s framework—enhances students’ calculus problem solving skills. Artifacts and interview transcripts have been collected and organized. Data analysis is ongoing, and the presentation of this work will focus on the frameworks developed by the author, with the goal of gaining insights from attendees at the MAA Metro NY Section Annual Meeting.

3:05 PM

Approaching the Teaching of Mathematical Modeling Using Four Essential Principles

Elizabeth Arnold* (Montana State University), Elizabeth Burroughs* (Montana State University)

Mathematical modeling is widely recognized as an important practice in K-16 mathematics education, and there is ongoing discussion about how to conceptualize and teach it. While existing approaches often portray modeling as an iterative cycle of steps or as engagement with a collection of mathematical modeling tasks, these perspectives can obscure the underlying nature of modeling itself. In this talk, we propose an alternative approach grounded in an essentialist perspective that aims to identify defining characteristics of mathematical modeling. Drawing on our experiences as modelers, as classroom teachers, as mathematics teacher educators, and researchers across K–16 contexts, we articulate four essential principles that characterize modeling: (1) modeling begins and ends outside the mathematical world, (2) modeling addresses open and complex situations, (3) modelers exercise judgment informed by values, and (4) modelers decide when a solution is good enough.

Pedagogy/Math Education Session 3

Maguire 122, Presider: Shamita Dutta Gupta

2:50 PM

Classification in an Imbalanced World

Josh Hiller (Adelphi University)

Imbalanced datasets are pervasive in real-world classification problems and can lead to misleading model performance and harmful outcomes when minority classes are overlooked, however they are seldomly addressed in undergraduate data science courses. In this talk we examine the challenges of classification under class imbalance using k-nearest neighbors (kNN) as a motivating example, showing how skewed class distributions distort decision boundaries and render standard metrics like accuracy unreliable. We review alternative evaluation approaches, including precision–recall–based and ranking metrics, and survey common mitigation strategies such as oversampling, undersampling, synthetic data generation (e.g., SMOTE), and class-weighted algorithms. Each approach is analyzed in terms of its trade-offs, particularly its sensitivity to noise and impact on model generalization. We argue that effectively addressing class imbalance requires both technical care and domain-specific judgment, as well as an awareness of the ethical consequences when rare but critical cases are misclassified.

3:05 PM

Infinity and a Theory of Mind for Mathematics Educators

George McCormack (CUNY LaGuardia Community College)

This article discusses the role of mathematics educators and curriculum in cultivating the next generation of mathematicians. The embodied mind is a product of maturation that is a result of action in the social and physical world, and mathematics itself is also a product of that maturation, resulting from a series of developments in mathematical content. One component of the environment in which development and mathematics education takes place is the classroom, which includes the intellectual interior of the instructor. The instructor often has a philosophy of education and its implementation, but what is often lacking in the classroom environment is an instructor who possesses a theory of mind. This article proposes that a theory of mind expands the classroom environment and directs the implementation of mathematics education. Instructors must understand how their own minds work and how their students' minds work. The article further proposes that the implementation of concept formation follows developmental, psychological, and cognitive principles. A capstone concept in mathematics education is non-denumerability. This concept requires a developmental historical approach that recapitulates the development of consciousness. The article suggests that the transmission of the foundational concept of uncountability follows the dictates of the

orthogenic principle, which proceeds from a more global, syncretic state to an increasingly differentiated state, and then to a hierarchical state. The path to understanding Georg Cantor's proof of non-denumerability follows the orthogenic principle in a historical developmental fashion toward hierarchization. The psychological mechanism of concept formation can be found in psychoanalysis and among the insights of mathematicians themselves.

3:20 PM

The Art of Bansho: Visualizing Mathematical Thinking for Meaningful Learning

Liubov Pogorelova (New York University School of Professional Studies)

In an era when technology dominates the educational landscape, the art of blackboard writing remains a cornerstone of effective teaching practice. The paper explores how the Japanese pedagogical practice of Bansho can facilitate the development of mathematical reasoning, collaborative problem-solving, and higher-order thinking skills when teaching the topic of functions. The paper synthesizes research that examines the art of Bansho in different educational contexts, and it conducts a qualitative analysis of the Third International Mathematics and Science Study (TIMSS) video "Japanese Lesson 1: Areas of Triangles" (1995). Analysis of the video reveals how Japanese teachers systematically plan blackboard layouts, anticipate student responses, guide classroom discussions, and use multiple representations—graphs, tables, equations, and verbal descriptions—to promote conceptual understanding. The paper then develops a theoretical framework for using the art of Bansho to transform the classroom environment into a dynamic space where students' thinking becomes visible, ideas are organized coherently, and an environment for meaningful discourse on the topic of functions is provided. This research contributes to the literature on Japanese pedagogical techniques and offers actionable strategies for transformative teaching practices using the art of Bansho teaching mathematics. The principles of Bansho can also be applied in virtual spaces, inspiring interactive and collaborative academic experiences guided by traditional blackboard use.

Pure Mathematics Session 2

Maguire 118, Presider: Ezra Halleck

2:50 PM

Metric Dimension of Generalized Theta Graphs

David Martinez* (CUNY Graduate Center), **Nadia Benakli** (CUNY New York City College of Technology), **Nicole Froitzheim** (CUNY Baruch College)

The metric dimension of a graph, also known as the locating number, is a graph invariant that allows the identification of vertices based on their distances to a selected set of reference vertices. A generalized theta graph consists of two distinct vertices connected by multiple internally vertex-disjoint paths. These graphs have been investigated in different contexts. When exactly three such paths exist, the graph is simply referred to as a theta graph. Despite their seemingly simple structure, determining the metric dimension of generalized theta graphs has proven to be a challenging problem. In this work, we present new results on the metric dimension of these graphs, revisiting known results, and discuss some conjectures.

3:05 PM

Fractals: Mathematical Foundations and Historical Evolution

Andrew Metzner (SUNY Suffolk County Community College)

Advisers: Vera Hu (SUNY Suffolk County Community College), **Krystyna Janicka-Wlodek** (SUNY Suffolk County Community College)

This paper explores the intersection of recursive algorithms and complex dynamics, tracing the evolution of fractal geometry from 19th-century mathematics to the modern computational era. By examining both the mathematical proofs and computer graphics, we analyze how simple iterative rules generate infinite complexity.

The study provides a breakdown of the Escape Criterion ($|z| > 2$) within the context of the Mandelbrot and Julia sets. It utilizes the Fundamental Theorem of Algebra and Cauchy's Bound to prove that the dynamics of the quadratic map $f(z) = z^2 + c$ are contained within a specific radius. Through the application of the Triangle Inequality, we demonstrate that any orbit exceeding this boundary must diverge to infinity, as the growth ratio $|z_{n+1}|/|z_n|$ eventually scales by a factor strictly greater than unity.

By looking at how simple lines can evolve into complex, space-filling shapes, we can better understand the geometry of the real world. This research highlights fractal geometry as the perfect tool for describing "rough" surfaces. It reveals a surprising truth: the most complex structures in nature are often born from a single, simple feedback loop.

3:20 PM

Multiplication is to Addition as Addition is to What?

Howard Sporn (CUNY Queensborough Community College)

When children are first taught about multiplication of the natural numbers, it is usually presented as repeated addition. Later, raising to an exponent is presented as repeated multiplication. Then the following analogy is obvious: addition is to multiplication as multiplication is to raising to an exponent. An interesting question is to ask what happens if we go in the other direction. That is, multiplication is to addition as addition is to what? In this talk, we will answer this question and show that there are several possible operations that could be used to answer the question. Some of them will be presented in connection with algebraic semi rings. We will also get into a bit of “tropical” geometry.

Pure Mathematics Session 3

Maguire 126, Presider: Eric Rowland

2:50 PM

Integers in Sequences Generated by Recurrences with Non-Integer Coefficients

Max Lippmann (Roslyn High School)

Adviser: Eric Rowland (Hofstra University)

Let $u = a/b$ and $v = c/d$ be non-integer rational numbers in lowest terms, and consider the second-order recurrence

$$S_{n+2} = uS_{n+1} + vS_n, \quad S_0, S_1 \in \mathbb{Z}.$$

Setting $K := bd$, the scaled values $K^n S_n$ are integers, so $S_n \in \mathbb{Z}$ holds precisely when K^n divides $K^n S_n$. We prove two complementary results about this integrality pattern. First, for any $r \geq 1$ we construct coprime initial conditions for which $S_n \in \mathbb{Z}$ holds at least r distinct indices n . Second, once the coefficients and coprime initial conditions are fixed, we give an explicit cutoff index N beyond which $S_n \notin \mathbb{Z}$ for all $n \geq N$.

3:05 PM

Universal Matrices for Counting Fibonomial and C-Nomial Coefficients with a Cryptographic Application

Arav Chand (Harvard College)

Adviser: Eric Rowland (Hofstra University)

Cryptographic systems securing global communications depend on computationally hard mathematical problems. Yet, the divisibility structure of combinatorial objects like Pascal's Triangle remains a largely untapped source of such hardness. Rowland established a matrix product formula encoding prime divisibility behavior for binomial coefficients, raising the question of whether this structure extends to far more general objects and higher dimensions. In this research, I derived matrix product formulas for the prime divisibility of C-multinomial coefficients, a family of generalized binomial coefficients defined by an integer sequence C, across all dimensions $k \geq 2$. After performing large-scale symbolic computation in Mathematica to detect structural patterns and formulate conjectures, I then proved these conjectures via bijective counting arguments and the Principle of Inclusion-Exclusion. The central result is a universality theorem: the same family of matrices governs the divisibility of binomial, C-nomial, multinomial, and C-multinomial coefficients simultaneously, regardless of the choice of sequence C. This is surprising because the matrices carry no information about C whatsoever. My theorem reduces computational complexity from $O(n^3 \log n)$ to $O(\log n)$. Leveraging this efficiency, I constructed a cryptographically secure pseudorandom number generator grounded in this number-theoretic structure, whose output passed all NIST 800-22 statistical tests over 500 million bits and resisted state-compromise extension attacks via time-based reseeding. These results unify the divisibility theory of infinitely many combinatorial sequences under one framework, while establishing that purely number-theoretic structure can serve as an independent cryptographic hardness foundation.

3:20 PM

Bivariate Polynomials Associated with Binary Trees Created by QuickSort

Johann Thiel* (City Tech), David M. Bradley (University of Maine)

In this talk we describe a generating series whose coefficients are polynomials that, for a given positive integer n , encode the depth at which the various list entries appear as labeled nodes in the binary trees obtained by QuickSorting permutations of the list consisting of one copy of each of the first n non-negative integers. Extracting the appropriate coefficients yields information for the number of times a given list entry appears at a given depth, the total number of list entries that appear at a given depth, and consequently the average number of list entries that appear at a given depth taken over all $n!$ permutations.

Student Session 2

Costello 104, Presider: Lauren Rose

2:50 PM

Sharpness of a Bound for Dual Segal-Bargmann Spaces

Max Trimmer (Muhlenberg College)

Adviser: William Gryc (Muhlenberg College)

The Segal-Bargmann space $L_{hol}^p(\gamma_{\alpha p/2})$ is defined as the space of entire functions such that

$\int_C |f(z)e^{-\alpha|z|^2/2}|^p dz < \infty$ for a fixed positive constant $\alpha > 0$ and $1 < p < \infty$. Hölder's inequality can be

used to show that for functions $f \in L_{hol}^p(\gamma_{\alpha p/2})$ and $g \in L_{hol}^q(\gamma_{\alpha q/2})$ where $\frac{1}{p} + \frac{1}{q} = 1$,

$\frac{|(f,g)_{L^2}|}{\|f\|_{L^p(\gamma_{\alpha p/2})} \|g\|_{L^q(\gamma_{\alpha q/2})}} \leq \frac{2}{p^{\frac{1}{p}} q^{\frac{1}{q}}}$. Let C_p be the smallest possible constant such that $\frac{|(f,g)_{L^2}|}{\|f\|_{L^p(\gamma_{\alpha p/2})} \|g\|_{L^q(\gamma_{\alpha q/2})}} \leq C_p$ for all

$f \in L_{hol}^p(\gamma_{\alpha p/2})$ and $g \in L_{hol}^q(\gamma_{\alpha q/2})$. So we have $C_p \leq \frac{2}{p^{\frac{1}{p}} q^{\frac{1}{q}}}$. In the paper "On sharp constants for dual

Segal-Bargmann L_p spaces", William Gryc and Todd Kemp showed that $\sqrt{\frac{2}{p^{\frac{1}{p}} q^{\frac{1}{q}}}} \leq C_p$. This presentation

will introduce Segal-Bargmann spaces and the results from the paper "On sharp constants for dual Segal-Bargmann L_p spaces" as well as progress towards finding the exact value of C_p and the techniques used to find the value.

3:05 PM

Sensitivity Analysis of Different Minimization Methods of Least Squares Loss

Nicolas Rizzuto* (SUNY Suffolk County Community College), Hyuk-Joong Kim Seeman* (SUNY Suffolk County Community College)

Advisers: Vera Hu (SUNY Suffolk County Community College), Krystyna Janick Wlodek (SUNY Suffolk County Community College)

Loss functions quantify the error between actual and predicted values. Least squares loss (LSL) is a loss function that has a prominent role in modern data analytics and it is best used in regression analysis to determine relationships between variables. Notably, least squares loss has been applied in large language models such as ChatGPT, Gemini, and others, to improve performance in responses to prompts. LSL connects concepts such as optimization, model fitting, bias vs variance, and statistical assumptions about noise. This makes it a foundational concept in machine learning. The present study will review the

mathematical model of LSL and how it relates to these concepts. It will discuss and apply the various mathematical methods of computing LSL including: the normal equation, gradient descent, QR decomposition, and Singular Value Decomposition. These methods will be implemented in a Python program and their runtimes will be compared to each other with varying datasets.

3:20 PM

Gradientscape

Santiago Rodriguez (Adelphi University)

Understanding the optimization of high dimensional loss functions remains a primary hurdle for students of artificial intelligence. While the mathematical foundations of gradient descent are well defined, the intuitive grasp of how hyperparameters like learning rates or different optimizer architectures influence model convergence is often lost in abstract calculus. GradientScape is an interactive three dimensional environment designed to bridge this pedagogical gap. By representing the loss function as a navigable physical terrain and the model state as a dynamic agent, the tool allows users to witness the immediate consequences of their design choices in real time. Users can experiment with varied terrains including convex bowls, local minima, and saddle points to observe the behavior of different optimizers like SGD, Momentum, and Adam. The application synchronizes three dimensional spatial movement with a traditional two dimensional loss chart to reinforce the connection between physical intuition and standard data science telemetry. GradientScape transforms the abstract process of machine learning into a tangible sandbox, fostering a deeper conceptual understanding of the mechanics that power modern neural networks. This presentation will demonstrate the technical architecture of the tool alongside its effectiveness in providing an intuitive foundation for optimization theory.

CONTRIBUTED POSTER SESSION
12:45–1:15 PM

Supervisor: Dr. Richard Gustavson

Monitoring Heat in New York City Subway Systems

Sabina Abduvakhidova (CUNY New York City College of Technology), Saba Alkobadi (CUNY New York City College of Technology), Zeshan Rafiq (CUNY City College of New York), Abdou Bah (CUNY New York City College of Technology), Reginald Blake (CUNY New York City College of Technology), Hamid Norouzi (CUNY New York City College of Technology)

New York City faces significant challenges due to the accelerating impacts of climate change. The most affected infrastructures are underground transportation systems, which are particularly vulnerable to the intensifying frequency and duration of heat waves. The fluctuation in temperature within the subway system during these extreme weather events poses serious health and safety risks not only to daily commuters but also transit employees working in these environments. Despite the potential dangers, the extent and dynamics of temperature changes within the subway remain insufficiently understood. To address this knowledge gap, this study conducts a comprehensive investigation into temperature, relative humidity, and air quality variability across multiple subway stations in NYC, aiming to inform future mitigation strategies and urban planning.

Monitoring Heat and Air Quality in Brooklyn Subway System

Addree Barua (CUNY New York City College of Technology), Harmony Divine (CUNY New York City College of Technology), Maria Hashmi (CUNY New York City College of Technology), Zohaib Khan (CUNY New York City College of Technology), Babacar Sarr (CUNY New York City College of Technology), Abdou Bah (CUNY New York City College of Technology), Reginald Blake (CUNY New York City College of Technology), Hamid Norouzi (CUNY New York City College of Technology)

This research analyzes environmental conditions inside Brooklyn subway stations by measuring platform-level temperature, relative humidity, particulate matter (PM_{2.5} and PM₁₀), and carbon dioxide (CO₂). Using portable sensors, our team collected data across multiple stations, lines, and times of day to assess thermal discomfort and air quality in the underground environment. We calculated the Heat Index for each reading using NOAA's temperature-humidity model and compared heat exposure patterns with observed ventilation levels. Additional statistical analysis examined the relationship between temperature, Heat Index, and pollutants such as PM_{2.5}, PM₁₀, and CO₂. Results show that several stations experience significant heat buildup and elevated particulate levels, particularly during warmer afternoon hours and in locations with limited air circulation. By generating station-by-station environmental averages and scatter-plot relationships, this project identifies stations with the highest thermal stress and poorest air quality. These findings support the MTA's Climate Resilience initiative by highlighting priority stations for cooling improvements, ventilation upgrades, and targeted climate-adaptation strategies.

Arav Chand (Harvard College)

Adviser: Eric Rowland (Hofstra University)

Cryptographic systems securing global communications depend on computationally hard mathematical problems. Yet, the divisibility structure of combinatorial objects like Pascal's Triangle remains a largely untapped source of such hardness. Rowland established a matrix product formula encoding prime divisibility behavior for binomial coefficients, raising the question of whether this structure extends to far more general objects and higher dimensions. In this research, I derived matrix product formulas for the prime divisibility of C-multinomial coefficients, a family of generalized binomial coefficients defined by an integer sequence C, across all dimensions $k \geq 2$. After performing large-scale symbolic computation in Mathematica to detect structural patterns and formulate conjectures, I then proved these conjectures via bijective counting arguments and the Principle of Inclusion-Exclusion. The central result is a universality theorem: the same family of matrices governs the divisibility of binomial, C-nomial, multinomial, and C-multinomial coefficients simultaneously, regardless of the choice of sequence C. This is surprising because the matrices carry no information about C whatsoever. My theorem reduces computational complexity from $O(n^3 \log n)$ to $O(\log n)$. Leveraging this efficiency, I constructed a cryptographically secure pseudorandom number generator grounded in this number-theoretic structure, whose output passed all NIST 800-22 statistical tests over 500 million bits and resisted state-compromise extension attacks via time-based reseeding. These results unify the divisibility theory of infinitely many combinatorial sequences under one framework, while establishing that purely number-theoretic structure can serve as an independent cryptographic hardness foundation.

Yoseni Chen (Centereach High School)

Adviser: Vera Hu (SUNY Suffolk County Community College)

The Michaelis-Menten Equation is a mathematical model used in biochemistry to determine the reaction rate of an enzyme at a given substrate concentration: $v_0 = \frac{V_{max}[S]}{K_m + [S]}$. This study uses this equation to determine the relationship between soil pH and the kinetics of an enzyme and how it connects to the coloration of the sepals in Hydrangea Macrophyllas. In acidic soils, the sepals appear to be blue, whereas in basic soils, the sepals appear to be pink. This is due to the aluminum ion concentration ($[Al^{3+}]$) in soil, which is toxic to the plant. In lower pHs, the $[Al^{3+}]$ increases, and the hydrangea releases citric acid to detoxify the aluminum ions. This further consists of the enzyme Chalcone synthase and the substrate p-coumaroyl-CoA, which initiates the production of the anthocyanin delphinidin-3-O-glucoside with the purpose of binding with the product of the citric acid and aluminum ions. Using a constant K_m value of 0.6 μM , a normalized V_{max} value of one and a range of different substrate concentrations from 0.1M to 10.0M, increasing by 0.3 with each calculation to simulate varying environmental conditions, the activity of the enzyme increased as the concentration did as well. These results suggest that the relationship between pH and enzyme kinetics is that at lower pHs, the activity of Chalcone synthase is higher than at higher pHs. This then corresponds to more vibrancy in the blue pigment being produced at more acidic pHs.

The Principle of Inclusion and Exclusion: A Deeper Connection to Pascal's Triangle

Sophia DeGregorio (Stuyvesant High School)

The Principle of Inclusion and Exclusion (PIE) provides a classical method for counting the size of unions of overlapping sets, with standard formulas established that express the size of the union of n sets as an alternating sum of their intersection sizes. However, many combinatorial and classification problems require a more refined count: determining the number of elements contained in at least k of those n sets. Although such generalizations appear sporadically in combinatorics literature, they are not accompanied by detailed proofs or structural interpretations.

This research presents a complete elementary derivation of a generalized PIE formula that counts elements contained in at least k of n sets. Building on the classical PIE formula for n sets, the method analyzes how many times an element belonging to exactly r sets contributes to each intersection term S_r , and develops coefficients that ensure each qualifying element is counted exactly once. The resulting identity reveals a direct structural relationship: the coefficients in the generalized formula correspond precisely to the entries along the k^{th} diagonal of Pascal's Triangle, with alternating signs.

The generalization provides both a theoretical insight into the structure of inclusion-exclusion and a practical closed-form expression for counting the number of elements that lie in at least k of n sets.

Using Differentiation to Optimize Revenue and Cost Functions

Trishita Dey (St. Thomas Aquinas College)

My paper explores the application of differentiation in solving optimization problems, particularly in maximizing profit and minimizing cost in real world scenarios. By modeling revenue and cost as continuous functions, derivatives are used to identify critical points and determine optimal solutions. Additionally, marginal analysis is introduced to interpret rates of change and support economic decision making. The study demonstrates how fundamental calculus concepts extend beyond theoretical mathematics and provide practical tools in business and data driven contexts.

Principal Component Analysis of Academic Performance and Support Factors in MACSS and Non-MACSS Students.

Abdoul Ahad Diouck* (CUNY Hostos Community College), Moise Koffi (CUNY Hostos Community College), Nieves Angulo (CUNY Hostos Community College), Diandra Jugmohan (CUNY Hostos Community College), Reginald Dorcelly (Hostos Community College)

This study examines academic performance and perceptions of support among MACSS and non-MACSS students over three years. Analysis of student records shows that MACSS students maintain higher median GPAs (3.37 vs. 2.69), lower coefficients of variation ($CV \approx 0.15$ vs. 0.46), and higher credit completion ratios ($CCR \approx 0.93$ vs. 0.80), reflecting more consistent academic outcomes. Non-MACSS students exhibit greater GPA variability and lower CCR. Mann-Whitney U tests indicate these differences are statistically significant ($p < .001$). Separately, survey data were analyzed using Principal Component Analysis, identifying four key factors—Academic Self-Regulation, Academic Support Services, Perceived Academic Challenge, and Perceived Improvement—explaining about 65% of the variance. These factors highlight how students' effort, structured support, and course challenge relate to GPA stability and credit completion.

Financial aid emerged as an enabling factor, facilitating use of personal and institutional resources. Overall, findings suggest that academic outcomes are shaped by the interaction of self-regulation, programmatic support, course difficulty, and financial support, with MACSS students demonstrating alignment with these key factors.

When Does the Lake Freeze? Linking Ground-Based Cameras and Satellite Observations of Lake Ice

Emmanuel Forte (CUNY New York City College of Technology), Marzi Azarderakhsh (CUNY New York City College of Technology)

Lake ice cover is a sensitive indicator of climate change, particularly in northern regions where small shifts in air temperature can significantly alter freeze-up and break-up timing. Long-term changes in lake ice duration affect lake ecology, water temperature, and regional climate feedbacks. However, accurately determining ice-on and ice-off dates remains challenging, especially for small and remote lakes. In this project, we use time-lapse images collected by a shoreline camera at a lake over NY state to visually document the seasonal transition between open water and ice cover. An undergraduate researcher will analyze daily images to identify ice-on (first persistent ice cover) and ice-off (complete ice disappearance) dates over multiple seasons. These ground-based observations will then be compared with satellite remote sensing products (e.g., Landsat or Sentinel imagery) to evaluate how well satellites capture lake ice dynamics at local scales. This project provides hands-on experience in environmental data analysis, image interpretation, and climate change research, while contributing to a broader effort to improve satellite-based monitoring of inland waters. The results will help assess uncertainties in remote sensing observations and improve our understanding of how lake ice phenology is responding to a warming climate in the Adirondack region.

Noninvasive Lupus Nephritis Monitoring Based on Urine Immune Cell Profiling

Hayley Geoghegan (Stuyvesant High School)

Adviser: Arnon Arazi (Feinstein Institutes for Medical Research)

Lupus Nephritis (LN) is kidney inflammation caused by Systemic Lupus Erythematosus (SLE). SLE affects approximately 50% of the 1.5 million Americans with lupus. Current monitoring relies on invasive kidney biopsies, which are rarely repeated due to patient risk. Since immune cells from the kidney pass into urine during active inflammation, this study aimed to build statistical models predicting kidney immune cell profiles from urine immune cell data using de-identified data from 127 LN patients. Principal component analysis was applied to urine data to reduce dimensionality and eliminate multicollinearity across 61 immune cell types. Forward stepwise regression models were then trained for each of 33 kidney immune cell types using PCA-derived urine signatures as predictors. Models were evaluated under a 70/30 train-test split repeated 100 times with fixed seeds. Urine cell count thresholds and PC limitations were systematically tested to optimize performance. A urine cell count quota of 150 and a limitation of PCs 1–16 produced the best results, achieving a mean train error of 48.8% and mean test error of 61.7%. Although error rates remain high, these findings demonstrate that urine immune cell profiles are a feasible predictor of kidney immune cell composition in LN patients, with implications for future development of noninvasive, accessible monitoring tools.

Evaluating Cloud Radiation - Hydrometeor Species Interaction in WRF: Implications for Lower Troposphere Temperature and Precipitation Type

Kazi Islam (CUNY New York City College of Technology), Yanna Chen (CUNY New York City College of Technology)

This research aims to improve the understanding of the influence of the snowfall patterns, amount and precipitation type (P-type) associated with interaction of cloud-radiative forcing (CRF) between radiation and hydrometeors in the WRF model. These parameterization processes may impact the buoyancy, temperature, moisture transport, and vertical stability of the atmosphere, influencing snow depth and P-type. The experiments test the role of each type of hydrometeor supported by the microphysics scheme—those being cloud water, cloud ice, snow, and rain—in influencing the temperature and stability of the lower atmosphere and its effect on snowfall. These experiments either start with the control run and remove hydrometeor species one by one (the subtraction runs) or start with a simulation lacking CRF with respect to shortwave (SW) or longwave (LW) radiation and adding one species at a time (the addition runs). Regarding the latter, we show that reactivating individual hydrometeor types in the NOSWCRF simulations leads to varying increases in planetary boundary layer (PBL) temperatures compared to the simulation with all hydrometeors activated, subsequently altering the type of precipitation. Specifically, these temperature changes result in an increase in warm precipitation and a decrease in cold precipitation. Conversely, in the NOLWCRF simulations, reactivating individual hydrometeor types leads to substantial cooling of the PBL compared to the simulation with all hydrometeors activated, promoting increased frozen precipitation, and significantly enhancing snow depth. Among the hydrometeor types, cloud water and snow have the most pronounced effect on both SW and LW CRF simulations, while rain has the least impact, and cloud ice has a moderate influence.

Pop Culture as a Gateway to Research: Challenging Barriers and Expanding Belonging in Mathematics

Qianyi Jiang* (Adelphi University), Niharika Nirankari* (Adelphi University)

Adviser: Mónica Morales-Hernandez (Adelphi University)

Over the past seven decades, STEM-themed films have played a significant role in shaping public perceptions of scientists, mathematicians, and other technical professionals. This study investigates how such films encode social, racial, gender, and economic stereotypes in their portrayals of protagonists and examines how these representations evolve across time. Beyond film analysis, the project compares how these figures are described in human-written Wikipedia articles and in ChatGPT-generated summaries, exploring whether and how implicit biases persist, shift, or are reproduced across platforms often perceived as neutral or objective. Using a structured coding framework, the study analyzes narrative roles, character traits, markers of identity, and patterns of visibility or marginalization. By placing cinematic portrayals alongside digital knowledge representations, the project highlights how stereotypes may be reinforced, softened, or subtly transformed through algorithmic and crowd-sourced text production. From an educational perspective, this work demonstrates how mathematical and statistical analysis can be applied to questions of representation and bias. Engaging students in this research process invites them to critically examine how knowledge about STEM is constructed and circulated, while fostering a more inclusive understanding of who belongs in mathematics and related disciplines.

A Computational Pipeline for Personalized CAR-T Antigen Ranking Using Matched Tumor-Normal Transcriptomic Data

Eva Kastoun (Stuyvesant High School)

Adviser: Meng-Ping Tu (Stuyvesant High School)

CAR-T cell therapy has demonstrated strong efficacy in treating certain cancers, but identifying optimal target antigens remains a major challenge. Effective targets must be highly expressed in tumor cells while minimally expressed in healthy tissue to avoid off-target toxicity. Most existing approaches rank antigens at the population level, which can overlook clinically significant patient-to-patient variation.

This research presents a computational pipeline that ranks CAR-T antigen candidates on a per-patient basis using matched tumor and normal RNA-seq data from the TCGA cohort. For each patient with paired samples, genes are scored using a two-component metric: a delta term representing the \log_2 expression difference between tumor and normal tissue, and a specificity ratio in linear space capturing fold-change. These components are combined into a unified score, $\text{delta} \times \log_2(\text{specificity} + 1)$, prioritizing genes that are both strongly upregulated in tumors and minimally expressed in healthy tissue. Antigens are first ranked per patient, then aggregated into a population-level score weighted by consistency across patients.

The pipeline was applied to the TCGA breast cancer dataset, ranking 20,530 genes across 139 matched patient pairs. Results are provided as per-patient ranked outputs alongside an interactive browser-based visualization with adjustable filters for expression level, fold-change, and cross-patient consistency. This framework enables more personalized antigen prioritization and is generalizable to any cancer type with matched expression data.

Decomposition of Polysymmetric Functions and Stack Partitions

David Martinez (CUNY Graduate Center)

Adviser: Anna Pun (CUNY Baruch College)

Polysymmetric functions, introduced by Asvin G and Andrew O'Desky as a generalization of symmetric functions, have natural connections to algebraic geometry and provide a foundation for further developments. In this paper, we study polysymmetric functions using stack partitions and develop combinatorial descriptions of several polysymmetric bases. We introduce two new signed polysymmetric bases and give explicit transition formulas among the monomial, homogeneous, elementary, power, and signed polysymmetric bases. These results extend many familiar identities from symmetric function theory to the polysymmetric setting.

George McCormack (CUNY LaGuardia Community College)

This article discusses the role of mathematics educators and curriculum in cultivating the next generation of mathematicians. The embodied mind is a product of maturation that is a result of action in the social and physical world, and mathematics itself is also a product of that maturation, resulting from a series of developments in mathematical content. One component of the environment in which development and mathematics education takes place is the classroom, which includes the intellectual interior of the instructor. The instructor often has a philosophy of education and its implementation, but what is often lacking in the classroom environment is an instructor who possesses a theory of mind. This article proposes that a theory of mind expands the classroom environment and directs the implementation of mathematics education. Instructors must understand how their own minds work and how their students' minds work. The article further proposes that the implementation of concept formation follows developmental, psychological, and cognitive principles. A capstone concept in mathematics education is non-denumerability. This concept requires a developmental historical approach that recapitulates the development of consciousness. The article suggests that the transmission of the foundational concept of uncountability follows the dictates of the orthogenic principle, which proceeds from a more global, syncretic state to an increasingly differentiated state, and then to a hierarchical state. The path to understanding Georg Cantor's proof of non-denumerability follows the orthogenic principle in a historical developmental fashion toward hierarchization. The psychological mechanism of concept formation can be found in psychoanalysis and among the insights of mathematicians themselves.

Andrew Metzner (SUNY Suffolk County Community College)

Advisers: Vera Hu (SUNY Suffolk County Community College), Krystyna Janicka-Wlodek (SUNY Suffolk County Community College)

This paper explores the intersection of recursive algorithms and complex dynamics, tracing the evolution of fractal geometry from 19th-century mathematics to the modern computational era. By examining both the mathematical proofs and computer graphics, we analyze how simple iterative rules generate infinite complexity.

The study provides a breakdown of the Escape Criterion ($|z| > 2$) within the context of the Mandelbrot and Julia sets. It utilizes the Fundamental Theorem of Algebra and Cauchy's Bound to prove that the dynamics of the quadratic map $f(z) = z^2 + c$ are contained within a specific radius. Through the application of the Triangle Inequality, we demonstrate that any orbit exceeding this boundary must diverge to infinity, as the growth ratio $|z_{n+1}|/|z_n|$ eventually scales by a factor strictly greater than unity.

By looking at how simple lines can evolve into complex, space-filling shapes, we can better understand the geometry of the real world. This research highlights fractal geometry as the perfect tool for describing "rough" surfaces. It reveals a surprising truth: the most complex structures in nature are often born from a single, simple feedback loop.

On 132-Avoiding Permutations with an Adjacency Constraint

Nathaniel Nader (Ramapo College of New Jersey / Don Bosco Prep)

Adviser: Katarzyna Kowal (Ramapo College of New Jersey)

Permutation pattern avoidance is a central topic in enumerative combinatorics, with classical 132-avoiding permutations enumerated by the Catalan numbers. We refine this class by imposing a local adjacency constraint $|\pi_{i+1} - \pi_i| \leq m$, thereby combining a global pattern restriction with a bounded-difference condition. This interaction produces substantial structural rigidity. Let $A_n^{(m)}$ denote the number of permutations in S_n that avoid 132 and satisfy the adjacency bound. We completely solve the first nontrivial case $m = 2$, proving that the maximum element n may occur only in positions 1, 2, or n , which yields a finite structural decomposition of the class. From this collapse we derive an explicit linear recurrence with constant coefficients and a rational ordinary generating function for $A_n^{(2)}$, leading to precise asymptotics $A_n^{(2)} \sim C\alpha^n$, where $\alpha > 1$ is the unique real solution of $\alpha^3 = \alpha^2 + 1$. We further analyze the case $m = 3$, establish analogous positional restrictions on the maximum element, and provide computational evidence supporting a finite-state description. We conjecture that for each fixed m the class admits a finite structural decomposition and hence a rational generating function. This family interpolates between the rigid regime $m = 1$ and the Catalan regime obtained when the adjacency constraint becomes vacuous.

The Art of Bansho: Visualizing Mathematical Thinking for Meaningful Learning

Lioubov Pogorelova (New York University School of Professional Studies)

In an era when technology dominates the educational landscape, the art of blackboard writing remains a cornerstone of effective teaching practice. The paper explores how the Japanese pedagogical practice of Bansho can facilitate the development of mathematical reasoning, collaborative problem-solving, and higher-order thinking skills when teaching the topic of functions. The paper synthesizes research that examines the art of Bansho in different educational contexts, and it conducts a qualitative analysis of the Third International Mathematics and Science Study (TIMSS) video “Japanese Lesson 1: Areas of Triangles” (1995). Analysis of the video reveals how Japanese teachers systematically plan blackboard layouts, anticipate student responses, guide classroom discussions, and use multiple representations—graphs, tables, equations, and verbal descriptions—to promote conceptual understanding. The paper then develops a theoretical framework for using the art of Bansho to transform the classroom environment into a dynamic space where students’ thinking becomes visible, ideas are organized coherently, and an environment for meaningful discourse on the topic of functions is provided. This research contributes to the literature on Japanese pedagogical techniques and offers actionable strategies for transformative teaching practices using the art of Bansho teaching mathematics. The principles of Bansho can also be applied in virtual spaces, inspiring interactive and collaborative academic experiences guided by traditional blackboard use.

Aerodynamics of Airplanes on Mars

Marina Dedlovskaya (CUNY LaGuardia Community College), Malgorzata Marciniak (CUNY LaGuardia Community College), Vladimir Przhebelskiy* (CUNY LaGuardia Community College)

The density of Mars' atmosphere is 70 times less than that on Earth. The gravity is 3 times less. There are many projects of Mars airplanes.

- 1) Mars Aerial and Ground Global Intelligent Explorer (MAGGIE)
- 2) Raymer Mars airplane. These airplanes have rectangular wings with high aspect ratios: MAGGIE has $AR=15$ Raymers Mars airplane has $AR = 25$. These airplanes have a rectangular wing with high aspect ratio. They can fly at less speeds.
- 3) The ARES (Aerial Regional-scale Environmental Survey) It has a wing with moderate ratio, $AR = 5.6$. It will fly at a higher speed, Mach number up to 0.7. So, the compressibility of the air will be considered. It has a swept wing, which helps reduce the drag.

We shall calculate the lifting force of both types of Mars airplanes, using precalculus formulas. For a rectangular wing with high aspect ratio we shall use elliptic wing formula, suggested by AI. For a swept wing in compressible flow, we shall use a Datcom formula.

The material can be used as a project in precalculus class.

GPA Variability, Retention, and Students' Perceptions of the Impact of Institutional Support in Mathematics and Computer Science Majors

Moise Koffi (CUNY Hostos Community College), Nieves Angulo (CUNY Hostos Community College), Diandra Jugmohan (CUNY Hostos Community College), Reginald Dorcelly (CUNY Hostos Community College), Adrian Rhoden* (CUNY Hostos Community College), Abdoul Ahad Diouck* (CUNY Hostos Community College)

This study examines factors influencing academic performance, retention, and student success among Mathematics and Computer Science majors at a Hispanic-Serving Institution (HSI) from Spring 2022 to Spring 2025. The research investigates how personal challenges, financial stress, and motivation interact with institutional support to affect Credit Completion Rates (CCR) and GPA variability. Institutional records were integrated with survey responses from 104 students to examine how academic and financial support influence retention and graduation, aligned with the AMTE vision for equitable STEM success. The primary goal was to compare GPA performance, variability (Coefficient of Variation, CV), and CCR between MACSS and non-MACSS students to inform data-driven improvements in STEM education. The survey instrument demonstrated strong reliability (Cronbach's $\alpha = 0.70-0.90$). Findings show that MACSS participants achieved near-perfect completion rates ($CCR \approx 99\%$) and substantially lower GPA variability ($CV \approx 15\%$) compared to non-MACSS students ($CCR: 79-85\%$; $CV: 40-47\%$). Personal and financial difficulties were associated with greater GPA instability, while targeted academic and financial support was perceived as highly influential in promoting persistence and success. The MACSS model demonstrates a high-impact, scalable framework for reducing achievement gaps and increasing STEM retention. By emphasizing metrics such as CV (academic stability) and CCR (completion momentum), this study highlights the importance of holistic, evidence-based support strategies to improve outcomes for underrepresented students.

Development and Evaluation of an MPAS-Based Urban Modeling System for the New York City Region

Kristian Rice (CUNY New York City College of Technology), Marco Yu (CUNY New York City College of Technology), Yanna Chen (CUNY New York City College of Technology)

The Model for Prediction Across Scales (MPAS) with variable resolution provides a powerful framework for improving urban-scale weather hazard forecasts, including heat waves and extreme precipitation, by consistently coupling global and urban processes. This project develops the first urban modeling capability within MPAS by implementing a Single-Layer Urban Canopy Model (SLUCM) into the MPAS model, coupled with the Noah-MP land surface model. Rather than relying on traditional nested downscaling, we employ a global variable-resolution mesh with horizontal resolutions ranging from 30 km to 500 m. Initial testing and evaluation of the newly developed MPAS-Urban system are presented, along with applications to case studies over the New York City metropolitan area.

Sensitivity Analysis of Different Minimization Methods of Least Squares Loss

Nicolas Rizzuto* (SUNY Suffolk County Community College), Hyuk-Joong Kim Seeman* (SUNY Suffolk County Community College)

Advisers: Vera Hu (SUNY Suffolk County Community College), Krystyna Janick Wlodek (SUNY Suffolk County Community College)

Loss functions quantify the error between actual and predicted values. Least squares loss (LSL) is a loss function that has a prominent role in modern data analytics and it is best used in regression analysis to determine relationships between variables. Notably, least squares loss has been applied in large language models such as ChatGPT, Gemini, and others, to improve performance in responses to prompts. LSL connects concepts such as optimization, model fitting, bias vs variance, and statistical assumptions about noise. This makes it a foundational concept in machine learning. The present study will review the mathematical model of LSL and how it relates to these concepts. It will discuss and apply the various mathematical methods of computing LSL including: the normal equation, gradient descent, QR decomposition, and Singular Value Decomposition. These methods will be implemented in a Python program and their runtimes will be compared to each other with varying datasets.

Gradientscape

Santiago Rodriguez (Adelphi University)

Understanding the optimization of high dimensional loss functions remains a primary hurdle for students of artificial intelligence. While the mathematical foundations of gradient descent are well defined, the intuitive grasp of how hyperparameters like learning rates or different optimizer architectures influence model convergence is often lost in abstract calculus. GradientScape is an interactive three dimensional environment designed to bridge this pedagogical gap. By representing the loss function as a navigable physical terrain and the model state as a dynamic agent, the tool allows users to witness the immediate consequences of their design choices in real time. Users can experiment with varied terrains including convex bowls, local minima, and saddle points to observe the behavior of different optimizers like SGD, Momentum, and Adam. The application synchronizes three dimensional spatial movement with a traditional two dimensional loss chart to reinforce the connection between physical intuition and standard data science telemetry. GradientScape transforms the abstract process of machine learning into a tangible sandbox, fostering a deeper conceptual

understanding of the mechanics that power modern neural networks. This presentation will demonstrate the technical architecture of the tool alongside its effectiveness in providing an intuitive foundation for optimization theory.

Monitoring Heat and Air Quality in Queens Subway Stations

Rean Shahidullah (CUNY New York City College of Technology), Abodu Bah (CUNY New York City College of Technology), Reginald Blake (CUNY New York City College of Technology) and Hamid Norouzi (CUNY New York City College of Technology)

This research examines heat and air quality conditions in the Queens subway system, with a focus on environmental exposure at EFMR line stations. Using portable sensor arrays, we collected temperature, relative humidity, carbon dioxide (CO₂), and particulate matter (PM_{2.5} and PM₁₀) data at both platform and street levels. Measurements were taken at multiple time points over several days to identify a pattern. Our analysis found that platform heat indices were consistently higher than street level, with some stations showing substantial differences. CO₂ concentrations spiked during rush hours, indicating limited ventilation and high occupancy. Several stations also recorded elevated PM_{2.5} and PM₁₀ levels, particularly in areas with poor airflow or mechanical particle sources such as braking systems and track wear. These findings underscore the need for improved thermal regulation and air quality control in underground transit environments. Chronic exposure to excess heat and airborne particulates presents health risks to civilians and transit workers, especially in densely populated or underserved areas. Targeted interventions such as enhanced ventilation, localized filtration, and platform cooling are essential for building a more recommended and safer transit infrastructure.

Powers, Primes, and Pascal's Triangle

Eric Rowland (Hofstra University), Allison R. Siegel* (Hofstra University)

Pascal's triangle has been a source of mathematical insight for over a thousand years. For our purposes, we are interested in the many number theoretic properties of Pascal's triangle. For example, consider the 5th row on Pascal's triangle, which is (1, 5, 10, 10, 5, 1), and consider the prime 2. The exponent to which 2 divides each entry is (0, 0, 1, 1, 0, 0). In particular, 4 of the 6 entries are not divisible by 2, resulting in 0's. These 0's represent 2^0 . The remaining 2 entries are 1's, which represent divisibility by 2^1 but not 2^2 . We count entries on the n th row of Pascal's triangle by how many times a fixed prime divides them. We present a new proof of a theorem of the first-named author that describes the structure of this enumeration. This new proof will generalize more easily to other sequences.

Shifting Villanelle Refrains

Najalia Singh (CUNY Queens College)

Adviser: Christopher Hanusa (CUNY Queens College)

This study examines the combinatorial structure of the villanelle, a poetic form consisting of 19 lines and two repeating refrains, A and B , each appearing four times. Traditionally, refrain A occurs in lines 1, 6, 12, and 18, while refrain B appears in lines 3, 9, 15, and 19. The analysis investigates the number of possible arrangements of these refrains when their positions are allowed to vary. Several constraints are imposed to preserve structural coherence: refrains A and B can not overlap on the same line, the first occurrence of A must precede the first occurrence of B , and symmetric pairings, $BA = AB$, are excluded. Additionally, the spacing between consecutive appearances of each refrain is restricted, allowing line gaps ranging from one to five. Using arithmetic methods and the Principle of Inclusion–Exclusion, the study enumerates the valid configurations under these constraints. This approach determines the total number of distinct ways the refrains can be arranged without adhering to the traditional villanelle structure.

A Carousel Property for Compact Convex Sets

Yiming Song (Columbia University)

Adviser: Kira Adaricheva (Hofstra University)

We prove that if A_0 and A_1 are compact convex sets contained in a convex n -gon with vertices g_1, \dots, g_n , and n is strictly greater than the number of common supporting lines of A_0 and A_1 , then there exist $i \in \{0, 1\}$ and $j \in \{1, \dots, n\}$ such that A_i is in the convex hull of A_{1-i} and $(\{g_1, \dots, g_n\} - \{g_j\})$. This recovers and generalizes previous results of Adaricheva–Bolat and Czédli. We also show that this bound is sharp for even n .

Sensor Fusion of FMG, sEMG, and IMU for Continuous Joint Torque Estimation in an Arm Exoskeleton

Jacob Spitzer (Stuyvesant High School)

Adviser: Meng Ping Tu (Stuyvesant High School)

Effective control of exoskeleton devices requires real-time estimation of a user’s muscle activation to predict and support movement. Currently, the gold standard for measuring muscle activation is Surface Electromyography (sEMG). While intramuscular EMG is far more accurate, it is invasive, which makes it an impractical long term option. Surface EMG, is known to be subject to a number of flaws, including motion artifact, electrode displacement, and signal noise.

Another popular method is Force Myography (FMG). However, FMG is also subject to a number of flaws, most notably that its accuracy significantly decreases during non-isometric movements, due to changes in muscle belly length at different positions. This can be partially compensated for by incorporating IMU data.

Joint torque estimation has broad real-world applications, including rehabilitation settings where patients require assisted movement to regain strength, and industrial environments where workers need supplemental force for demanding tasks. It is particularly critical in lower limb exoskeletons, where precisely proportional torque assistance is required to preserve balance. In upper limb applications, prior systems such as the Elbow

SideWinder have struggled with accurate torque estimation and delivering assistive force without introducing mechanical resistance that interferes with natural motion. Addressing these limitations is a central motivation for this study, which aims to provide continuous, proportional torque assistance that adapts in real time to the user’s applied force by using a neural net to perform trimodal sensor fusion.

Metric Distortion and Miscalibration in Prediction Markets

Matteo Sylvestre (St. John’s University)

Adviser: Mikhail Ostrovskii (St. John’s University)

Prediction markets are increasingly used as probability forecasting tools, where a contract trading at 70 cents is interpreted as a 70% probability of the underlying event. A fundamental assumption embedded in this interpretation is that contracts are priced independently—that the market for one event does not structurally inform the pricing of another. We argue this assumption fails in a geometrically meaningful way.

Let V be the set of binary prediction market contracts on Kalshi active between January 1, 2024 and March 31, 2025. We define two natural metrics on V . The semantic metric

$\rho_s(u, v) = 1 - \langle \phi(u), \phi(v) \rangle / \|\phi(u)\| \|\phi(v)\|$ is the cosine distance in the sentence-transformer

embedding space (all-MiniLM-L6-v2), where $\phi(u) \in R^{384}$. The price-path metric

$\rho_p(u, v) = 1 - |\text{Pearson}(u, v)|$ is one minus the absolute Pearson correlation between daily probability time series; we have verified that ρ_p satisfies the triangle inequality on V .

Analyzing 120 settled contracts across three domains—Companies, Financials, and Science & Technology—we identify high-distortion pairs empirically. Two examples: “How many SpaceX launches in 2025?” and “Will an AI win gold at the International Math Olympiad?” yield $\rho_s = 0.663$, $\rho_p = 0.003$, and a lower bound on distortion of 168. “Who will be the wealthiest person at year-end?” and “Will there be a new pandemic by 2025?” yield $\rho_s = 0.649$, $\rho_p = 0.003$, distortion lower bound 160, and Pearson correlation 0.934.

We propose localizing conformal prediction to semantic neighborhoods as a correction mechanism. If $id: (V, \rho_s) \rightarrow (V, \rho_p)$ has distortion D , we conjecture coverage no better than $1 - f(D)$ for some explicit increasing f with $f(1) = 0$. We also investigate whether (V, ρ_p) admits a low-distortion embedding into a Hilbert space. Our empirical results demonstrate that high-distortion cross-domain pairs exist in real Kalshi data, providing evidence that geometric incompatibility between ρ_s and ρ_p is an observable market phenomenon.

Simple Brute-Forcing of Difficult Inequalities with Multivariate Homogeneous Symmetric Polynomials

Maria Tartakovsky (Council Rock South High School)

Adviser: Elena Goloubeva (Webb Institute)

We introduce a new “reduction” method for proving inequalities involving multivariate homogeneous symmetric polynomials. Unlike classical approaches that rely on Muirhead’s and/or Schur’s inequalities and often require a type of “deus ex machina” complex algebra, this method is simple and systematic. The problem reduces to verifying non-negativity of a series of lower-degree symmetric polynomials in fewer variables. Applied to the most challenging problems found in the literature, this method consistently transforms complex inequalities into easily manageable components. To summarize, the reduction method provides a structured approach, offering a reliable and easily automatable way to prove symmetric polynomial inequalities and create new ones.

The Art of Hiding: The Power of the Chinese Remainder Theorem

Johnson Tran (University of Houston - Downtown)

Adviser: Sergiy Koshkin (University of Houston - Downtown)

The Chinese Remainder Theorem (CRT) is one of the most important results in number theory, with roots going back to ancient China. We study its generalizations and applications to solving modular equations, finding modular roots of unity, efficient RSA decryption in cryptography, and constructing arbitrarily large invisible squares in integer lattices. We first prove both the classical and generalized forms of the theorem, then apply them to compute m -th roots of unity in modular arithmetic by reducing the general problem to prime powers. We further show how CRT enables efficient RSA decryption by decomposing a single large computation into two smaller ones. Finally, we prove new results on visibility of points in lattices when only some of their points obstruct the view, deriving explicit visibility criteria for families of blocking sublattices and generalizing the classical construction of invisible squares to this setting.

Conformal Maps

Marc Verma-Bonany* (CUNY New York City College of Technology), Serigne Diaw* (CUNY New York City College of Technology)

Adviser: Satyanand Singh (CUNY New York City College of Technology)

Conformal maps are functions that preserve angles and local geometric structure. While they may stretch or compress distances at individual points, they maintain the angles between intersecting curves and thus preserve local shape. In this work, we present some important examples of conformal mapping and explore their key properties. We also discuss a range of applications across diverse fields, including physics, complex analysis, computer graphics, and biology, highlighting how conformal mappings provide powerful tools for modeling and problem-solving in these disciplines.

Assessing the Neuroanatomical Correlates of a Cognitive Marker of Preclinical Alzheimer's Disease

Grace Yang (Stuyvesant High School), Ian McDonough (Binghamton University)

Adviser: Meng-Ping Tu (Stuyvesant High School)

Preclinical Alzheimer's disease (AD) refers to the stage in which AD related-pathology develops before clinical symptoms have emerged. Ability discrepancy, the difference between crystallized and fluid abilities, has been proposed as a less biased and effective cognitive assessment of preclinical AD risk, but its neural correlates are not well understood. In this study, we examined the associations between ability discrepancy and regional cortical thickness and volume in sixty-seven participants aged 50-74 drawn from the Alabama Brain Study on Risk for Dementia (ABSORD) and five hundred and three participants aged 61-95 from the Human Connectome Project Aging/Aging Adult Brain Connectome (HCP-A/AABC). For each cohort, we utilized standard ordinary least squares (OLS) models where we evaluated linear, quadratic, and linear positive ability discrepancy subset associations. For ABSORD, we also employed robust regressions with the same three model specifications. While the smaller exploratory ABSORD analysis lacked cross-sample stability, the larger confirmatory HCP-A/AABC cohort revealed significant volume reductions in the right parieto-occipital sulcus area 1 for the quadratic model, the right Area 24dv of the anterior cingulate cortex for the positive subset model, and the right superior temporal sulcus (STS) for the linear and positive subset models. These findings suggest that regions responsible for executive control and higher-order multimodal integration may be linked to ability discrepancy, providing a biological foundation for its use in identifying preclinical AD risk. Nonetheless, replication with more samples and confirmation with longitudinal data are vital to determine the consistency of these associations.

Analyzing Weather Station Reliability During Extreme Precipitation Events

Mabel Yang (Stuyvesant High School)

Adviser: Nir Krakauer (CUNY City College of New York)

The Global Historical Climatology Network Daily (GHCND), maintained by NOAA's National Centers for Environmental Information, provides archived daily climate observations from over 25,000 stations worldwide. During extreme precipitation events, having accurate weather station data is crucial, as flooding and infrastructure problems increase hazards. However, these same events often disrupt weather stations through power outages, sensor failure, or complete physical damage. This study evaluates U.S. weather station reliability during extreme precipitation events, such as U.S. hurricanes, by analyzing patterns of missing or incomplete data. Using Python and QGIS, missing-value percentages were quantified before and during each event, and station characteristics such as missing data percentages, urbanization level, and station density were compared. Although the percentage of stations failing in rural and coastal regions appears similar, reliability outcomes differ because rural regions have far fewer stations, making each failure more consequential. The work highlights geographic clusters of disruption during major storms and demonstrates the importance of network density in interpreting station reliability, suggesting that sparse networks produce observational blind spots during extreme weather.

Our Experiences in AMC 8 Enrichment Workshops

Elyse Yip (INTEGRATE Program), Chloe Zhao (INTEGRATE Program), Austin Zheng (INTEGRATE Program), Kaden Chen (INTEGRATE Program), Andy Liu (INTEGRATE Program), Yu Chun Woo (INTEGRATE Program)

Adviser: Shamita Dutta Gupta (Pace University)

In this poster we will discuss our experiences of deep dives into math topics and finding the interactions between topics through workshops as we prepared for the AMC 8 contest. After the process, we have a deeper understanding and appreciation of Mathematics. We find that we approach the real-world problems with vigor, trying to explain the mathematics surrounding it. We look for logical explanations rather than taking explanations for granted. We are now ambassadors of STEM areas.

SECTION INITIATIVES

METRO NExT (NEW EXPERIENCES IN TEACHING)

Metro NExT (New Experiences in Teaching) is a local version of MAA's Project NExT, a professional development program for new or recent Ph.D.s in mathematics. Our goal is to build a community of new faculty and graduate students in the Metro New York MAA Section to help each other develop effective strategies for all aspects of our professional lives from teaching to research to service.

Metro NExT is open to all faculty members in or around the Metro New York area who teach mathematics at a post-secondary institution. Metro NExT is also open to all graduate mathematics or mathematics education students in their final two years of doctoral study.

Please contact Dr. Andrew Lee at alee2@adelphi.edu or Dr. Mónica Morales-Hernandez at mmoraleshernandez@adelphi.edu for more information.

MATHEMATICS SPEAKERS BUREAU

The Mathematics Speakers Bureau is composed of dedicated mathematicians who volunteer to speak to students and faculty of regional middle schools, high schools, colleges and universities on topics reaching beyond the traditional mathematics curriculum. The primary goals of the Mathematics Speakers Bureau are to stimulate the interests of local youth in mathematics, provide opportunities for students to meet active and enthusiastic mathematicians, motivate students towards careers in the mathematical sciences, and encourage cooperation between corporate and academic institutions in the mathematical education of area youth.

Please contact Dr. Ben Gaines at bgaines@iona.edu with any questions.

Find out more about these programs and more at our website:
<http://sections.maa.org/metrony/>

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