ANNUAL MEETING

AT

PACE UNIVERSITY

April 29, 2023

PACE
UNIVERSITY

THE METROPOLITAN NEW YORK SECTION MEETING 2023

Dear MAA Metro New York Conference Participants,

It is my distinct honor to welcome you to our annual meeting of the Mathematical Association of America Metropolitan New York Section (MAA Metro NY)! We are elated to be at PACE university, and we express our gratitude to the PACE administration for providing us with this opportunity.

We look forward to your participation in today's meeting in this face-to-face setting. We have a wide range of presentations that promise to inspire you. I would like to express my appreciation and thanks to our MAA committee members, the local organizing committee and all the volunteers whose diligence and hard work helped bring this meeting to fruition.

Our special thanks go out to our invited speakers, Dr. Boyan Kostadinov and Dr. Talithia Williams, who will share with us exciting mathematics today that promise to stimulate and challenge our way of thinking. We would also like to thank our sponsors, Maplesoft and Pearson, for supporting us and sharing their educational tools with our community. We express our deep appreciation to you for attending and contributing to our meeting and invite you to become part of our vibrant MAA Metro NY community.

This year's program features over sixty presentations, with presenters showcasing a wide variety of topics, some of which highlight research in mathematics, pedagogy, technology, data science, machine learning, diversity, equity, and inclusion. We hope that you will interact with our Metro NExT panel and our panel on Understanding Implicit Bias.

Thank you for coming and we hope that our meeting exceeds your expectations.

With best regards,
Satyanand Singh on behalf of the MAA Metro New York section

MAA
MATHEMATICAL ASSOCIATION OF AMERICA

WELCOME

METROPOLITAN NEW YORK SECTION

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CONTRIBUTED PAPER AND POSTER SESSIONS ORGANIZING COMMITTEE

Ezra Halleck, Nadia Kennedy, Boyan Kostadinov (Chair), and Ariane Masuda

LOCAL ORGANIZING COMMITTEE

Brian Evans, Shamita Dutta Gupta(Chair) & Kathy Macleod

LOCAL VOLUNTEERS

Eduardo Chan, Beatrice Levin & Analee Miranda

PHOTOGRAPHER

Thomas Cheung

THE MAA ANNUAL MEETING OF THE METROPOLITAN NEW YORK SECTION

APRIL 29, 2023

AGENDA

8:30-8:45 AM	Welcome (Bianco Room) Dr. Satyanand Singh, *Chair of the Metropolitan New York Section of the MAA* Dr. Brian Evans, *Associate Dean of School of Education & Chair of the Mathematics Department, PACE University*
8:50-9:45 AM	Invited Speaker: Dr. Boyan Kostadinov, (Bianco Room) *MAA Metro NY Chair Elect, New York City College of Technology*
9:50-10:00 AM	Welcome (Bianco Room) Dr. Tresmaine Grimes, *Dean of Dyson College of Arts and Sciences & School of Education, PACE University*
10:05-10:15 AM	Janet Liou-Mark Student Awards (Bianco Room) Dr. Joseph Lindquist
10:20-11:15 AM	Invited Speaker: Dr. Talithia Williams (Bianco Room) *Associate Dean for faculty development & diversity and Associate professor Harvey Mudd College, MAA Pólya Speaker and host of NOVA wonders mini-series*
11:20-11:30 PM	Break
11:35-12:05 PM	Sponsor Presentation: Discover Maplesoft's Math Suite (W618) Sponsor Presentation: Pearson Publishers (W623)

Contributed Paper Sessions I

12:10-12:40 PM

Research Session: Applied Mathematics I (Presider: Dr. F. Patricia Medina) (W610)
Research Session: Pure Mathematics I (Presider: Dr. Ezra Halleck) (W615)
Research Session: Data Science and Miscellaneous (Presider: Dr. Boyan Kostadinov) (W616)
Pedagogy Session: Mathematics Education I (Presider: Dr. Shamita Dutta Gupta) (W622)
Student/Faculty Session I (Presider: Dr. Joseph Lindquist) (W618)

12:45-1:30 PM

Lunch Break/Contributed Poster Session (Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua (Sara) Wang) (Student Center)

Contributed Paper Sessions II

1:35-2:50 PM

Research Session: Applied Mathematics II (Presider: Dr. Johanna Franklin) (W610)
Research Session: Pure Mathematics II (Presider: Dr. Elena Goloubeva) (W615)
Pedagogy Session: Mathematics Education II A(Presider: Dr. Benjamin Gaines) (W616)
Pedagogy Session: Mathematics Education II B(Presider: Dr. Sandie Han) (W622)
Student/Faculty Session II (Presider: Prof. Bruce Kan) (W618)

2:55-3:40 PM

Workshops:
Metro NExT Meeting- "How Covid has Changed In-person Instruction" (W623)
Dr. Johanna Franklin, Dr. Benjamin Gaines, Dr. Elena Goloubeva, Monica Morales Hernandez, Dr. Andrew Lee, Dr. Kate Poirier & Dr. David Seppala-Holtzman

Understanding Implicit Bias: A workshop for building an inclusive STEM community (W618)
Dr. Sandie Han, Dr. Diana Samaroo & Kirsten Tam

3:45-4:45 PM

Business Meeting (Presider: Dr. Satyanand Singh) (Bianco Room)

GUEST WIFI

username: mmetrony **password: q7$4S**

hashtag for this event is #MAAatPACE

INVITED SPEAKERS

Dr. Boyan Kostadinov, New York City College of Technology, CUNY

Title: Using Data Science Tools for Investigating Chat Logs from the Conti Ransomware Group

Abstract: The main goal of this presentation is to showcase some results from a comprehensive analysis done on the cache of chat logs from the notorious ransomware group Conti. The chat logs were made publicly available on February 27, 2022. They contain 393 json files with chat logs from the instant messaging service Jabber that was used by Conti. We employed a variety of modern data science tools for text mining, natural language processing, network analysis and geospatial analysis to investigate the Conti chat logs so that we could better understand the command and control structure of the network and discover any valuable information hidden in the data, such as Bitcoin, IP, email and web addresses, as well as any other information that can lead to further insights into the inner workings of the Conti group. This work was done in collaboration with two City Tech students, Joseph Liu and Julio Rayme, and the *Center for Criminal Investigations and Network Analysis* at George Mason University. This project has been funded by the Department of Homeland Security (DHS). All opinions expressed in this presentation are the author's and do not necessarily reflect the policies and views of the DHS, or any other federal agency.

Bio: Boyan Kostadinov is an Associate Professor at NYC College of Technology, CUNY. He joined the Mathematics Department in 2009. Prior to that, he held positions as a quantitative researcher in London and New York. Before obtaining his Master's in Finance from Princeton University in 2007, he completed his PhD in mathematics at UCLA in 2005. His dedication to teaching has been rewarded by receiving the prestigious *Robert Sorgenfrey Distinguished Teaching Award* from UCLA, and the *2020 Distinguished Teaching Award of the Mathematical Association of America, Metro NY Section*. Professor Kostadinov has a strong commitment to undergraduate student research and has been a faculty adviser to over 70 students, who have given presentations at local, regional and national conferences. His main research interests are Computational Problem Solving in STEAM Education, and Applied Data Science. He believes that computational thinking can be understood as a fundamental skill in the 21st century that everyone can use to get valuable insights and solve difficult problems in any field.

INVITED SPEAKERS

Dr. Talithia Williams, Associate Dean for faculty development and diversity and Associate Professor at Harvey Mudd College, MAA Pólya Speaker and host of NOVA wonders mini-series.

Title: The Power of Talk: Engaging the Public in Mathematics

Abstract: When it comes to inspiring the future productivity and innovation of our nation, mathematicians are on the front lines. In this talk, I will discuss the importance of engaging a wide range of audiences in conversations about the nature of our work and of scientific discovery. As we change the way communities think about the natural world and the STEM disciplines, we can begin conversations that improve public perception of science and bring people from all backgrounds into this important work.

Bio: Dr. Talithia Williams is a host of the PBS series *NOVA Wonders*, a groundbreaking professor, popular TED speaker, inspiring author and passionate STEM/STEAM advocate. She has made it her life's work to get people of all ages and backgrounds excited about the bold possibilities of a STEM education and to "STEMpower" women and minorities to enter these professions. Her latest book, *Power in Numbers: The Rebel Women of Mathematics* reflects Williams' passion to re-brand the field of mathematics as anything but dry, technical or male-dominated. Renowned for her popular TED Talk, "Own Your Body's Data," she advocates for all of us to deploy data as a way of taking charge of our own health. A vibrant, engaging and energizing speaker, Dr. Williams demystifies data, statistics, probabilities and the mathematical process in amusing and insightful ways. She also passionately champions the contributions of scientists, technologists, engineers and mathematicians and their vital role in transforming our future.

Dr. Williams is Associate Dean for Faculty Development and Diversity and Associate Professor of Mathematics at Harvey Mudd College, where she develops statistical models which emphasize the spatial and temporal structure of data, applying them to real world problems. Focused on data analytics, mathematics, statistical modeling and STEM outreach, she is the first African-American woman to achieve tenure at the college. She hosts *NOVA Wonders*, a PBS mini-series that explores the biggest questions on the frontiers of science. The *Los Angeles Times* praised the show for sending the message "that scientists come in a range of ages, genders, colors and hairstyles." She also appeared in NOVA's Prediction by the Numbers, a series exploring the history of probabilities and gambling which Forbes called, "an entertaining, fun piece that conveys her knowledgeable and deep interest in this predictive method." In addition to her teaching and television work, she has partnered with the World Health Organization in developing a cataract model used to predict the cataract surgical rate for countries in Africa. Her professional experiences include research appointments at NASA's Jet Propulsion Laboratory, NASA's Johnson Space Center, and the National Security Agency.

An exceptional communicator and gifted teacher, Dr. Williams won the Mathematical Association of America's Henry L. Alder Award for distinguished teaching. She also developed a 24-part college level lecture series, "Learning Statistics: Concepts and Applications in R", for *The Great Courses*, an online platform for lifelong learners. Dr. Williams earned a bachelor's degree in mathematics from Spelman College, a master's degree in mathematics from Howard University and a PhD in statistics from Rice University. In 2019, she received an honorary doctorate from Fielding Graduate University for her "substantial impact on higher education" and for "championing the development of women in the STEM professions."

Described by audiences as engaging, relevant, funny, accessible, and a joy to work with, Dr. Williams captivates and inspires with her contagious enthusiasm for STEM in general and math in particular. Applying the data-driven approach made famous in her TED talk to a range of subjects, she takes sophisticated numerical concepts and makes them understandable to a wide audience, debunking perceptions with an energizing call to "show me the data!"

SPONSORS PRESENTATIONS

Discover Maplesoft's Math Suite (W618)

11:35 AM – 12:05 PM

The Maplesoft Mathematics Suite is a family of math software products that help you help your students succeed in math and subjects that involve math, like engineering, physics, or economics. This family of products makes it extremely easy to explore, visualize, and solve mathematical problems from high school all the way through to graduate studies. Each one provides access to the world's most powerful mathematics engine through an easy-to-use interface that is designed to meet the needs of students at different phases of their education. Join this short session to see for yourself how these technologies can engage, motivate, and enlighten your students.

Organizers: **Eram Dost**
Ashish Kamat

Pearson (W623)

11:35 AM – 12:05 PM

Resources that are designed to improve the Educational Experience

Today's instructors are under pressure to meet a wide variety of student needs in in-person, digital, and hybrid classroom settings. We look at some new resources that are designed to improve the educational experience for all, including: 3D printable models for Calculus, GeoGebra exercises, and interactive learning in Calculus and Statistics.

Organizers: **Monique Bettencourt**
Laura Briskman
Allison Deville

METRO NExT (NEW EXPERIENCES IN TEACHING):
How Covid Changed In-person Instruction
2:55 PM – 3:40 PM
(W623)

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

In this session we will discuss how the Covid-19 pandemic has affected many different aspects of instruction in our courses. Join our panel of distinguished teachers for a discussion on what has changed already, and what might be coming next. Come by and find out how you can get involved!

Organizers: **Dr. Johanna Franklin**, *Hofstra University*
Dr. Benjamin Gaines, *Iona University*
Dr. Elena Goloubeva, *Webb Institute*
Monica Morales Hernandez, *Adelphi University*
Dr. Andrew Lee, *St. Thomas Aquinas College*
Dr. Kate Poirier, *New York City College of Technology, CUNY*
Dr. David Seppala-Holtzman, *St. Joseph University*

Understanding Implicit Bias:
A workshop for building an inclusive STEM Community
2:55 PM – 3:40 PM
(W618)

This workshop will examine implicit bias habits as part of building bias literacy, a term used by Women in Science & Engineering Leadership Institute (WISELI) at the University of Wisconsin-Madison, for promoting institutional change and improving department climate. The workshop participants will have the opportunity to discuss and share high impact practices that mitigate implicit bias and cultivate a climate of equity and inclusion in the classroom and the workplace.

Organizers: **Dr. Sandie Han**, *New York City College of Technology, CUNY*
Dr. Diana Samaroo, *New York City College of Technology, CUNY*
Kirsten Tam, *Great Neck North High School*

JANET LIOU-MARK STUDENT AWARDS

ALMA COOPER United States Military Academy

Alma Cooper is a Mathematical Science major at the United States Military Academy. Since her Sophomore year, Alma has traveled across the country with West Point's Leadership, Ethics, and Diversity in STEM (LEADS) where she has led middle and high school students through ethical leadership discussions and taught STEM modules. Upon graduation, Alma will serve as a Military Intelligence officer and will attend Stanford University for a Master's in Statistics and Data Science.

DOMINIC RUDAKEVYCH United States Military Academy

Dominic Rudakevych comes from Hatboro, Pennsylvania and pursued a major in Mathematical Sciences with a minor in Applied Statistics during his time at West Point. Outside of his studies, Dom served as president of the Mathematics Forum as well as captain of the chess team. After graduation he will be commissioned as a second lieutenant and begin service as a Military Intelligence Officer. His first assignment will be Camp Humphreys, South Korea.

DISTINGUISHED SERVICE AWARD

Dr. Boyan Kostadinov **New York City College of Technology, CUNY**

Boyan Kostadinov is an Associate Professor at NYC College of Technology, CUNY. He joined the Mathematics Department in 2009. Prior to that, he held positions as a quantitative researcher in finance in London and New York.

His dedication to teaching has been rewarded by receiving the prestigious *Robert Sorgenfrey Distinguished Teaching Award* from UCLA, and the *2020 Distinguished Teaching Award of the Mathematical Association of America, Metro NY Section*. Prof. Kostadinov has a strong commitment to undergraduate student research, and has been a faculty adviser on research projects to over 70 students, who have given presentations at local, regional and national conferences. His main research interests are Computational Problem Solving in STEAM Education, and Applied Data Science.

Professor Kostadinov has been involved with co-organizing the MAA Metro NY Annual Meeting since 2015. In 2021, he was elected to serve as the Chair-Elect of the Mathematical Association of America (MAA) Metro New York Section. Prior to that he was elected to serve a 3-year term as the Vice-Chair for 4-Year Colleges. Professor Kostadinov has been a member of the MAA Metro NY organizing committee for the last 10 MAA Metro NY Conferences. Prof. Kostadinov's hard work and dedication were instrumental in moving the MAA Metro NY conference online in 2020, 2021 and 2022.

Professor Kostadinov has worked very hard to bring students and faculty from the Metro NY area together in an environment that promotes discourse, diversity, pedagogy and research.

DISTINGUISHED TEACHING AWARDS

Dr. Shamita Dutta Gupta PACE UNIVERSITY

Shamita Dutta Gupta is a Professor of Mathematics and the Associate Chair of the Department of Mathematics at Pace University. She graduated with a Ph.D. from Brown University in 1995. She joined The Pennsylvania State University at State College thereafter for a fixed term research Assistant Professor position, next moving to a tenure track Assistant Professor position at the Florida International University in 1996. Professor Dutta Gupta then moved to Pace University as a tenure track Assistant Professor in 2000. At Pace University, she was tenured and promoted to Associate Professor in 2002 and rose to the rank of Professor in 2006.

Professor Dutta Gupta's work in MAA started back during her days at Florida International University. The Gold Coast Section of MAA was inactive for several years. Professor Dutta Gupta revived the Gold Coast Section of MAA conducting the annual meetings in this section for the three years she was at Florida International University. Her ardent involvement in the education of her students earned her the Excellence in Teaching Award at Florida International University.

Professor Dutta Gupta is passionate about curriculum development at Pace University. She has created several Learning Communities in partnership with the English Department titled Crossing the Divide: The Art of Mathematical Thinking and the Science of Rhetoric and with Women's Studies titled Culture and Math: The intersectionality of Gender, Race and Class. Her Writing Enhanced courses spruce up learning statistics with writing professional reports. In her Service-Learning Calculus courses Teach and Learn Calculus, she partners with neighborhood high schools having each of her students offer 36 hours of tutoring to high school students in Algebra and Pre-Calculus. Recently, she launched Embedded Mini Boot Camps to handle on the spot remediation in her Calculus sequence courses. She has created special online study modules which provide for each of her student custom made remediation, thus promoting student success and hence retention.

Professor Dutta Gupta has four main research areas, Number Theory, Actuarial Science, Financial Mathematics and Mathematics Education. In Number Theory, her work involves application of Rankin-Selberg methods to modular forms associated with Elliptic Curves over function fields. In Actuarial Science, her work focuses on the risk return profile of Life Settlement as an investment. Her work also covers Property Insurance reserving, Social

Security modeling, valuation of variable annuity guarantees. In Financial Mathematics, her work covers capital requirements for banks, Asset Backed Securitization, and application of Simulation methods and sampling methods in finance and insurance. In Mathematics Education, her work includes retention and success rate in mathematics courses and ways to model courses with student centric tools that result in student success. She develops and tests models for student success in pivotal mathematics courses that are indicators for STEM success and those for Business school. She has successfully won Pace University internal grants. She has over 25 publications.

Professor Dutta Gupta loves to build community. She volunteers her time in middle and high schools, giving talks, coaching in the math-clubs, and always encouraging students to continue to college.

Dr. Behailu Mammo HOFSTRA UNIVERSITY

Behailu (aka Alu) Mammo was born in Ethiopia, East Africa and is a professor of mathematics at Hofstra University, New York. He earned his BS and MS in Mathematics from Addis Ababa University, Ethiopia. In 2000, he joined Temple University, Philadelphia for his graduate education as an international student. Five years later, he received his Ph.D. in Mathematics and joined Hofstra University as a tenure-track assistant professor and got promoted to full professor in 2021. While at Temple, he had full responsibility teaching courses ranging from College Algebra to Calculus III. Clarity, simplicity, interactivity, and being caring for students' learning are some of the salient features of his teaching practice. In 2004, he received an award for outstanding teaching by a graduate student. At Hofstra, his teaching evolved and added "multifaceted student feedback" as an additional attribute to his teaching practice to further strengthen student learning. In 2020, he became the teacher of the year at Hofstra University for the College of Liberal Arts and Sciences. His impact on teaching goes beyond his own classrooms. Starting from 2011, he has received more than $2 million from the National Science Foundation (NSF) for the Hofstra Noyce Program that recruits, prepares, and retains mathematics and science education majors so that they become high-quality teachers, especially in high-need schools. Creating equitable learning opportunities for all students is the overarching goal of this program. So far, the program awarded scholarships to 49 Hofstra students, and most have already taught thousands of high-need school students. Behailu lives in Long Island, New York with his wife and two sons.

CONTRIBUTED PAPER SESSIONS I

12:10 PM – 12:40 PM

RESEARCH SESSION: APPLIED MATHEMATICS 1

ROOM W610

Presider: Dr. F. Patricia Medina

12:10 p.m. **The Optimal Tennis Serve**

David Seppala-Holtzman, St. Joseph's University

Consider the tennis serve. The server has two fundamental decisions to make: in what direction she should aim the ball and with how much force she should hit it. In any given direction, she could use the minimal amount of force that has the ball just making it over the net. Call this the "short serve." Alternatively, she could use the maximal amount of force that has the ball just stay in bounds at the far end of the service box. Call this the "long serve." We compute the distance between the ball's point of landfall in the short and long serves as a function of direction. We derive the direction in which this distance is the greatest, affording the server with maximal leeway between using too much or too little force. It is the most forgiving direction. We call it the optimal tennis serve.

12:25 p.m. **From Varadhan's Limit to Eigenmaps: A Guide to the Geometric Analysis behind Manifold Learning**

Chen-Yun Lin and Christina Sormani, Lehman College

We present an overview of the history of the heat kernel and eigenfunctions on Riemannian manifolds and how the theory has lead to modern methods of analyzing high dimensional data via eigenmaps and other spectral embeddings. We begin with Varadhan's Theorem relating the heat kernel to the distance function on a Riemannian manifold. We then review various theorems which bound the heat kernel on classes of Riemannian manifolds. Next we turn to eigenfunctions, the Sturm-Liouville Decomposition of the heat kernel using eigenfunctions, and various theorems which bound eigenfunctions on classes of Riemannian manifolds. We review various notions of convergence of Riemannian manifolds and which classes of Riemannian manifolds are compact with respect to which notions of convergence. We then present Bérard-Besson-Gallot's heat kernel embeddings of Riemannian manifolds and the truncation of those embeddings. Finally we turn to Applications of Spectral embeddings to the Dimension Reduction of data sets lying in high dimensional spaces reviewing, in particular, the work of Belkin-Niyogi and Coifman-Lafon. We also review the Spectral Theory of Graphs and the work of Dodziuk and Chung and others. We close with recent theorems of Portegies and of the first author controlling truncated spectral embeddings uniformly on key classes of Riemannian manifolds. Throughout we provide many explicitly computed examples and graphics and attempt to provide as complete a set of references as possible. We hope that this article is accessible to both pure and applied mathematicians working in Geometric Analysis and their doctoral students.

RESEARCH SESSION: PURE MATHEMATICS I

ROOM W615

Presider: Dr. Ezra Halleck

12:10 p.m. **The Pythagorean Reciprocal Identity and Generation of All Solutions**

Alexander Rozenblyum and Satyanand Singh, New York City College of Technology

In our presentation, we derive and generate all solutions to the Pythagorean reciprocal equation $a^{-2} + b^{-2} = d^{-2}$ that has its roots in a right triangle. We will also show that $d \equiv 0 \, mod \, 12$, and illustrate how to solve these equations for any fixed d. In particular we will establish that when $a<b$, $d < a < 2^{1/2}d$.

12:25 p.m. **On Some Polynomial Reciprocity Formulas**

Brad Isaacson, New York City College of Technology, CUNY

Carlitz proved a powerful reciprocity theorem for generalized Dedekind-Rademacher sums. Among its many consequences was an interesting polynomial reciprocity theorem which holds under a certain restriction of its parameters. Carlitz remarked that it was unclear how this restriction could be removed. In this talk, we remove this restriction and obtain a generalization of Carlitz's polynomial reciprocity theorem which is equivalent to the polynomial reciprocity theorem of Beck and Kohl.

RESEARCH SESSION: DATA SCIENCE

ROOM W616

Presider: Dr. Boyan Kostadinov

12:10 p.m. **Product Coefficients in Machine Learning in LiDAR**

F. Patricia Medina, New York City College of Technology

The authors in [1] focused on measures defined on dyadic sets which are sets with an ordered binary tree of subsets. An example is the partition of the unit interval into dyadic subintervals. The measures are defined on the sigma algebra generated by the subsets in the binary tree. They presented three types of theoretical results based on theorems in [2] to obtain a dyadic product formula representation lemma. The dyadic product formula representation lemma provides an explicit set of product coefficient parameters which are sufficient to distinguish measures on dyadic sets. The authors experimented with applying the product formula representation to a counting measure derived from a set of LiDAR (light detection and ranging, an optical sensing technology to estimate , and coordinates) sample data. The experiment shows that decision rules for distinguishing two measures (here vegetation and ground) can be approximately inferred from histograms of the product coefficients. Note that previous work in [3] had examined this same data using a multi-scale SVD approach to build a support vector machine (SVM) based classification rule that could, with high accuracy, reproduce the vegetation/ground labeling. They conjecture that the results could be improved by combining product coefficient methods with multi-scale SVD methods. In this presentation a way of using product coefficients in a machine learning model. Beyond the specific machine learning task, I'd like to present this application as a way of telling a story (the evolution from theory to application) of how a mathematical area such as measure theory can provide insight on data.

[1] D. Bassu, R. Izmailov, A. McIntosh, L. Ness, and D. Shallcross. *Centralized multi-scale singular vector decomposition for feature construction in lidar image classification problems.* In IEEE Applied Imagery and Pattern Recognition Workshop (AIPR). IEEE, 2012.

[2] Robert Fefferman, Carlos Kenig, and Jill Pipher. *The theory of weights and the dirichlet problem for elliptical equations.* Annals of Math., 134:65–124, 1991.

[3] N. Brodu and D. Lague. *3d terrestrial lidar data classification of complex natural scenes using a multiscale dimensionality criterion: Applications in geomorphology.* ISPRS Journal of Photogrammetry and Remote Sensing, 68:121 – 134, 2012.

12:25 p.m. **Using Deep Learning to Generate Knots with Prescribed Invariants**

Mark Hughes, Brigham Young University

Generative techniques from deep learning have proven successful at producing realistic artificial images and videos, as well convincing synthetic data in several domains. In this talk I will outline an approach to using generative adversarial networks (GANs) to produce knots with specified invariant values. In particular, we show how to construct a GAN which takes as input a Jones polynomial, and outputs a knot with that Jones polynomial. We demonstrate how such GANs can learn to produce new knots that weren't involved in the training process, and how they can potentially be used to produce counterexamples to open conjectures. This is joint work with Amy Eubanks and Jared Slone.

PEDAGOGY SESSION: MATHEMATICS EDUCATION I

ROOM W622

Presider: Dr. Shamita Dutta Gupta

12:10 p.m. **Exploring Limits of a Function Using Desmos Online Graphing Calculator**

Lucie Mingla, LaGuardia CC, The City University of New York

As we thrive to continuously be more globally competent as educators, we also want our students to be able to learn, gain the necessary skills, and engage in global problem-solving. The ability to communicate in different methods is one of key components. Digital communication helps us understand and explain challenging concepts that are almost impossible to do otherwise. Desmos online graphing calculator is a great digital platform that helps faculty develop pedagogical content using computational approaches to actively engage students and enhance learning. This talk is focused on exploring limits of various functions as a fundamental concept in calculus that enables understanding of the behavior and sketching the graph, derivatives, integrals, etc. As abstract as it is as a concept, the limit can be explored and defined by using computations and visualizations in any advanced graphing calculator such as, for example, desmos. That is because the features of this online digital platform allow us to input different types of functions, build the table values, build the sliders, and label a moving point in the graph to trace the graph. When we want to observe approaches, desmos allows us to get very close to the point where we want to explore and gives the coordinates with very small jumps. It enables us to explore the limits of functions when x approaches infinity and infinite approaches of the function values. Come explore with me in an interactive session some special cases of limits, asymptotes, continuity, and other behaviors of graphs of functions.
Example: https://teacher.desmos.com/activitybuilder/custom/6403d477bdff7a9a7c4fc996

12:25 p.m. **Open Educational Resources and Technology in Differential Equations**

Reva Narasimhan, Kean University

In the past few years, there has been a shift away from the formulaic approach to the subject of differential equations and towards the use of modeling and technology. The availability of free, sophisticated resources for computation and visualization has accelerated this pedagogical shift. In this presentation, we will illustrate the use of commonly available tools which can enhance the study of differential equations. One of the main issues when incorporating technology for a subject is the effort involved in managing multiple resources on the web and weaving them into a coherent narrative. We will illustrate the use of OneNote as a central repository for our web-based resources. The book-like structure of OneNote will aid in organizing the material into a live, interactive eBook. We will show how to incorporate Desmos and GeoGebra activities into the notebook, as well as relevant videos and open source textbooks.

STUDENT/FACULTY SESSION I

ROOM W618

Presider: Dr. Joseph Lindquist

12:10 p.m. **An Introduction to Topological Data Analysis through the Lens of Persistent Homology**

Celine Lukito, Molloy University
Advisor: Dr. Manyiu Tse, Molloy University

Topological Data Analysis (TDA) is a rapidly growing field in data science that utilizes tools from algebraic topology to extract and analyze geometric structures of complex data sets. There is an urgent need for new methods of data analysis that can process high-dimensional, noisy, and complex data due to the rapid increase in data volume across various fields. TDA provides a powerful set of tools to analyze such data by focusing on its intrinsic geometric and topological properties. We will discuss how persistent homology is used to measure these features across different spatial resolutions.

12:25 p.m. **Costs and Benefits of Raising the US Army BMI Standards**

CDT Alma Cooper, Dr. Diana Thomas, COL Michael Yankovich, and MAJ Maria Smith, United States Military Academy
Advisors: Dr. Diana Thomas and MAJ Maria Smith

The U.S Army has fallen below expected recruiting milestones. In 2022, the US Army missed their recruiting benchmark by 25%. As a result, their recruiting goal for this quarter was decreased by 10,000 recruits. To join the military, recruits must meet a series of physical, educational, and behavioral standards. Recruits must pass the Armed Forces Qualification Test with a minimum score of 31, pass a medical examination, have at least a high school diploma, be between the age of 17-35, and be of good civil standing. Drug use, obesity, and education levels are common factors that limit the recruiting population in the United States. Recruiting issues pose a risk to national security and the ability to maintain an all-volunteer force. The current body mass index standard for military recruiting is capped at BMI of 25. This year, I conducted research on cost benefit analysis on raising the BMI standard for enlisting soldiers. I used National Health and Nutrition Examination Survey Data from 2017-March 2020 Pre-Pandemic. As the world begins to return to normalcy for the first time since February 2020, this dataset provides a glimpse of what the current US population may look like. The CDC's latest obesity report provides BMI 30 as Stage 1 Obesity. The questions lies: Who are these Americans and what costs/benefits would the Army incur if they were to join the recruiting population?

CONTRIBUTED POSTER SESSION I

12:45 PM – 1:30 PM

MISCELLANEOUS RESEARCH

Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua(Sara) Wang

Occurrences of Microplastics in Nature and Possible Correlation to Human Statistics

Angelina Amatulli-Griffith, Kevin Zhuo, Joseph Nunez, Kyle Polund, Suffolk County CC
Advisor: Vera Hu, Suffolk County Community College

This study will investigate the correlation between increased multitudes of microplastics, as defined by plastic objects smaller than 5 millimeters, in the natural environment and possible relevance to increased concentrations found in the human anatomy. The research will be primarily quantitative and will include background information of qualitative materials regarding known impacts of microplastic exposure on human health; where environmental concentration is the independent variable and internal concentration within people is the dependent variable. Data used for the purposes of this experiment are secondarily sourced from reputable scientific journals and investigational findings. This is explicitly due to lack of access to necessary laboratory equipment as this experiment is being performed in investigative settings at the Associates level. The conclusion of our findings is expected to support or reject the theory that increased amounts of environmental microplastics may have statistical relation to information regarding increased population of these particles in human physiology. It is expected that the research will yield a direct relationship between the independent and dependent variable such that we will find a producible equation for exponential growth.

An Algorithm to Find the Free Generators of a Subgroup of a Free Group Based on Geometric Group Theory

Aaron Li, Newark Academy High School
Advisor: Guillermo H. Goldsztein

A free group over a given set consists of all words that can be built from members of. The members are called free generators of, and the number of free generators is the rank of the free group. The rank is all that matters in characterizing. In this paper, we explore a graph theoretic approach to construct a free set of generators of a free subgroup and include an implementation of the algorithm.

A Reduction Algorithm for Volterra Integral Equations

Sarah Rosen and Richard Gustavson, Manhattan College
Advisor: Richard Gustavson

An integral equation is a way to encapsulate the relationships between a function and its integrals. We develop a systematic way of describing Volterra integral equations – specifically an algorithm that reduces any separable Volterra integral equation into an equivalent one in operator linear form, i.e., one that only contains iterated integrals. This serves to standardize the presentation of such integral equations to only consider those containing iterated integrals. We use the algebraic object of the integral operator, the twisted Rota-Baxter identity, and vertex-edge decorated rooted trees to construct our algorithm.

A "Lill" Magic

Christos Tsakalakos and Olivia Larkin, Fiorello H. LaGuardia High School
Advisor: Christos Tsakalakos

Think of all the ways you know to solve a quadratic equation: factoring, grouping, completing the square, quadratic formula, graphing and even Professor Loh's innovative method that was recently published. This presentation will introduce Lill's Circle, a fascinating new way to solve quadratics equations using nothing more than basic high school Geometry. The method is highly visual, utilizing the intersection of circles and right-angle paths to locate the roots on the coordinate plane. Extending beyond quadratics, Lill's Methods can be used to solve cubic equations and polynomial equations of any degree. The sheer power and beauty of "Lill" is truly awe-inspiring and will leave you wondering how this method is not more widely known and taught in our classrooms. Whether you are a math teacher or simply a math enthusiast, the goal of this presentation is to investigate a new way to solve polynomials, and ultimately, to experience a "Lill" magic!

Utilizing Machine Learning to Comprehend the Spatial Consistency of Floods in the United States, their Climate Correlations and Predictability

Stephen Rosario (Hunter College)
Advisors: Ololade Alonge, and Naresh Devineni (CCNY)

Data Science and Machine Learning have proven to be powerful tools recently, in flood frequency analysis. This research aims to determine the spatial concordance of flood events, and their relationship to large-scale climate and atmospheric teleconnections. It also focuses on classifying such spatially concordant events into various types of risk based on their impact in terms of drainage area and population and assets exposed. The at-site risk, i.e., the probability of any site (region) under a spatially concordance event at any given time is also estimated. Daily streamflow data from the United States Geological Survey's (USGS) HCDN stream gauge stations over a period of 68 years (1950-2015) was used in this analysis. These stations are minimally impacted by anthropogenic influence. Using the 95th percentile of the daily streamflow data as a threshold for extreme flood events, a Bernoulli event matrix and Poisson Counts vector were created, detailing the days and stations with extreme flood events and the daily total number of stations simultaneously flooding. The drainage areas for the extreme flood events were then mapped into the Bernoulli event matrix and Poisson Counts vector, which resulted in the computation of the total area exposed to extreme floods. Risk typology is established based on the bivariate distribution of Poisson counts and the total area exposed. Further, spatial clustering techniques are employed to separate regions at high risk from regions at low risk. Various non-linear dependence techniques are employed to detect the predictability of this risk conditional on climate and atmospheric teleconnections, which then allows us to study the similarities in the simultaneous floods and the causes and effects of these floods. This risk data and analyses will be crucial in creating forecast models to predict future flood events and the percentage of drainage area this might affect. Our current findings show a considerable number of stations flooding simultaneously across the United States. The highest number of simultaneous floods observed reached 142 stations (out of 318) on a single day, with a total area exposure of close to 100,000 square kilometers.

Potential Satellite Imagery for Detecting Harmful Algal Blooms Over New York Lakes

Sulayman Baba Konateh (Bronx Community College)

Advisors: Marzi Azar, Hamid Norouzi, and Reginald Blake (New York City College of Technology)

Recently, many national economies have been devastated by the increasing growth and the extensive prevalence of autotrophic algae and heterotrophic protists that are collectively called harmful algal blooms (HABs). HABs occur naturally (circulation, upwelling relaxation, river flow) and anthropogenic waterway discharges that lead to eutrophication. When colonies of these cyanobacteria grow out of control, they deplete oxygen in waters and/or release toxins that put human health at risk, aquatic ecosystems, and livestock resulting in overall adverse impacts to economies. Moreover, these colonies also threaten the water quality of lakes and limit water availability. For decades, methods were developed to detect HABs in potential areas of interest. A possible alternative manner of monitoring the water's algae levels would be remote sensing, and Landsat-8 and Sentinel-2 observations are well-suited for this type of monitoring application. In this study, we utilized these satellite observations in conjunction with in situ data to examine the effectiveness of existing satellite remote sensing algorithms to develop a regionally robust method that is applicable for lakes in New York. The Google Earth Engine Cloud-based platform and a Machine Learning model were used to develop a monitoring system to detect HABs. The model is trained and validated using Chl-a measurements from various monitoring stations. This approach largely outperforms other traditional experimental algorithms as it is tailored for each individual lake and considers other variables including water depth, vegetated water bodies, and previous algal bloom activities. The method presented here may indicate location with high exposure to HABs. However, they might need to be developed and revised specifically on a region-by-region basis.

Effective, Structured, Summer Research Teams: Learning Coding Skills by Studying Neighborhood Scale Urban Heat Island Mitigation Strategies

Lillian Ameling (Bronx Community College),

Advisors: Carolien Mossel, Hamid Norouzi, and Reginald Blake (New York City College of Technology)

Research-focused internships often require a significant investment in time to prepare students, and thus much of the short time allotted to the summer internship is spent not doing research. The NASA Climate Change Research Initiative (CCRI)'s mentoring structure provided opportunities to make a specific project's "spin-up" period faster and allowed all participants to explore their individual research interests, while contributing in meaningful ways to the larger project. The CCRI team focused on Urban Heat Islands (UHI), which are caused by impervious surfaces and lack of vegetation in cities and result in higher temperatures than in rural regions. They are more likely to occur in historically redlined communities that were denied investments and loans during the 20th century, oftentimes because of systemic racism against BIPOC populations in these areas. The effects remain today, seen in the lack of robust infrastructure that would reduce heat, and thus the related fatalities and other health issues that occur during heat waves. Both flowing water and vegetation are known to mitigate UHIs by evapotranspiration; in this context, we call these methods Blue/Green Infrastructure (BGI). One such UHI, and the subject of this study, is the neighborhood of Bedford-Stuyvesant in Brooklyn, New York. The community has responded to a lack of cooling infrastructure for over 50 years by opening fire hydrants and building community gardens - measures also referred to here as community-based UHI mitigation strategies. These specific mitigation strategies are often touted as effective by NYC officials but have never been quantified before. In seeking to quantify the cooling impact of hydrants and community gardens, the satellite data from Landsat 8 was evaluated for its ability to capture the cooling impact of these small-scale BGI's at a 30-meter resolution. To conduct the research, all participants in the summer research group, ranging from high school to graduate level, learned to use Python. By having all participants install identical Python environments and assigning tasks that required similar skill sets, group collaboration and problem solving was encouraged. This built confidence, and increased the depth of the research the team was able to conduct over the short summer period. The research done to quantify these cooling effects is important to help empower these community-based efforts of heat mitigation in spaces where the existing municipal urban infrastructure is inadequate to protect neighborhoods from the development and deadly effects of UHIs. Providing data for this validates what the community members of Bedford-Stuyvesant already know: that community gardens and open fire hydrants are and will continue to be inherently valuable as climate change exacerbates the UHI effect.

Bioinformatic Identification of Interspecies Nucleotide Sequence Divergence Within Putative bHLH and OTX2 Transcription Factor Binding Sites in the ThrbICR Retinal Enhancer Element

Laure Ouoba (Bronx Community College), Nafisa Tabassum (New York City College of Technology), Advisors: Mykel Barrett, and Mark Emerson (CCNY)

Proper retinal development requires precise spatiotemporal regulation of gene transcription. Interactions between enhancers and transcription factors mediate the regulation of gene transcription. The ThrbICR enhancer, which is active in developing photoreceptors and ganglion cells, drives the expression of Thrb, a gene implicated in regulating opsin expression in the mature retina. ThrbICR contains "CANNTG" motifs which likely enable its activation by bHLH transcription factors, such as NeuroD1. Previous studies have shown that point mutations in transcription factor binding sites sometimes alter transcriptional output. To test the hypothesis that different species possess variant transcription factor binding sites in ThrbICR that affect its ability to drive transcription, a bioinformatic analysis was conducted. Phylogenetic footprinting, performed on BLAT alignments of ThrbICR, reveals that it contains five putative bHLH binding sites that exhibit nucleotide divergence between species. For example, at one of these loci, the Chinese softshell turtle, shrew, pika, armadillo, naked mole rat, and platypus genomes contain "CACCCG" "CATGTG," "TACCTG," "AACCTG," "CATCTG," and "CATCCA" sequences, respectively, which deviate from the "CANNTG" motif produced from in vitro HT- SELEX assays. These sequence variants likely alter the activity of the ThrbICR by perturbing TF-DNA binding affinity. Our data will be used to design mutagenesis experiments that will test the functional consequences of these transcription factor binding site variations in vivo. The information produced by this research can be used to inspire the development of new therapies for retinal disease, particularly those aimed at controlling the expression of delivered therapeutic genes.

Geological Mapping of Landfill Gas Emissions

Richard Rohoman, New York City College of Technology
Advisor: Masato Nakamura

Landfill sites are one of the main locations that generate Methane (CH4) which is a powerful greenhouse gas. Landfill gasses are produced when organic waste is dumped in the site, covered with soil, and decomposed during the biological process by bacteria. Our research is mainly focused on data analysis for mapping landfill gas emissions developing a numerical model and using GIS. Students will participate in this geological research project utilizing computer skills and environmental knowledge for data-driven sustainability.

Analysis of Global Lake Temperature Variability using MODIS Aqua Observations

Samuel Hector Leriche, New York City College of Technology
Advisor: Abdou Bah, Hamid Norouzi, and Reginald Blake

Anthropogenic climate change has made a noticeable impact on our worldwide ecosystem, often leading to cascading effects that impact human lives. Although lakes consist of a small percentage of global water bodies, they nevertheless have a significant influence on their surrounding environment, impacting the lives around them. For this research, 519 lakes from all over the world were studied using daily observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) from the NASA website. The Lake Surface Water Temperature (LSWT) was found to be an indicator of climate change. In the study, LSWT was compared with Land Surface Temperatures and related factors. Results were analyzed using MATLAB. Approximately 54.24% of the lakes studied were shown to be warming, while 40.03% were shown to be cooling; in addition, 68.44% of the lakes were found to be shrinking, while 24.85% were found to be growing. Continued studies of lake surface temperature trends of global lakes are imperative for communities that depend on them for survival, as well as the entirety of Earth.

Water Quality Monitoring of Lakes Using Satellite Remote Sensing

Samuel Hector Leriche, New York City College of Technology
Advisors: Marzi Azar, Hamid Norouzi, and Reginald Blake

The presence of Harmful Algal Blooms (HABs) occurs when colonies of cyanobacteria grow out of control and produce toxic or harmful effects on humans, fish and livestock. They are among the most important factors that threaten water quality of lakes. Chlorophyll-a (Chl-a) concentration can be a very strong proxy of lake water quality and trophic state. Therefore, many efforts are put into measuring and predicting the Chl-a concentration. Currently, the NJ Department of Environmental Protection (NJDEP) Ambient Lake Monitoring Network monitors a finite number of lakes throughout the state each year. The data collection for these lakes is sparse and some are only monitored once per year. Therefore, there is a lack of continuous data record of Chl-a level in NJ lakes for effective water quality management. An alternative, or complement, to in situ measurements is satellite remote sensing technology to derive water quality parameters. Many remote sensing algorithms have been previously proposed for large scale and national level using observations from Landsat and Sentinel-2A satellites. While these models perform reasonably at large scale, their applicability and reliability in local scale (such as New Jersey) is far from guaranteed. Here, we propose a study to utilize observations from Landsat 7, 8 and Sentinel-2A satellites to estimate and evaluate existing models. The study will perform a thorough analysis of these satellites and the models. The results will be used to develop a regionally robust algorithm and data product that is validated using in situ data.

Investigating the Uncertainties of Forecasting NE Cold Season Precipitation in Numerical Weather Prediction Models

Anam Riaz, New York City College of Technology
Advisor: Yanna Chen

A major winter storm on March 2, 2018, was a big forecast challenge with respect to predicting precipitation type (P-type) for the northeast U.S including the Hudson Valley of eastern New York. Forecasts from the National Weather Service (NWS) blended the colder solution from the operational North American Mesoscale (NAM) model, and the warmer solution from the operational Global Forecast System (GFS) model, resulting in a mix of rain and snow in the Hudson Valley. However, the observations showed that the major P-type was snow even at the lower elevations in the mid and upper part of the Hudson Valley, and the snow depth forecast errors were around 8-12 inches near the Albany area. The Weather Research and Forecasting (WRF) model was used to explore experiments sensitivity to model physics (including microphysics, cumulus, boundary layer, and radiation schemes) and domain configuration. The largest sensitivities with respect to snow depth were associated with cumulus and radiation schemes, and the vertical resolution in the middle troposphere was also found to be influential. The WRF simulated results were compared with the NWS snowfall analysis observations from the Gridded Automated Zonal Precipitation and Complete Hi-res Output (GAZPACHO) using the point observations from public data statements (PNS) with an enhancement scheme that provides a more representative analysis for snowfall amounts in mountainous areas based on terrain slope. Additional measurements from the New York State Mesonet (NYSM) were added to the PNS and also used for the verification of surface temperature, snow depth, precipitation, solar insolation, and shortwave incoming radiation. These comparisons are providing clues regarding the causes of this dramatic forecast failure. This research aims to improve the understanding of the influence of the snowfall patterns, amount and P-type associated with the combination of interaction of both radiation and cumulus schemes in the WRF model. These parameterization processes may impact the buoyancy, temperature, moisture transport, and vertical stability of the atmosphere, resulting in the difference of snow depth and P-type.

CONTRIBUTED POSTER SESSION II

12:45 PM – 1:30 PM

PEDAGOGY SESSION: MATHEMATICS EDUCATION

Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua (Sara) Wang

A Short Derivation of the Quadratic Formula

Jason Zimba

Instead of deriving the quadratic formula by successively transforming the quadratic equation, I derive the formula as a consequence of an identity. I then compare this derivation to the usual one based on completing the square. Finally, I offer some pedagogical observations on the derivation.

Infinity and Beyond

Jonathan Wu, Shannon Ryan, and Sol Sylvia, Suffolk County Community College
Advisor: Vera Hu

For most people, infinity is understood as something that is never ending. German mathematician Hermann Weyl called mathematics "the science of the infinite." In math, infinity is generally defined as "that which is boundless, endless or larger than any natural number." This makes us wonder how we know that infinity is larger than any natural number and forces us to find a way to prove it. In calculus, we study infinite series and improper integrals. Why do we use infinity and how does it affect the math that we learn in class? Where did the "∞" symbol come from? We must also question the philosophy of math: How do these differing perspectives of mathematicians change how infinity is used? Our purpose is to understand more about infinity in multiple ways. One of which is by understanding sets in mathematics as we talk about infinity, and beyond. We will also go into another form of this based on the ordinal and cardinal infinity of set theory. We plan to approach this concept using one-to-one correspondence between an infinite set and its proper subset. The history behind infinity is also an important part of understanding the idea of infinity and will be examined along with the philosophy of infinity in mathematics.

CONTRIBUTED POSTER SESSION III

12:45 PM – 1:30 PM

RESEARCH SESSION: APPLIED MATHEMATICS

Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua (Sara) Wang

Crafting a Stock Portfolio in an Optimal Way

Elma Kastrat and Akinyemi Apampa, New York City College of Technology
Advisor: Satyanand Singh

In our study we work on an optimization of an appropriate stock portfolio based on available information. Our work takes into consideration the average return and any associated risk. We produce an investment strategy that predictively allows a portfolio to grow with high yields.

Using Fermi Function in the Decision-Making Process to Explore Diffusion in Networks

Nur Dean and George Nakashyan, Farmingdale State College

Information diffusion in social networks has garnered the attention of numerous researchers. As a result, studies are conducted in a portion of real-world networks to gain a comprehensive understanding of the social interaction of humans. In this research, we aim to understand the decision-making process using the Fermi function based on the payoff difference between agents and their neighbors and the agents' popularity. To fulfill this goal, we compared results from running the Prisoner's Dilemma game, the most commonly used game in various fields, on a Watts-Strogatz network and a real-world Facebook network.

The Generalization of Mathematical Morphology to Non-numeric Sets

Xiaojin Ye (Farmingdale State College, SUNY) and Robert Haralick (The Graduate Center, CUNY)

It is well known that mathematical morphology plays an important role in image analysis as it enables locating and detecting shapes as well as noise filtering. This paper shows how many of the important properties in mathematical morphology hold in a much more general setting of symbolic or non-numeric sets. This includes the operations of dilation, erosion, opening and closing. For example, dilation of a union is the union of dilations. Dilation is a union preserving operation. Erosion of an intersection is an intersection of erosions. Erosion is an intersection preserving operation. If A is a subset of B, then the dilation of A is a subset of the dilation of B and the erosion of A is a subset of the erosion of B. There is a duality between dilation and erosion. Openings are formed by erosion followed by dilation. Closings are formed by a dilation followed by erosion. Openings are idempotent: doing it more than once is the same as doing it once. Closings also are idempotent. And there are other properties of mathematical morphology that hold in the setting of arbitrary sets. Further that properties like idempotence of openings and closings happen in a setting of general sets whose elements are not numerical and where there are no numerical calculations and no orderings is surprising and unexpected.

Kuratowski Shadows of Smooth Curves

Karla Hernandez (Lehman College, CUNY) and Tabitha Ramirez (The City College of New York, CUNY)
Advisor: Chen-Yun Lin and Sormani, Lehman College, CUNY

We study the finite dimensional projections of the Kuratowski map of smooth curves. First, we used MATLAB to explore the properties of such maps by taking finite collections of points along helix curves, building a distance matrix, and then graphing the two-dimensional projections of the Kuratowski map. We observed and then rigorously proved that when the intrinsic arclength distance is used to define the Kuratowski map, the image is a collection of straight line segments running between the images of base points. We next observed and then rigorously proved that when the extrinsic Euclidean distance is used to define the Kuratowski map, the images are differentiable curves with corners at the images of the base points.

Solving Linear Systems on a Quantum Computer

Jeremie E. Botobikpissi, Saint Peter's University
Advisor: Rebecca Conley

Quantum computing has the potential to make computers faster, find new medicines, and develop new materials. Unlike standard computers, which use bits that can only be 0's or 1's, quantum computers use quantum bits or qubits, which can be in superposition, meaning a qubit can equal 0 and 1 simultaneously. This makes quantum computers much faster at certain tasks than standard computers. Quantum computing is becoming more accessible; for example, people can create a free account on IBM Quantum. One area of active research is using quantum computers to solve systems of linear equations (also known as matrix equations). Systems of linear equations frequently arise in mathematical applications and need to be solved accurately and efficiently. This research looks at how certain matrix conditions affect the accuracy of the solution on a quantum computer. We use IBM Quantum to run these tests on matrices of size 3 by 3. We represent each solution value using 4 qubits, resulting in a test problem of 12 qubits. Since the outcome of quantum algorithms is probabilistic (not deterministic), we compare the probabilities of arriving at the correct solution for the test problems.

Bioinformatic Identification of Interspecies Nucleotide Sequence Divergence Within Putative OTX2 Transcription Factor Binding Sites in the ThrbICR Retinal Enhancer Element

Mykel Barrett, Laure Ouoba, Hunter College, and Nafisa Tabassum, Baruch College
Advisor: Arthur Ford

Proper retinal development requires precise spatiotemporal regulation of gene transcription. The regulation of gene transcription is mediated by interactions between cis-regulatory DNA regions such as enhancers, and transcription factors. The ThrbICR enhancer, which is active in photoreceptors and developing inner retinal cells, drives the expression of Thrb, a gene implicated in regulating opsin expression. The ThrbICR enhancer contains "CANNTG" motifs which likely enable its activation by bHLH transcription factors, such as NeuroD1. Previous studies have shown that point mutations in transcription factor binding sites sometimes alter transcriptional output. To test the hypothesis that in ThrbICR, different species possess variant transcription factor binding sites, a bioinformatic analysis was conducted. Phylogenetic footprinting, performed on BLAT alignments of ThrbICR, reveals that it contains five putative bHLH binding sites that exhibit nucleotide divergence between species. For example, at one of these loci, the Chinese softshell turtle, shrew, pika, armadillo, naked mole rat, and platypus genomes contain, "CACCCG," "CATGTG," "TACCTG," "AACCTG," "CATCTG," and "CATCCA," sequences, respectively, which deviate from the "CANNTG" motif produced from in vitro HT- SELEX assays. These sequence variants likely alter the activity of the ThrbICR by perturbing TF-DNA binding affinity. Our data will be used to design mutagenesis experiments that will test the functional consequences of these transcription factor binding site variations in vivo. The information produced by this research can be used to inspire the development of new therapies for retinal disease, particularly those aimed at controlling the expression of delivered genes.

CONTRIBUTED POSTER SESSION IV

12:45 PM – 1:30 PM

RESEARCH SESSION: DATA SCIENCE

Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua (Sara) Wang

Analyzing Heat Waves in New York City and Sub-urbans Using Historical Weather Station Data

Sameeha Malikah, Gabriella Garcia, Stephanie Avila, Kaylen James, Veebhu Shah, Alexander Zeng, Tarendra Lakhankar, Naresh Devineni (The City College of New York)

Advisor: Tarendra Lakhankar

According to the IPCC, the global average temperature has been rising at a rate of 1.7°C per century since 1970. This rise in temperature has been influencing the climate and weather patterns in regions throughout the world, such as the frequency of heat waves. Heat waves are an important environmental hazard that impacts human health, especially in vulnerable populations such as the youth, elderly, and low income populations who may not have access to sufficient cooling. The goal of this project is to determine the trends in historical temperature records for New York City, New Jersey, and Connecticut to better understand potential future trends. Using Python and arcGIS software, this project analyzes temperature data from 44 weather stations located throughout the tri-state area. While most of the stations had data available starting from the 20th century, a few had data starting from as early as 1869. Several temporal analyses have been done for the NYC region. A historical rise has been observed in the average seasonal temperature for a period of about 150 years. Annual standard deviation trends indicate that not only are summer days becoming hotter, but winter days are also getting warmer. The count of extreme heat days were found to be increasing at a rate of four to five days per century. As research is continued for the New Jersey and Connecticut weather stations, it is hypothesized these regions will have temporal trends similar to NYC, and spatial trends corresponding to the Urban Heat Island effect.

New York's Redistricting and Gerrymandering

Jojo Jose, St. Thomas Aquinas College

Advisor: Andrew Lee

In recent times, redistricting and gerrymandering have become increasingly important topics in the United States. This project aimed to analyze New York's redistricting and gerrymandering practices using Python programming language. Using libraries such as geopandas, maup, and gerrychain, we analyzed spatial data and, through the process of data manipulation, we examined New York's district boundaries. To begin the project, I installed the necessary libraries and imported the required packages. I then used geospatial data from a New York state dataset and manipulated the data using packages like Gerrychain and Geopandas to clean the data to get it ready for the ReCom simulation. The resulting data, a graph of New York's precincts, was then preprocessed by removing islands and unconnected components, which could potentially skew the analysis. Using Gerrychain's Markov Chain simulations and the ReCom algorithm, the project explored various redistricting plans while maintaining population balance within a specified tolerance. This method allowed for the examination of the efficiency gap and mean-median scores, two metrics commonly used to quantify gerrymandering. The project culminated in the visualization of the redistricting proposals generated, allowing for a better understanding of the patterns and potential issues related to gerrymandering in New York. In conclusion, this Python-based analysis proved to be a valuable tool for examining redistricting and gerrymandering practices, contributing to the broader discussion on ensuring fair representation in the United States.

Interdisciplinary Undergraduate Data Science Projects: A Joint Collaboration Between City Tech and Brigham Young University

Daniel Gallego (City tech), Kelly Chang (BYU), Qing Chen (City Tech), Juliana Corbridge (BYU), Dezjaron Dorsey (BYU), Eben Lonsdale (BYU), Amelia McGuire (BYU), Allison Oler (BYU), Celestino Razatos (City Tech), Ian Roman Villanueva (BYU)

Advisors: Mark Hughes (BYU), Holly Carley, F. Patricia Medina and Charlotte Welker (City Tech)

This poster showcases four exciting projects that will be completed by the end of the Spring semester 2023. The projects cover a range of fields, including urbanization, astrophysics, electromagnetics, and sentiment analysis. To complete these projects, City Tech students and BYU students will collaborate in two workshops held in April and May. The first project aims to tackle the issue of Urban Heat Islands (UHI) caused by urbanization in the United States. To do this, we will develop a statistical method for categorizing the effectiveness of urban green spaces (UGS) based on the proportion of tree canopy to overall area of the UGS using remote sensing data. This project is linked to a project led by Professor Holly Carley and Ethan Peters from CUNY-City Tech.

The second project focuses on astrophysics and seeks to understand how galaxies evolve. Our goal is to identify cosmic filaments and determine properties of galaxies that indicate whether they belong to the filament. We will experiment with auto-encoders to reduce the dimensionality of this nonlinear dataset. This project is linked to a project led by Professor Charlotte Welker and Daniel Gallego from CUNY-City Tech. The third project is an application to electromagnetics, where we aim to achieve good performance by combining physical principles with careful data preprocessing and network training. This project builds upon previous work in the field and is linked to a project led by Professor Randy Paffenroth and his team from Worcester Polytechnic Institute. The fourth project involves mining the social web to perform sentiment analysis on students' tweets on a specific topic. We will use transfer learning on movie data to analyze the tweets. Reference: https://www.oreilly.com/library/view/mining-the-social/9781491973547/

Overall, these projects highlight the interdisciplinary nature of scientific research and demonstrate the power of collaboration between institutions to tackle important research questions.

CONTRIBUTED POSTER SESSION V

12:45 PM – 1:30 PM

Pure Mathematics

Supervisors: Prof. Andrew Vaughn & Dr. Xiaohua(Sara) Wang

Number Theoretic Arithmetic Functions and Dirichlet Series

Ivan Morozov, New York City College of Technology
Advisor: Satyanand Singh

We will study number theoretic functions and their associated Dirichlet series. This study lays the foundation for deep research that has applications in cryptography and theoretical studies. Our work will venture into the complex plane.

The Mathematics Behind the RSA, a Public-Key Cryptosystem

Nora Broyles, Pace University
Advisor: Shamita Dutta Gupta

RSA, named after its inventors Ron Rivest, Adi Shamir, and Leonard Adleman, is one of the most widely used public-key cryptography systems. It's a mathematical algorithm that transforms a message into an unreadable code and vice versa, using two keys – one for encryption and one for decryption. The security of RSA lies in the mathematical problem of factoring the product of two large prime numbers, which is considered computationally infeasible. Now, let's delve into the connection between RSA and two mathematical concepts – the Fundamental Theorem of Arithmetic and the Euclidean Algorithm. The Fundamental Theorem of Arithmetic states that every positive integer can be represented as a unique product of primes, which is used in RSA to generate the two prime numbers that make up the private key. The Euclidean Algorithm, on the other hand, is used in RSA to find the greatest common divisor (GCD) of two numbers, which is crucial in generating the public key. In conclusion, RSA is a marriage between mathematics and cryptography. Its reliance on the Fundamental Theorem of Arithmetic and the Euclidean Algorithm, two cornerstones of number theory, make it a sturdy and dependable method of keeping messages secure. So, next time you hear someone talking about RSA, you can impress them with your knowledge of its mathematical roots.

Abacus System: A New Approach to the Mystery of Integer Partitions

Tahda Queer, Hunter College, City University of New York
Advisor: Rishi Nath, York College

This poster is a radical attempt to convey traditionally algebraic ideas through geometric illustrations, avoiding the use of mathematical jargons. Our research project connects different systems that represent integer partitions and highlights advantages of the abacus system. In particular, we explore an analogous problem inspired by "Ramanujan's most beautiful identity." By demonstrating the intuitiveness and versatility of the abacus system, the poster serves as an accessible starting point for researchers from various mathematical fields.

CONTRIBUTED PAPER SESSIONS II

1:35 PM – 2:50 PM

RESEARCH SESSION: APPLIED MATHEMATICS II

ROOM W610

Presider: Dr. Johanna Franklin

1:35 p.m. **A Comparative Study of h- and p-Geometric-Refinement of Curved Boundaries in High-Order Finite and Spectral Element Methods**

Rebecca Conley (Saint Peter's University), Jacob Jones and Xiangmin Jiao (Stony Brook University)

Finite element methods (FEM) and spectral element methods (SEM) are widely used in solving elliptic partial differential equations. Isoparametric elements are commonly used, in which a curved boundary is approximated to the same degree as the solution. SEM can potentially deliver better accuracy due to the potential superconvergence for well-shaped tensor-product elements. However, for complex geometries, the accuracy of SEM often degrades due to a combination of geometric inaccuracies near curved boundaries and the loss of superconvergence with simplicial or non-tensor-product elements. We propose to overcome the first issue by using h- and p-geometric refinement, to refine the mesh near high-curvature regions and increase the degree of geometric basis functions, respectively. We solve the convection-diffusion-reaction equation and show that when Neuman boundary conditions are applied using isoparametric elements, there may be a significant loss of accuracy of the solution. We then show that both h- and p-geometric-refinement can significantly alleviate the issue and increase the accuracy of the solution near the boundary, which have the advantages of simplicity and efficiency, respectively. With the improved accuracy, we then show that the solutions near the boundary can be significantly improved using a novel post-processing step based on AES-FEM, so that the solutions near curved boundaries can match the accuracy of the superconvergent spectral element solutions in the interior of the domain.

1:50 p.m. **Dynamics of a Charged Particle in an Electric Lattice**

Diogo Pinheiro, Brooklyn College, CUNY

We will discuss some qualitative properties of the motion of a charged particle interacting with a planar lattice of fixed charges under the influence of a uniform magnetic field orthogonal to the plane where the motion takes place. This dynamical system is Hamiltonian with two degrees of freedom. If the interaction potential is of Coulomb type, for a suitable regime of parameters, there are invariant subsets on which the system contains a suspension of a subshift of finite type with positive entropy, i.e. the system is chaotic and not integrable.

2:05 p.m. **Two Competing Pathogen Strains with Infection History**

Susana Pinheiro (Queensborough Community College), Diogo Pinheiro (Brooklyn College)

We will discuss a compartmental model describing the competition between two strains of the same pathogen. Our results include the following: (a) If one of the pathogens strains' basic reproduction number is sufficiently higher than that of the other strain, only the strain with the higher basic reproduction number becomes endemic, the other strain becomes extinct in the long run, regardless of having a basic reproduction number greater than one. That is, we provide conditions on the basic reproduction numbers of the two pathogen strains guaranteeing that they eventually do not co-circulate within a susceptible population; (b) If both strains' basic reproduction numbers are greater than one and sufficiently close to one another, the two variants become endemic in the long run. This sort of closeness condition on the basic reproduction numbers prevents one of the strains from out-competing the other and driving it to extinction. Finally, we will summarize our results in terms of a bifurcation diagram, attempting to provide a clear qualitative picture for all the possible alternative asymptotic outcomes.

2:20 p.m. **Beyond Borders: How Instructor Exchange Program Enhances Teaching Skills and Diverse Perspectives**

William Freiberg, USMA Department of Mathematical Sciences, West Point

Teaching within a program or course for an extended period of time presents challenges to keep the curriculum (and instructors for that matter) fresh. Many instructors look to conferences, colleagues, and student feedback to make adjustments that ensure a “living” syllabus. While these are all great ways to gain perspective, another rarely used but impactful activity is the instructor exchange. This talk will provide perspectives on how a semester-long instructor exchange between two schools provided substantial benefits to the instructors, to both programs, and ultimately to the students that they serve. We’ll discuss planning considerations, goals, components, and impacts of a successful exchange as told through the “exchanged” instructor’s eyes.

2:35 p.m. **Occurrences of Microplastics in Nature and Possible Correlation to Human Statistics**

Angelina Amatulli-Griffith, Kevin Zhuo, Joseph Nunez, Kyle Polund (Suffolk County CC)
Advisor: Vera Hu, Suffolk County Community College

This study will investigate the correlation between increased multitudes of microplastics, as defined by plastic objects smaller than 5 millimeters, in the natural environment and possible relevance to increased concentrations found in the human anatomy. The research will be primarily quantitative and will include background information of qualitative materials regarding known impacts of microplastic exposure on human health; where environmental concentration is the independent variable and internal concentration within people is the dependent variable. Data used for the purposes of this experiment are secondarily sourced from reputable scientific journals and investigational findings. This is explicitly due to lack of access to necessary laboratory equipment as this experiment is being performed in investigative settings at the Associates level. The conclusion of our findings is expected to support or reject the theory that increased amounts of environmental microplastics may have statistical relation to information regarding increased population of these particles in human physiology. It is expected that the research will yield a direct relationship between the independent and dependent variable such that we will find a producible equation for exponential growth.

RESEARCH SESSION: PURE MATHEMATICS II

ROOM W615

Presider: Dr. Elena Goloubeva

1:35 p.m. **Compositionality in an Analytical Setting**

Adam M. Yassine, Bowdoin College

Classical mechanics is the mathematical study of how everyday objects move. This talk explores and develops a basic principle of reasoning, the principle of compositionality. We will introduce the use of compositionality in the study of classical mechanical systems. We develop a basic principle of reasoning which helps us to understand the heuristics that physicists use when studying classical mechanical systems, such as mass spring systems.

1:50 p.m. **Discrete Approximation of p-Adic Brownian Motion**

David Weisbart, University of California, Riverside

A p-adic Brownian motion is a continuous time stochastic process in a p-adic state space that has a Vladimirov operator as its infinitesimal generator. Any such process is the scaling limit of a discrete time random walk on a discrete group, just as in the real setting. The study of discrete time approximations to Brownian motion provides intuition about Brownian motion that is important in applications and such intuition is now available in a non-Archimedean setting.

2:05 p.m. **Counting convex lattice paths of fixed width**

C-Y Jean Chan (Central Michigan U.), Thomas Hagedorn (The College of New Jersey), Joel Louwsma (Niagara University), Michael Wijaya

A lattice path is a sequence of vectors in the integer lattice Z^2. We say a lattice path is convex if the corresponding polygonal chain is simple (with consecutive segments intersecting only at endpoints) and concave up. This presentation will begin by briefly discussing the relevance of convex lattice paths to the study of singularities of plane algebraic curves. We will derive a rational generating function with coefficients that encode the number of convex lattice paths of fixed height and width 3. We will also present an explicit bijection between m by 3 convex lattice paths and partitions of m as a sum of three non-negative integers where not all three integers are equal. Finally, we will share some computational findings that suggest the rationality of generating functions for convex lattice paths of arbitrary width.

2:20 p.m. **Using Finite-State Machines to Study Randomly-Generated Dominating Sets**

Max Sehaumpai, City College of New York, CUNY
Advisor: Michael Wijaya

Let be a graph with vertex set V(G). A subset S of V(G) is a dominating set if every vertex in V(G) is either in S or is adjacent to a vertex in S. We are interested in the properties of randomly-generated dominating sets on path graphs. To generate data, we used a random process which builds a dominating set one vertex at a time. We then used finite-state machines to model the dominating sets we can obtain and showed that the sets form a regular language. We were then able to derive further properties by computing the associated generating function. In this talk, we will explain the methods we used to arrive at our conjectures, the challenges we faced, and how we overcame those challenges.

2:35 p.m. A Plethora of Fibonacci Number Tricks

Jay Schiffman, Rowan University

Many pre-service teachers are familiar with the following Fibonacci number trick: Select any ten consecutive Fibonacci numbers and divide the sum by eleven. The quotient is always the seventh term in your sequence. Hence if I were given 13 as the first of ten consecutive terms of my sequence, I know 233 is my final answer. The question is how? This paper will resolve a series of Fibonacci number tricks that are very palatable and easily amenable to anyone who possesses a knowledge of basic algebra. We finally establish a Fibonacci-Pythagorean connection and an additional Fibonacci-Lucas connection and form several conjectures. Please join us to view appealing mathematics that is engaging, accessible and fun.

PEDAGOGY SESSION: MATHEMATICS EDUCATION II Part A

ROOM W616

Presider: Dr. Benjamin Gaines

1:35 p.m. The Times of Transitions in the Modern Education

Malgorzata Marciniak, LaGuardia CC, CUNY

Living and working during these times of transitions in modern education may be extremely confusing for teachers of all levels since the education they received and were taught to provide is not what they are required to perform. This was particularly exposed during the pandemic when thousands of teachers worldwide were forced to teach remotely regardless of their digital skills. Reflecting whether any actions could have prepared the teachers for such events, I would point toward expanded professional development. It is not a mystery that the key to shaping future generations lies in a proper professional development of teachers of all stages of their path. But the questions of the character and shape of this development remains open. This work tries to analyze a few pivoting moments in the history of education to follow up on the ideas of Thomas Kuhn as presented in his book "The Structure of Scientific Revolutions". Here the discussion is applied to the structure of the revolutions of education with the pandemic being one of them. The question: what the long-term influences of the pandemic on teaching and learning will be, remains open and fully credible answers can be provided only with time. We will try to answer this question based on short-term recent experiences and observations.

1:50 p.m. Extra Credit as a Spaced-Study Motivator

Si Park, Margaret Reynolds and Michael Rocha, United States Military Academy

One big challenge in academia is motivating students and helping them manage and store information long-term. One method to help students retain information that has been investigated is spaced versus bulk learning, which allows for certain intervals of time in which concepts are re-tested versus waiting until the end of a block or semester to test a learning objective. One method to help motivate students is implementation of bonus opportunities that keep students engaged in the material. We look at combining these methods via a spaced versus bulk review program incentivized with bonus points for completing either daily board sheets or bulk review. In order to investigate this combined method, we designed and implemented a classroom research experiment throughout the Fall of 2022 at the United States Military Academy in three different courses. We found that students who were incentivized to do either the daily or bulk review bonus opportunities were primarily those who already were doing well in the class. We also found that those who chose not to pursue the bonus opportunities in either type of section indicated that time was their limiting factor. We present our findings in further detail including quantitative and qualitative results via course grades, mid-semester, and end-of-semester surveys, as well as our own anecdotal experiences with our students. We then discuss the merit and potential improvement of the experiment in order to better understand the relationship between student motivation and long-term information retention.

2:05 p.m. Lessons Learned from Standards-Based Learning in a Math for Liberal Arts Course

Benjamin Gaines, Iona University

Standards-Based Learning (SBL) is a method of assessment based on the premise that what matters for a course is that students eventually achieve certain specific outcomes which demonstrate a student has learned what the course is intended to teach. This means grades do not come from a weighted average of all topics, but from showing achievement with a particular number of these standards, possibly augmented in some way with other assignments or certain "core" standards. SBL is typically tied to opportunities to retry past work to show eventual achievement, and in that way rewards growth, grit, and perseverance. In 2023, we implemented SBL in two sections of a Math for Liberal Arts class that had typically been taught using more traditional assessment methods. In this paper we will share the specifics of how SBL was implemented in this course, what went well, what was learned, how students perceived SBL, and how it impacted final student grades.

2:20 p.m. Post-pandemic Trends in Calculus

Shamita Dutta Gupta, Pace University

Observations in post-pandemic trends in Calculus course will be discussed. Remedies to smooth such trends and its effectiveness will be the focus of this talk.

2:35 p.m. From Transformation of a Function to the Schrödinger Equation

Frank Wang, LaGuardia Community College, CUNY

Transformation of the graph of a function is a standard topic in precalculus. Many students are puzzled by the property that $y = f(x + c)$, $c > 0$, is the graph of f shifted horizontally left c units. We use a Taylor series of $f(x + c)$ to establish the connection between infinitesimal transformation and elementary textbook problems. We will briefly review the theory of continuous transformation groups pioneered by Sophus Lie and Wilhelm Killing. The generators of the transformation groups are identified with physical quantities such as momentum and energy. Imposing the unitarity condition in quantum mechanics, the time-dependent Schrödinger equation is obtained from the transformation of $f(t)$ to $f(t + c)$.

PEDAGOGY SESSION: MATHEMATICS EDUCATION II Part B

ROOM W622

Presider: Dr. Sandie Han

1:35 p.m. **The Value of Identifying Error Terms**

David Weisbart, University of California, Riverside

Error terms are often ignored in calculations in basic calculus classes. We will show that proper management of error terms can serve to simplify rather than complicate the presentation of the properties of differentiation. A study of the error terms that arise in the local linear approximation of a function connects the algebraic notion of differentiation in the polynomial setting to the definition of differentiation in the more general setting. This connection helps make the idea of local linear and local higher order approximation more vivid for students and introduces them to deeper mathematical ideas.

1:50 p.m. **Political Influence on Mathematics Education**

Jung Hang Lee, Hostos Community College; Xinyi Zhao, New York University

This study challenges the notion that mathematics education is a politically neutral subject. It examines mathematics education in one of the most closed countries in the world — North Korea, which is heavily influenced by political and ideological factors. The research explores the social and educational structures, as well as the political and ideological position of North Korea, to understand how it impacts secondary school mathematics education. In-depth interviews were conducted with former mathematics teachers and students who defected to South Korea to gain insight into their experiences with mathematics education in North Korea. Workers' Party's influence on mathematics education and the impact of the March of Suffering are examined. The study focuses on two main areas: introducing the extreme case of politically influenced mathematics education in North Korea and broadening participants' understanding of mathematics education as a subject shaped by political and ideological standpoints. This study aims to expand participants' understanding of mathematics education beyond a self-regulating subject based solely on axioms and theorems, and instead highlight its interconnectedness with societal structures and values. This can provide an opportunity for participants to reflect on their own mathematics education experiences with an enhanced perspective.

2:05 p.m. **Amplifying Students' Help-seeking Behavior**

Behailu Mammo and Matthew Gopaulchan, Hofstra University

To improve students' help-seeking behavior, it is documented in literature that teaching needs to emphasize productive struggle over "getting it right." However, given students' varying levels of mastery of prior knowledge, "productive struggle" for some may be "unproductive struggle" for others. In this presentation, my peer teacher and I will share our approaches to help students narrow the gap between where they are and where they should be, thereby shaping their help-seeking behavior. Time permitting, I will share some aspects of my teaching that earns me the MAA's distinguished teaching award of 2023. This work is supported by a Hofstra University research grant.

2:20 p.m. Mathematics Preparatory Workshops to Foster Student Success

Sandie Han, Diana Samaroo, Janet Liou-Mark, and Lauri Aguirre, NYC College of Technology

The lack of adequate preparation for mathematics courses is a barrier for student engagement in STEM courses. At New York City College of Technology, we offer free mathematics preparatory workshops prior to the beginning of the semester. We believe the head start students receive in the mathematics preparatory workshops helps improve student success and retention in foundational mathematics courses.

2:35 p.m. An Evaluation of Developmental Reviews Using Natural Language Processing

Dominic Rudakevych, United States Military Academy
Advisor: LTC Andrew Lee, United States Military Academy

As an institution committed to developing leaders of character, the United States Military Academy (USMA) holds a vested interest in measuring character growth. One such tool, the Periodic Developmental Review (PDR), has been used by the Academy's Institutional Effectiveness Office for over a decade. PDRs are written counseling statements evaluating how a cadet is developing with respect to his/her peers. The objective of this research was to provide an alternate perspective of the PDR system by using statistical and natural language processing (NLP) based approaches to find whether certain dimensions of PDR data were predictive of a cadet's overall rating. This research implemented multiple NLP tasks and techniques, including sentiment analysis, named entity recognition, tokenization, part-of-speech tagging, and word2vec, as well as statistical models such as linear regression and ordinal logistic regression. The ordinal logistic regression model concluded PDRs with optional written summary statements had more predictable overall scores than those without summary statements. Additionally, those who wrote the PDR on the cadet (Self, Instructor, Peer, Subordinate) held strong predictive value towards the overall rating. When compared to a self-reflecting PDR, instructor-written PDRs were 62.40% more probable to have a higher overall score, while subordinate-written PDRs had a probability of improvement of 61.65%. These values were amplified to 70.85% and 73.12% respectively when considering only those PDRs with summary statements. These findings indicate that different writer demographics have a different understanding of the meaning of each rating level. Recommendations for the Academy would be implementing a forced distribution or providing a deeper explanation of overall rating in instructions. Additionally, no written language facets analyzed demonstrated predictive strength, meaning written statements do not introduce unwanted bias and could be made a required field for more meaningful feedback to cadets.

STUDENT/FACULTY SESSION II

ROOM W618

Presider: Prof. Bruce Kan

1:35 p.m. **Almost All Wreath Product Character Values are Divisible by Given Primes**

Brandon Dong, Carnegie Mellon University
Hannah Graff, Creighton University
Josh Mundinger, University of Chicago
Skye Rothstein, Bard College
Lola Vescovo, Macalester College
Advisor: Nate Harman, University of Michigan

We introduce a new theorem about the prime divisibility of wreath product character values which generalizes the work of Peluse and Soundararajan on the character table of the symmetric group.

1:50 p.m. **An Algorithm to Find the Free Generators of a Subgroup of a Free Group Based on Geometric Group Theory**

Aaron Li, Newark Academy High School
Advisor: Professor Guillermo H. Goldsztein, Georgia Tech

A free group F_S over a given set S consists of all words that can be built from members of S. The members of S are called free generators of F_S and the number of free generators is the rank of the free group. The rank is all that matters in characterizing F_S. We explore a graph theoretic approach to construct a free set of generators of a free subgroup and include an implementation of the algorithm.

2:05 p.m. **A Reduction Algorithm for Volterra Integral Equations**

Sarah Rosen, Manhattan College
Advisor: Richard Gustavson, Manhattan College

An integral equation is a way to encapsulate the relationships between a function and its integrals. We develop a systematic way of describing Volterra integral equations – specifically an algorithm that reduces any separable Volterra integral equation into an equivalent one in operator linear form, i.e. one that only contains iterated integrals. This serves to standardize the presentation of such integral equations so as to only consider those containing iterated integrals. We use the algebraic object of the integral operator, the twisted Rota-Baxter identity, and vertex-edge decorated rooted trees to construct our algorithm.

2:20 p.m. **A "Lill" Magic**

Olivia Larkin, Fiorello H. LaGuardia High School
Advisor: Christos Tsakalakos, Fiorello H. LaGuardia High School

Think of all the ways you know to solve a quadratic equation: factoring, grouping, completing the square, quadratic formula, graphing and even Professor Loh's innovative method that was recently published. This presentation will introduce Lill's Circle, a fascinating new way to solve quadratics equations using nothing more than basic high school Geometry. The method is highly visual, utilizing the

intersection of circles and right angle paths to locate the roots on the coordinate plane. Extending beyond quadratics, Lill's Methods can be used to solve cubic equations and polynomial equations of any degree. The sheer power and beauty of "Lill" is truly awe-inspiring and will leave you wondering how this method is not more widely known and taught in our classrooms. Whether you are a math teacher or simply a math enthusiast, the goal of this presentation is to investigate a new way to solve polynomials, and ultimately, to experience a "Lill" magic!

2:35 p.m. Perfect Numbers in Quadratic Fields

Catherine McClure, Molloy University
Advisor: Dr. Manyiu Tse, Molloy University

We define perfect numbers and explore their fundamental properties in the natural numbers. We demonstrate how the definition of perfect numbers can be extended to the Gaussian integers by examining the properties of . We then generalize to quadratic fields and identify the limitations that arise when attempting to extend the definition of perfect numbers to , where d is square free, and show what is needed to extend it.

METROPOLITAN NEW YORK SECTION OF THE MAA
TREASURER'S REPORT

ASSETS	BALANCE	BALANCE
	04/30/22	04/29/23
Chase Business Classic	$9,123.27	$8,947.52
Chase Business Select High Yield Savings	$13,092.88	$13,094.18
NY Metro Section Total Assets	$22,216.15	$22,041.70

CHASE BUSINESS SELECT HIGH YIELD SAVINGS (0366)

Credits

Date	Description	Amount
04/1/22-04/30/23	Interest (does not include 04/23)	$1.30
Total Credits		$1.30

CHASE BUSINESS CLASSIC CHECKING (0365)

Deposits/Credits

Check #	Date	Description	Amount
	07/08/22	Annual Meeting registration	$548.25
Total Credits			**$548.25**

Debits

Check #	Date		
958	05/03/22	Abraham Mantell (plaques for award winners)	$190.00
959	08/20/22	Mathfest Registration for Johanna Franklin	$434.00
960	10/03/22	Metro NExT Workshop Honorarium for Kenan Ince	$100.00
Total Debits			**$724.00**

JANET LIOU-MARK SCHOLARSHIP FUND

Deposits/Credits			
	Date	**Description**	**Amount**
Total Credits			**$0.00**
Checks Paid/Debits			
Check #	**Date**	**Description**	**Amount**
Total Debits			
		BALANCE	**BALANCE**
		04/30/22	**04/29/23**
Fund Total		**$1,750.00**	**$1,750.00**

GRAPH THEORY DAY FUND (CONTAINED WITHIN 0365)

	BALANCE	**BALANCE**
	04/30/22	04/29/23
Fund Total	$2,172.41	$2,172.41

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By Subway

Not all trains run at all times and subway schedules are subject to change. For current schedules, weekly service advisories, and maps, contact the Metropolitan Transportation Authority (MTA) at (718) 330-1234 or visit the MTA website.

- 2 and 3 -- Take 2 Local or 3 Express to either Park Place/Broadway (then walk east across City Hall Park to the campus) or to Broadway-Nassau St./Fulton St. Station (exit at Fulton and Nassau St. and walk 2 blocks north on Nassau St. to campus).
- A and C -- Take the A Express or C Local to Broadway-Nassau St./Fulton St. Station. Exit at Fulton and Nassau St. and walk 2 blocks north on Nassau St. to campus.
- 4, 5, and 6 -- Take the 4 or 5 Express or 6 Local to the Brooklyn Bridge/City Hall Station (last stop on the 6). Take exit marked City Hall to street and walk south down Park Row to campus; or walk through underpass to exit marked Frankfort St. and exit to Pace Plaza and the campus.
- J and Z -- Take the J or Z Express to Broadway-Nassau St./Fulton St. Station. Exit at Fulton and Nassau St. and walk 2 blocks north on Nassau St. to campus.
- N and R -- Take the N Local or the R Local to City Hall/Broadway Station, then walk east across City Hall Park to campus.

By Bus

Buses running in lower Manhattan are subject to change. For up-to-date scheduling and maps, please visit the bus service section of the MTA Web site.

- M1 -- Take the M1 Bus to the City Hall/Broadway stop (walk east across City Hall Park to campus), the Brooklyn Bridge/City Hall stop (walk south down Park Row to campus), or the Broadway-Nassau St./Fulton St. stop (walk two blocks north on Nassau St. to campus).
- M6 -- Take the M6 Bus to the City Hall/Broadway stop (walk as directed above) or the Broadway-Nassau/Fulton St. stop (walk as directed above).
- M9 -- Take the M9 Bus to the City Hall/Broadway stop (walk as directed above) or the Brooklyn Bridge/City Hall stop (walk as directed above).
- M15 -- Take the M15 Bus to Pearl and Frankfort St. (at campus), to the City Hall/Broadway stop (walk as directed above), the Brooklyn Bridge/City Hall stop, the Broadway-Nassau/Fulton St. stop (walk as directed above) or the Fulton/William St. stop
- M22 -- Take the M22 Bus to the City Hall/Broadway stop (walk as directed above), the Brooklyn Bridge/City Hall stop, or the Broadway-Nassau/Fulton St. stop (walk as directed above)
- M103 -- Take the M103 Bus to the City Hall/Broadway stop (walk as directed above), the Brooklyn Bridge/City Hall stop, or the Broadway-Nassau/Fulton St. stop (walk as directed above)
- B51 -- Take the B51 Bus to the City Hall/Broadway stop (walk as directed above), the Brooklyn Bridge/City Hall stop, or the Broadway-Nassau/Fulton St. stop (walk as directed above)

By Train

Metro-North to Grand Central Station – Take the Metro-North Railroad using the Harlem, Hudson or New Haven lines to Grand Central Station. For schedule and fare information, call Metro-North direct at 1-800-METRO-INFO or visit the Metro-North Web site. From Grand Central you can:

- Take a taxi to the campus.
- Take the 4 or 5 Express or 6 Local downtown to the Brooklyn Bridge/City Hall Station (walk as directed above).

Amtrak, Long Island Rail Road, or New Jersey Transit to Pennsylvania Station–Take Amtrak, the Long Island Rail Road, or New Jersey Transit to Penn Station at 34th St. between 7th and 8th Ave. From Penn Station you can:

- Take a taxi to the campus.
- Take the X26 Express Bus (from 33rd St. and 7th Ave.) to the World Financial Center at Battery Park City.
- Walk across City Hall Park to campus.
- Take the 2 Local or 3 Express trains downtown to either Park Place/Broadway (walk as directed above) or to Broadway-Nassau St./Fulton St. Station (walk as directed above).

- Take the A Express or C Local trains downtown to Broadway-Nassau St./Fulton St. Station (walk as directed above).

By Car

Vehicles traveling in lower Manhattan are currently affected by a number of traffic restrictions and limited street access. For the latest advisories and maps, please visit the motorists page of the NYC Department of Transportation Web site.
Below are directions from the North, South, East and West. Visit Google maps to create door-to-door directions to our downtown campus.

From the North (Westchester, Uptown and the Bronx):

- Take the New York State Thruway (Route 87) South, the New England Thruway (Route 95) South OR the Saw Mill River Pkwy South to the Major Deegan Expressway (Route 87) South. Exit at Willis Ave./Third Ave. Bridge, make a right onto Bruckner Blvd. and take the bridge to the East River Drive (FDR). Take the FDR South to the "Brooklyn Bridge/Civic Center" exit (Exit 2). As you exit, keep right and take the right fork to the Civic Center, which will lead you onto Robert F. Wagner Place. Turn left onto Pearl St. Travel under the overpass and take an immediate right onto Frankfort St. (Do NOT enter the entrance ramp to the Brooklyn Bridge which is immediately before Frankfort St.) Take Frankfort St. to the traffic light and turn left onto Gold St. The campus is on your right, at the corner of Gold and Spruce St. Parking garages closest to campus are available on Gold, Spruce, and Beekman streets.
- Take the Saw Mill River Pkwy South until it turns into the Henry Hudson Pkwy South (Route 9A)/West Side Highway into Lower Manhattan. Turn left onto Chambers St., then right onto Centre St./Park Row. Make an immediate left onto Spruce St. The Schimmel Center for the Arts entrance on Spruce St. will afford you access to the Security office and the campus.
- Follow Broadway down the middle of Manhattan, south past City Hall (on your left). After City Hall, follow signs for left U-turn onto Park Row/Brooklyn Bridge. Travel north two blocks and stay right on Park Row to Pace University on your right.

From the South (Brooklyn and Staten Island):

- Travel across the Brooklyn Bridge to the end of the ramp and bear right onto Park Row South. At the first traffic light, turn left onto Spruce St. and the University is immediately on your left. Travel Spruce St. to Gold St. Parking garages closest to campus are available on Gold, Spruce, and Beekman streets.
- Car ferry service from Staten Island has been suspended. Instead, take the Verrazano Bridge to the Brooklyn/Queens Expressway and exit at the Brooklyn Battery Tunnel to Manhattan. Follow the East River Drive (FDR) North to Exit 2 "Brooklyn Bridge/Civic Center." Follow the ramp marked "Civic Center" to the end and at the light proceed straight ahead onto Frankfort St. to the first traffic light. At the light turn left onto Gold St. The campus is on your right, at corner of Gold and Spruce St. See above for parking information.

From the East (Queens and Brooklyn):

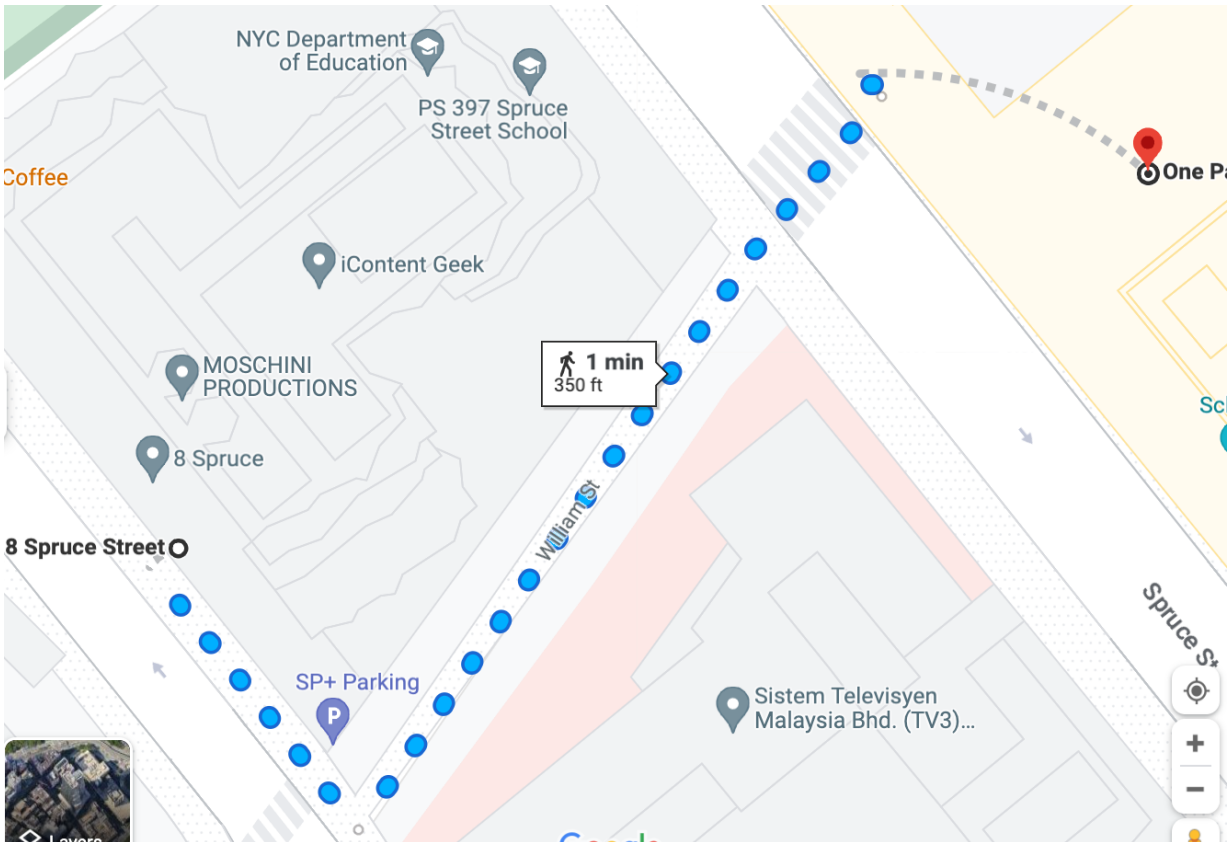
- Take the Brooklyn/Queens Expressway (Route 278) West towards Brooklyn. Take the Tillary St. exit (#29) toward the Manhattan Bridge/Brooklyn Civic Center. Turn slight right onto Tillary St. Turn right onto Brooklyn Bridge Blvd/Adams St. Turn slight right onto Centre St. Turn left onto Reade St. Turn right onto Elk St. Turn right onto Duane St./ Federal Plaza. Turn right onto Lafayette St. Turn slight right onto Centre St. Centre St. becomes Park Row. Turn left onto Spruce St. The campus at the corner of Gold and Spruce St. Parking garages closest to campus are available on Gold, Spruce, and Beekman streets.
- Take the Queens/Midtown Tunnel to the 35th St. exit on the left. Turn left onto 34th St. Merge onto FDR South and follow directions above.

From the West (New Jersey):

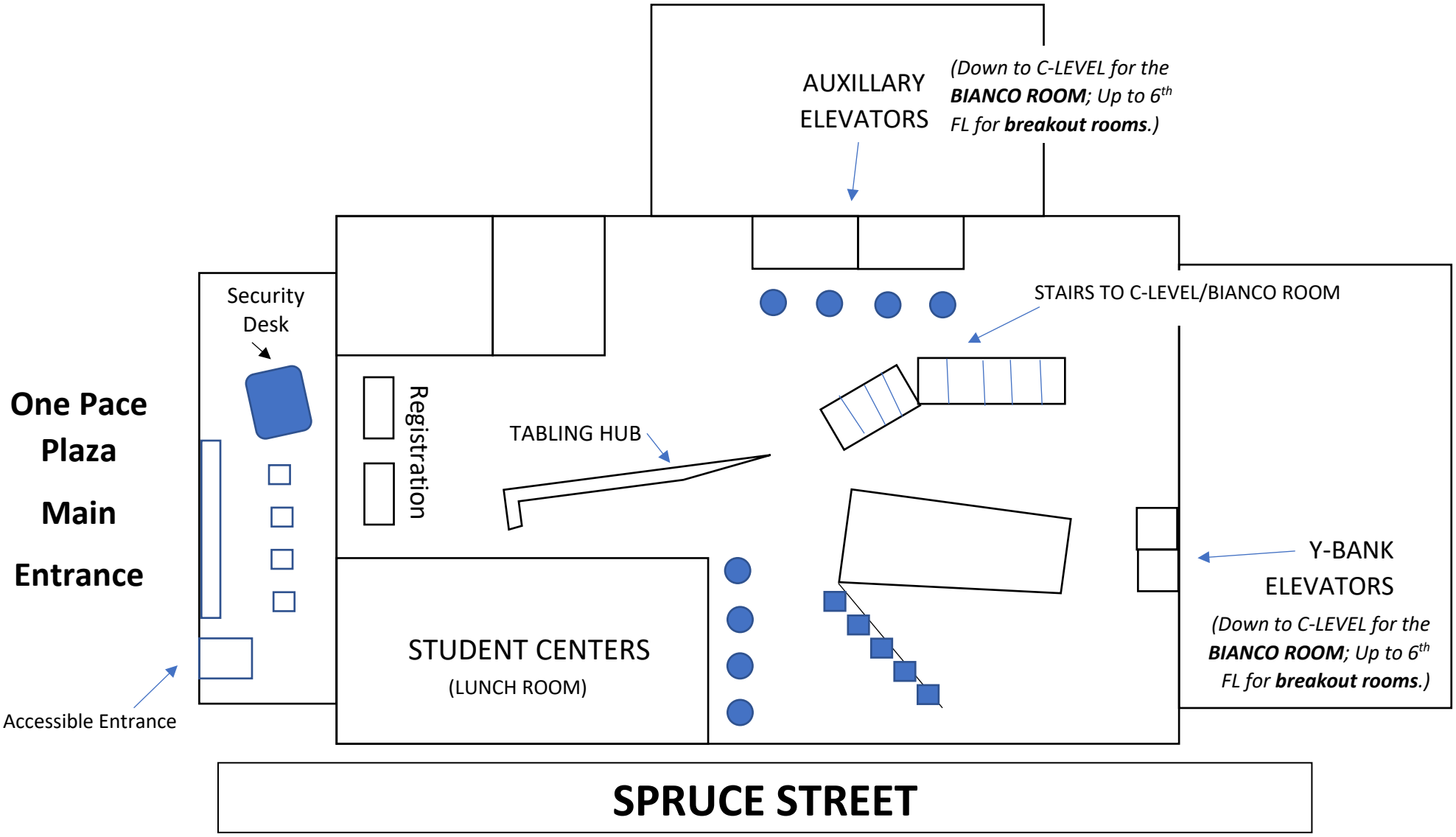
- Take the George Washington Bridge to the Major Deegan Expressway (Route 87) South. Follow directions above.
- Take the Holland Tunnel towards Downtown Manhattan/Brooklyn. Turn a slight left onto Beach St. Beach St. becomes Walker St. Turn right onto Lafayette St. Turn slight right onto Centre St. Centre St. becomes Park Row. Turn left onto Spruce St. The campus at the corner of Gold and Spruce St. Parking garages closest to campus are available on Gold, Spruce, and Beekman streets.
- Take the Lincoln Tunnel onto Dyer Ave. Turn right onto W 34th St. and left onto the West Side Highway. Take this into Lower Manhattan and follow directions above.

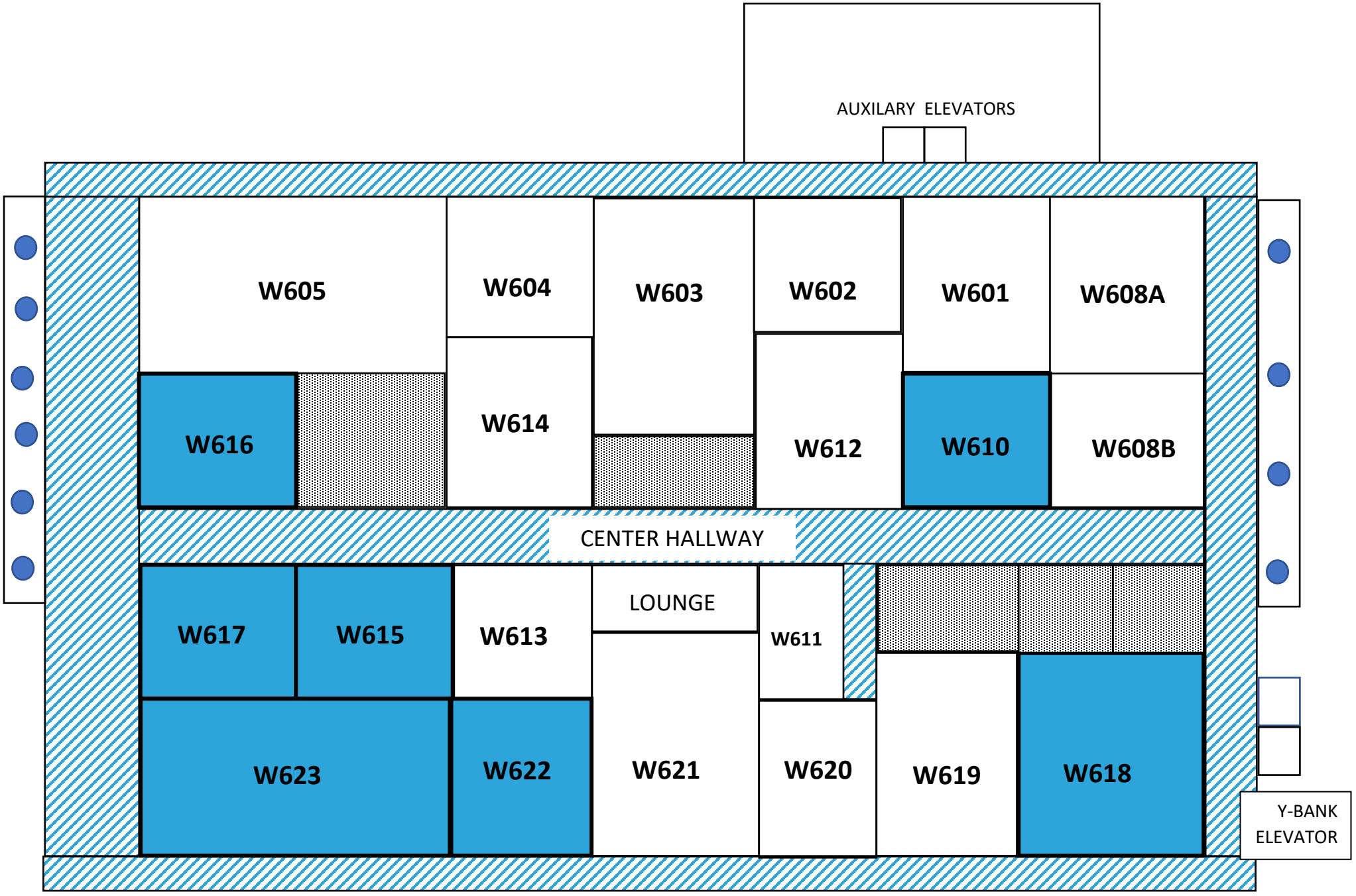
Ezra Halleck graciously provided the following updates on the directions.

Here is Map of the parking lot relative to PACE.

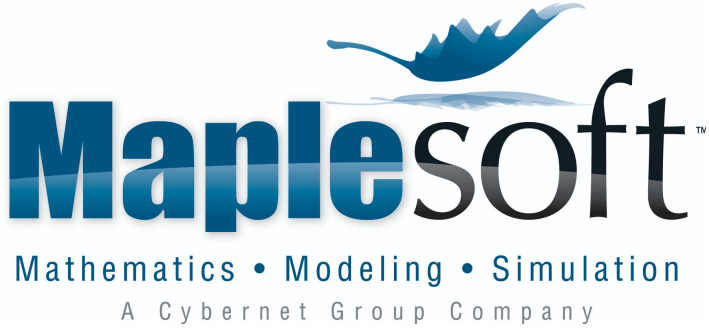


For those using subways, the A and C trains are using the F-line. So, use the 1, 2, or 3 lines instead or switch to the E at W14 or the 6 at Bleecker.


AUXILLARY ELEVATORS
(Down to C-LEVEL for the BIANCO ROOM; Up to 6th FL for breakout rooms.)
Security Desk
STAIRS TO C-LEVEL/BIANCO ROOM
One Pace Plaza Main Entrance
Registration
TABLING HUB
Y-BANK ELEVATORS
(Down to C-LEVEL for the BIANCO ROOM; Up to 6th FL for breakout rooms.)
STUDENT CENTERS
(LUNCH ROOM)
Accessible Entrance
SPRUCE STREET


AUXILARY ELEVATORS
W605
W604
W603
W602
W601
W608A
W616
W614
W612
W610
W608B
CENTER HALLWAY
W617
W615
W613
LOUNGE
W611
W623
W622
W621
W620
W619
W618
Y-BANK
ELEVATOR

Many thanks to:



Thank you for participating!