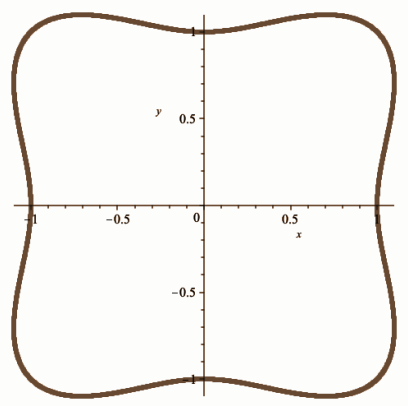
MAA
MATHEMATICAL ASSOCIATION OF AMERICA
SECTION
METRO
NEW YORK

ANNUAL MEETING



MAY 1, 2022

THE MATHEMATICAL ASSOCIATION OF AMERICA

THE METROPOLITAN NEW YORK SECTION
VIRTUAL MEETING 2022

Dear MAA Metro New York Conference Participants,

It is my distinct honor to welcome you to our third Virtual Annual Meeting of the Mathematical Association of America Metropolitan New York Section (MAA Metro NY)!

We look forward to your participation in today's meeting. We have an extensive array of presentations that promises to inspire you. I would like to express my appreciation and thanks to our MAA committee members, whose diligence and hard work helped bring this meeting to fruition.

Our special thanks go out to our invited speakers, Dr. Jose Perea and Dr. Jennifer Quinn, who will share with us exciting and cutting-edge mathematics today. We would also like to thank 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 topics that span a variety of studies which highlight research in mathematics, pedagogy and technology usage. Presenters include high school students, undergraduate and graduate students, mathematicians and industry professionals that come from various institutions across the United States.

Our section website now features a problem of the month which has a growing local and international following. We also encourage you to nominate colleagues for our section's distinguished awards that honor teaching, service, student researchers and mentoring for MAA Metro NExT fellows.

Thank you for coming and we hope that you have an uplifting experience at our meeting.

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

WELCOME

MAA METRO NEW YORK CONFERENCE ORGANIZERS

Armen Baderian, Nadia Benakli, Johanna Franklin, Benjamin Gaines, Elena Goloubeva, Ezra Halleck, Bruce Kan, Xiaomeng (Vivian) Kong, Nadia Kennedy, Boyan Kostadinov, Joseph Lindquist, Abraham Mantell, Ariane Masuda, Eric Rowland, David Seppala-Holtzman, Satyanand Singh (Chair) and Johann Thiel

CONTRIBUTED PAPER AND POSTER SESSIONS ORGANIZING COMMITTEE

Boyan Kostadinov (Chair), Ezra Halleck, Sandie Han, Bruce Kan, Nadia Kennedy, and Johann Thiel

PROGRAM COVER

The pleated square is found in the "Problem of the month" for May 2022, created by Dr. Satyanand Singh.

Explore the monthly problems by following the link below.

http://sections.maa.org/metrony/problemofthemonth.html

THE MAA ANNUAL MEETING OF THE METROPOLITAN NEW YORK SECTION

MAY 1ST, 2022

AGENDA

8:45-8:55 AM	Welcome Dr. Satyanand Singh *Chair of the Metropolitan New York Section* of *the MAA,* *New York City College of Technology, CUNY*
9:00-9:45 AM	Invited Speaker: Dr. Jose Perea *Northeastern University &* MAA *NAM Speaker*
10:00-10:45 AM	Invited Speaker: Dr. Jennifer Quinn *University of Washington, Tacoma & President of the MAA*
11:05-11:15 AM	Break
11:20-12:35 PM	Contributed Paper Sessions I Research Session: Applied Mathematics I (Presider: Dr. Ariane Masuda) Research Session: Pure Mathematics I (Presider: Dr. Ezra Halleck) Research Session: Data Science and Miscellaneous (Presider: Prof. Bruce Kan) Pedagogy Session: Mathematics Education I (Presider: Dr. Nadia Kennedy) Student/Faculty Session I (Presider: Dr. Eric Rowland)
12:40-1:25 PM	Lunch Break/Contributed Poster Session (Supervisor: Dr. Johanna Franklin)
1:30-2:45 PM	Contributed Paper Sessions II Research Session: Applied Mathematics II (Presider: Dr. Boyan Kostadinov) Research Session: Miscellaneous II (Presider: Dr. Johann Thiel) Pedagogy Session: Mathematics Education II (Presider: Dr. Nadia Benakli)
2:50-3:20 PM	Metro NExT Meeting Dr. Jennifer Quinn, *President of the MAA* Prof. Mónica Morales-Hernández, *Adelphi University* Dr. Andrew Lee, *St. Thomas Aquinas College* Dr. Tia (Mutiara) Sondjaja, *New York University* Dr. Johann Thiel, *New York City College of Technology, CUNY*
3:25-4:15 PM	Business Meeting (Presider: Dr. Satyanand Singh)

INVITED SPEAKERS

Dr. Jose Perea, Northeastern University & MAA NAM Speaker

Title: The Underlying Topology of Data

Abstract: Topology, and particularly algebraic topology, seeks to develop computable invariants to quantify the shape of abstract spaces. This talk will be about how such invariants can be used to analyze scientific data sets in tasks like time series analysis, semi-supervised learning and dimensionality reduction. I will use several examples to illustrate real applications of these ideas.

Bio: Jose Perea is an associate professor in the department of mathematics and the Khoury college of computer sciences at Northeastern University. Prior to Northeastern, he held positions as an assistant professor of CMSE and Mathematics at Michigan State (2015 – 2021), and as a visiting assistant professor of Mathematics at Duke University (2011 – 2015). He holds a PhD in Mathematics from Stanford University (2011) and a BSc in Mathematics from Universidad del Valle, Colombia (Valedictorian, Summa cum laude, 2006). He is one of the inaugural 2022-2024 lecturers for the Mathematical Association of America and the National Association of Mathematics, a recipient of a 2020 NSF CAREER award, a 2020 honoree of Lathisms (Hispanic Heritage Month), and a 2018 honoree of Mathematically Gifted and Black (Black History Month).

INVITED SPEAKERS

Dr. Jennifer Quinn, University of Washington, Tacoma & MAA President

Title: Solving Mathematical Mysteries

Abstract: Much as mysteries in fiction consider evidence, find common patterns, and draw logical conclusions to solve crimes, mathematical mysteries are unlocked using the same tools. This talk exposes secrets behind a numerical magic trick, a geometric puzzle, and an unknown quantity to find a fascinating pattern with connections to art, architecture, and nature.

Bio: Jennifer Quinn is President of the Mathematical Association of America (MAA) and Professor of mathematics at the University of Washington Tacoma. She earned her BA, MS, and PhD from Williams College, the University of Illinois at Chicago, and the University of Wisconsin, respectively. She received MAA's 2007 Haimo Award for Distinguished College or University Teaching and a 2006 Beckenbach Book award for *Proofs That Really Count: The Art of Combinatorial Proof*, co-authored with Arthur Benjamin. As a combinatorial scholar, Jenny thinks that beautiful proofs are as much art as science. Simplicity, elegance, transparency, and *fun* should be the driving principles. She strives to bring this same ethic to her classroom, administrative work, and professional service. Committed to making mathematics accessible, appreciated, and humane especially during the global pandemic, Jenny and the #TacomaMath workgroup of the STEAM Learning network chalked puzzles outdoors and produced Math Around Town Videos to create a culture of love for math in the community. In addition, Jenny began the blog Math in the Time of Corona, where she chronicles her experiences on emergency remote teaching of mathematics, maintaining humanity, and building community in isolation. And speaking of community, she hosts virtual social hours to bring MAA members together monthly. Look for announcements on MAA Connect.

METRO NExT (NEW EXPERIENCES IN TEACHING)
2:50 PM – 3:20 PM

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.

"Building Community"- Over the last two years, we have all been isolated to some degree and missed out on time together with colleagues and with students. How can we build(or rebuild) our math communities?

Organizers: Dr. Jennifer Quinn, *President of the MAA*
Prof. Mónica Morales-Hernández, *Adelphi University*
Dr. Andrew Lee, *St. Thomas Aquinas College*
Dr. Tia (Mutiara) Sondjaja, *New York University*
Dr. Johann Thiel, *New York City College of Technology, CUNY*

CONTRIBUTED PAPER SESSIONS I
11:20 AM – 12:35 PM

RESEARCH SESSION: APPLIED MATHEMATICS 1

Presider: Ariane Masuda

11:20 a.m. **Existence of Optical Vortex Solitons in Photorefractive Media**
Steven Zhang, New York University, Courant Institute of Mathematical Sciences

Optical propagation and vortices in nonlinear media have been intensively studied in modern optical physics. In this paper, we establish constraints regarding the propagation constant and provide an existence theory and numerical computations for positive exponentially decaying solutions for a class of ring-profiled solitons in a type of nonlinear media known as a photorefractive nonlinearity. Our methods include constrained minimization and finite element formalism, and we study the vortex profile and its propagation by fixing the energy flux.

11:35 a.m. **Superconvergence in a Hybrid Spectral Element Method on Domains with Irregular and Curved Boundaries**
Rebecca Conley, Saint Peter's University
Xiangmin Jiao, Stony Brook University
Jacob Jones, Stony Brook University

When solving a partial differential equation (PDE) using a spectral element method with tensor-product elements, it is possible to obtain superconvergence of the solution if the domain is regular. When solving a PDE on an irregular domain, such as one with irregular or curved boundaries, superconvergence is often lost due to distorted tensor-product elements or non-tensor-product elements. We propose a hybrid method, which combines superconvergent spectral elements with Gauss-Lobatto points and the adaptive extended stencil finite element method (AES-FEM) near irregular or curved boundaries. AES-FEM overcomes element-quality dependence of Lagrange finite elements and achieves high-order convergence. Our proposed hybrid method, called SPEAF, uses a hybrid mesh with tensor-product elements in the interior and simplicial elements near the boundary. SPEAF first solves the initial solution using spectral and finite elements on the hybrid mesh and then resolves the solution near the boundary using AES-FEM with the initial solution near the boundary as its artificial boundary condition. As a result, SPEAF preserves the global superconvergence of spectral elements in the domain's interior while recovering the same order of convergence near boundaries at minimal extra cost. We present numerical results for solving elliptical PDEs in 2D with Dirichlet and Neumann boundary conditions. We demonstrate order p+2 convergence rate in l2 norm and order p+1 convergence in H1 norm with degree-p spectral elements in the interior. These rates match the superconvergence of spectral elements and exceed the convergence rates of equidistant finite elements by one order while preserving their efficiency. With Neumann boundary conditions on curved boundaries, we show that superconvergence can also be achieved by using superparametric elements for the initial solution near the boundary. We compare the accuracy and efficiency of SPEAF to standard Lagrange finite elements generated by Gmsh and spectral elements.

11:50 a.m. **Comparison of high order meshfree methods for solving the 3D-Helmholtz equation in irregular domain**

Reza & Mollapourasl, Farmingdale State College
Majid Haghi, Shahid Rajaee Teacher Training University

In this study, we present and compare two high order meshfree methods known as radial basis function generated finite difference (RBF-FD) and radial basis function generated Hermite finite difference (RBF-HFD) methods for designing stencil weights to solve a 3D Helmholtz equation in an irregular domain. The RBF-FD and RBF-HFD are meshfree methods which incorporate the advantages of the RBF method with finite difference and Hermite finite difference schemes. These numerical strategies not only reduce the computational cost but also avoid the ill-conditioning issue that comes from global RBF methods. The convergence and stability of proposed schemes are investigated and compared numerically by solving a 3D Helmholtz equation in a three dimensional domain with irregular shape. Comparison of results shows that both RBF-FD and RBF-HFD methods are accurate and applicable for solving PDEs in irregular domains, however RBF-HFD is more accurate than RBF-FD.

12:05 p.m. **Tear Film Dynamics: Modeling the Glycocalyx as a Poroelastic Region**

Antonio Mastroberardino, Pace University, Javed Siddique, Penn State York, Richard Braun, University of Delaware, Daniel Anderson, George Mason University

The human tear film is a complex fluid structure composed of an aqueous layer, an outermost lipid layer, and the glycocalyx, a forest of large transmembrane mucins that provide stability to the ocular surface. We formulate a thin film model based on lubrication theory and mixture theory in order to understand the dynamics between the aqueous layer and the glycocalyx, which we treat as a poroelastic region.

12:20 p.m. **Bayesian Forecasting of Dynamic Extreme Quantiles**

Douglas Johnston, Farmingdale State College

We provide a novel Bayesian solution to forecasting extreme quantile thresholds that are dynamic in nature. This is an important problem in many fields of study including climatology, structural engineering, and finance. We utilize results from extreme value theory to provide the backdrop for developing a state-space model for the unknown parameters of the observed time-series. To solve for the requisite probability densities, we derive a Rao-Blackwellized particle filter and, most importantly, a computationally efficient, recursive solution. Using the filter, the predictive distribution of future observations, conditioned on the past data, is forecast at each time-step and used to compute extreme quantile levels. We illustrate the improvement in forecasting ability, versus traditional methods, using simulations and also apply our technique to financial market data.

RESEARCH SESSION: PURE MATHEMATICS 1

Presider: Ezra Halleck

11:20 a.m. **Proving Mathematical Conjectures Using Boolean Satisfiability Solvers**
Alexander Atwood, Suffolk County Community College

An overview of the application of Boolean Satisfiability (SAT) Solvers to prove difficult mathematical conjectures will be presented. Examples including the Collatz conjecture can be transformed by a rewriting process into formulas that use propositional logic and can be computer tested to see whether these rewriting systems eventually terminate.

11:35 a.m. **A Fibonacci Surprise**
Jay L. Schiffman, Rowan University

When securing the possible next term in an integer sequence, one often employs the method of finite differences and finds the sequence models a polynomial function. Recently a friend emailed me concerning the sequence 2, 2, 3, 4, 6, 9, 14, 22, 35, ... In this instance, the set of first differences is the Fibonacci sequence! This paper explores divisibility and periodicity ideas as well as securing prime outputs (which do not exist apart from the primes 2 and 3) and any palatable number tricks associated with the sequence. I was able to completely factor all but one of the initial five hundred terms in this shifted Fibonacci sequence (each term is one greater than the corresponding terms in the standard Fibonacci sequence) and discovered the initial entry points of each prime less than one thousand. In addition, we show using the recursion relation in our sequence that each prime, power of a prime and composite integer (using the least common multiple) is guaranteed to enter our sequence no later than two places prior to the end of the Pisano period. Of course, an integer may enter the sequence earlier as well. The lengths of the Pisano periods of each integer are the same as those in the traditional Fibonacci sequence. Please join us to view a neat sequence in action.

11:50 a.m. **Optimal Matrices for ElGamal Encryption**
Randall Helmstutler, University of Mary Washington

There has been recent interest in generalizing ElGamal encryption to the special linear groups over finite fields, both for potential computational and security advantages. The choice of working in the special linear groups is advocated so that attackers learn nothing from the determinants of public matrices. Using known constructs of finite geometry, we exhibit one way of instead selecting matrices in the general linear group that appears to minimize the attacker's chance of success in executing a brute force attack.

12:05 p.m. **Elliptic Curve Cryptography**
Justin Morelli

In this essay, I will first present the necessary Number Theory for understanding cryptosystems of any type, then starting with simpler introductory methods and building up to Public Key and Elliptic Curve Cryptography, I will survey the various encryption methods and compare their levels of security by considering the size of their keyspace, to discuss just how reliable these methods are, and if it is possible that there will come a time that these methods are made obsolete by either an efficient solution to the RSA problem or some leap in computational ability.

12:20 p.m. **On a polynomial reciprocity theorem of Carlitz**
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 "It is not clear how this restriction can be removed". In this talk, we remove this restriction and obtain a generalization of Carlitz's polynomial reciprocity theorem.

RESEARCH SESSION: DATA SCIENCE & MISCELLANEOUS

Presider: Bruce Kan

11:20 a.m. **Tidy Pivot Tables in R**
Evangeline Reynolds, United States Military Academy, West Point

Pivot tables are often the bread and butter of data analysts' day to day. In Microsoft Excel this summary tool is extremely popular, yet creating reproducible products with Excel is challenging. Using coded, reproducible workflows there are several implementations of pivot tables. This paper reviews existing coded tools for producing pivot tables and proposes a new implementation, in the 'tidypivot' R package. The merits and limitations of this approach are discussed.

11:35 a.m. **How Math can help in Machine Learning for LiDAR 3D point clouds**
F. Patricia Medina, New York City College of Technology, CUNY

LiDAR point clouds contain measurements of complicated natural scenes and can be used to update digital elevation models, glacial monitoring, detecting faults and measuring uplift detecting, forest inventory, detect shoreline and beach volume changes, landslide risk analysis, habitat mapping and urban development, among others. A very important application is the classification of the 3D cloud into elementary classes. For example, it can be used to differentiate between vegetation, man-made structures and water. The main goal of this talk is to showcase mathematical tools coming from areas such as measure theory that might help improve the accuracy of classification into several classes.

11:50 a.m. **Mathematical Interpretation of Chinese Wealth Gap, Population and Current Policies**
Yichen Qian, Ye Liu, Qihang Xu, Jianan Liao, NYU
Advisor: Timothy Christensen, NYU

The declining birth rate and the aging Chinese population have created a tremendous downward pressure on the consistent economic growth and industrial production of China, which concerns the authority. In response, the Political Bureau of the Central Committee of the Communist Party of China proposed the three-child policy on May 31st, 2021. The primary purpose of this paper is to conduct a mathematical interpretation sophisticatedly on China's wealth gap, population, and current policies. In the following sections, we utilize Difference in Difference (DiD) regression for our interpretation of multifactor correlation and our prediction of future production in terms of Nominal GDP. We will take into consideration the consistent influences of employment participation rate and urbanization on the persistently increasing Nominal GDP to analyze the contributions to production and economic growth. We will perform Principal Component Analysis to reduce the dimensions to store multifactors into one or two and figure out the best estimator by finding the relation between Eigenvalues. We aim to come to a conclusion regarding the relevant components that contribute to the economic differences between urban and rural areas across provinces.

12:05 p.m. **Win a Million Dollars! An Introduction to the Millennium Prize Problems**
Rebecca Coulson, United States Military Academy, West Point

The millennium prize problems were established by the Clay Institute in 2000. They began as a collection of seven famous unsolved problems, each with a $1M prize for their solution. One of these problems, the Poincare conjecture, was solved in 2010 by Grigori Perelman who refused the prize! In this talk we will review the history of the millennium prize problems, what they mean and why we care, and explore potential avenues of solutions.

12:20 p.m. **An introduction to the Actuarial Profession and how Actuaries saved the billion-dollar retirement industry during the COVID-19 pandemic**

Daanial Ahmad, Cornell University

We will introduce what it means to be an Actuary? What do Actuaries do? In which areas they work in, such as Life Insurance, General Insurance (Property and Casualty), Investments, Pensions and Enterprise Risk Management. We will talk about what is needed to become an Actuary and why Actuaries are so important to the social community. If Time permits, we will also discuss a very popular retirement Financial product which is Variable Annuities.

PEDAGOGY SESSION: MATHEMATICS EDUCATION 1

Presider: Nadia Kennedy

11:20 a.m. **The Enigma of Breaking Enigma**
Jeff Suzuki, Brooklyn College, CUNY

Breaking the German Enigma codes during World War II is hailed as one of the great achievements of mathematics. However, most books on cryptography don't go into details, since Enigma is based on an analysis of permutations. And most books on abstract algebra don't go into the details, since their cryptographic focus is on the ring of integers mod N. As a result, one of the greatest applications of mathematics in one of its most abstract areas is essentially forgotten. In this lecture, I'll show why the breaking of Enigma can become a key unit in any course on abstract algebra.

11:35 a.m. **Computing in Calculus**
Sandie Han, Boyan Kostadinov, Johann Thiel, NYC College of Technology, CUNY

An active learning approach was used in the teaching and learning of Calculus I and II, where computing and programming were incorporated to enhance concept visualization, real-world modeling, and computational problem-solving. Studies have shown that intertwining programming and mathematics is beneficial for deeper learning in mathematics as well as for developing coding skills through contexts. In this presentation, we report the results from implementing computing activities in the experimental Calculus sections and share some of the activities developed.

11:50 a.m. **Object-Oriented Mathematics Education: The Extreme Example of North Korea**
JungHang Lee, Hostos Community College, CUNY

This research study challenges a presumption about mathematics education as a socially and politically neutral subject. It presents the case of mathematics education in one of the most closed countries in the world — North Korea, which is an extreme example of politically prompted mathematics education with a clear objective in mind. The goal of North Korean mathematics education is to educate people who will carry on the socialist agenda and ideology, and the main focus is on the group and not on the individual. This study examines the case of the North Korean secondary school mathematics education through a review of North Korea's social and educational structures as well as its Workers' Party political and ideological agendas. I present results from In-depth interviews conducted with defectors (now in South Korea), former secondary school mathematics teachers, and students.

12:05 p.m. **Investigating Special Problems with Dynamic Geometry Software**
Jose Contreras, Ball State University

The formulation of conjectures are fundamental processes of mathematical activity. In this presentation, I illustrate how we can use dynamic geometry software to investigate a few special problems.

12:20 p.m. **Three Techniques That Saved Me from Pandemic Teaching Disaster**
Tanvir Prince, Hostos Community College, CUNY

In this presentation, I will describe three techniques that I had taken to survive online teaching during the covid19 pandemic: "Remind" for text message communication, "Zoom white board" for classroom activity and students participation, and "GeoGebra + Calculcu3D" plot to make my desktop computer a smart classroom. Some pros and cons of using these techniques will be discussed as well.

STUDENT/FACULTY SESSION 1

Presider: Eric Rowland

11:20 a.m. **Solution Points to the Multinomial Lucas Congruence Mod p^2**

Joshua Crisafi, Hofstra University
Advisor: Eric Rowland

The multinomial function is an extension of the binomial function to multiple variables and with a slight change in its coefficients. It is known to support a Lucas Congruence mod p for all inputs, for any prime p, and for any number of variables, but it only supports a Lucas Congruence mod p^2 for specific inputs. This paper will explain exactly which inputs will and will not have the multinomial function support a Lucas Congruence mod p^2 for any number of arguments. This paper is also a continuation of one by Eric Rowland in which certain special points were found that have the binomial function support a Lucas Congruence mod p^2, but a closed form for these points was not yet known. The results in this paper will explain exactly which points have the binomial function support a Lucas Congruence mod p^2 as well.

11:35 a.m. **Formulating an Algorithm for Flood-It Game**

Anesa Hanif, Ashleigh Hartwig, Dhiraj Kumar Chaudhary, Manoj Aryal, Matthew Antuofermo, Maria Di Carlo, Sambhav Shrestha, St. Joseph's University–Brooklyn
Advisor: David Seppala-Holtzman

Flood-It is a one-player combinatorial game played on a colored board consisting of a square grid (n*n) where each grid represents some color. The neighboring adjacent grids with the same color are considered to be flooded. While playing the game online (https://unixpapa.com/floodit/), a player has the liberty to choose grid size and color; against which a target no. of steps is generated within which the entire grid is to be converted into one color-- that target number is usually very close to the actual number of steps needed to achieve the goal. This analysis research aimed at finding the algorithm that given the grid size and no. of colors, returns the no. of target steps. This research uses a combination of mathematical computations and data science applications in order to develop an algorithm. The algorithm, however, is a case-based algorithm where a constant value changes based on the size of the grid and the initial no. of colors in the grid.

11:50 a.m. **Housing Comorbidities of NYC**

Terrence Tunnock, Manhattan College; Anthony Albanese, St Francis College
Advisor: Alin Tomoiaga, Manhattan College

Covid-19 exposed many of New York City's structural problems that aggravated the pandemic. This research identifies crowding, housing, and other demographic factors that caused Covid to impact some regions of the city more than others. Using data from the Furman Center, Google Mobility, and other public sources, the current research models Covid-19 rates based on the factors above, as well as discusses the financial hardships that constrain housing availability for the average New Yorker. Analyzing housing and COVID is a multifaceted discussion that may have emotional and political implications. The only way to discern fact from rhetoric is to look at the data. Data is essential for our analysis, our investigations and conclusions are solely data driven and fortunately, reliable and abundant information is available online.

12:05 p.m. **Reduction Algorithms in Volterra Integral Equations**

Sarah Rosen, 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 integral equation into an equivalent one in operator-linear form, i.e. one that only contains iterated integrals. This serves to formalize a method of simplifying integral equations to a form that has a more direct process of being solved. We use the algebraic object of the integral operator, the twisted Rota-Baxter identity, and vertex-edge decorated trees to construct and prove the validity of our algorithm.

CONTRIBUTED POSTER SESSION

12:40 PM – 1:25 PM

MISCELLANEOUS RESEARCH

Supervisor: Johanna Franklin

Art and Mathematics meet at the edge of Chaos
Julia Burnside, Katie Salas, New York City College of Technology, CUNY
Advisor: Satyanand Singh

We will investigate iterative mappings in the complex plane, study orbits and create fractals. Fractals are objects which are self similar and infinitely replicating. Some of this work traces its origins to the 1800's but became useful and important in modern studies as computers became more advanced. Some special sets that will be examined are Julia and Mandelbrot. We will use computer simulations, theoretical considerations and complex analysis to better understand and extend work on the special sets. We will also discuss practical applications of our work. Our research will culminate with a study of the underlying chaos that is present in these systems and touch upon chaotic dynamical systems.

An introduction to the Actuarial Profession and how Actuaries saved the billion-dollar retirement industry during the COVID-19 pandemic
Daanial Ahmad, Cornell University

We will introduce what it means to be an Actuary? What do Actuaries do? In which areas they work in, such as Life Insurance, General Insurance (Property and Casualty), Investments, Pensions and Enterprise Risk Management. We will talk about what is needed to become an Actuary and why Actuaries are so important to the social community. We will also discuss a very popular retirement Financial product which is Variable Annuities.

Existence of Optical Vortex Solitons in Photorefractive Media
Steven Zhang, New York University, Courant Institute of Mathematical Sciences

Optical propagation and vortices in nonlinear media have been intensively studied in modern optical physics. In this paper, we establish constraints regarding the propagation constant and provide an existence theory and numerical computations for positive exponentially decaying solutions for a class of ring-profiled solitons in a type of nonlinear media known as a photorefractive nonlinearity. Our methods include constrained minimization and finite element formalism, and we study the vortex profile and its propagation by fixing the energy flux.

Examining the Riemann Hypothesis, and Patterns in Ratios of Robin's Inequalities
Paul Johnson, Biostat Software Development;
Caroline Johnson, Davis Senior High School;
Ling Huang, Sacramento City College

Robin showed that the Riemann Hypothesis is true if and only if a certain inequality holds which involves the sum of the divisors of the positive integer n and Euler's constant. In the poster we examine the ratio of the inequality and compare this ratio to the boundary equal to 1.0. We randomly choose many large intervals for differing values of large n. We comment on the pattern of the up and down movements of the ratio as n increases. We calculate the ratio means of these up, down, up/up, down/down … etc. movement patterns. We examine the highest peaks that are close to the boundary/barrier of 1.0 for intervals for increasing n. We note the drastic drop in ratio

for the next adjacent n at these peaks; and that the peak itself is a 'sharp' peak. The differences and drops exceed that expected by comparing to the average mean difference for the down movements. We ask the following questions: What values for n are these peaks attained? Could one of the up movements move the ratio above the 1.0 level; or in fact could there be a sequence of up, up/up, up/up/up … etc. movement patterns that would move the ratio above the 1.0 level; thus disproving the Riemann Hypothesis / conjecture? Can we place probability statements for such an occurrence based upon examining mean ratios for various intervals for large n?

Fermat's Little Theorem and Cryptography

John Gupta-She, Stuyvesant High School
Advisor: Joseph Stern

Algorithmic Computer Science is an application of Mathematics. These algorithms give us tremendous computing power at our fingertips. Encryption is a classic example of Algorithmic Computer Science which is rooted in the field of Math known as Number Theory. Fermat's Little Theorem is at the heart of Cryptography. In this poster we discuss the connections between Fermat's Little Theorem, how to handle factorizations of large primes particularly Mersenne primes through computer programs and Cryptography.As the French music theorist, Jean Philippe Rameau, said, music after all is a mathematical science with a set of principles and axioms from which all elements of music can be deduced.

Game of Cycles

Shakinah Silverberg, Iona College
Advisor: Benjamin Gaines

The Game of Cycles is a two-player game on a graph in which both players aim to either complete a cycle or make the last legal move if a cycle is not possible. Depending on the graph used as a board, different players will have a winning strategy. In this project, we explore one particular class of boards called house graphs to determine who has the winning strategy. The one story house graph has been previously solved, but two story houses and beyond had not yet been. We focused specifically on the winning strategy for a two story house graph and found that Player 1 has a winning strategy. We found this strategy by creating a game tree and exhausting all of the potential Player 2 options necessary. Using the symmetry of the board, we were able to reduce the number of Player 2 options that had to be considered. We conclude by discussing how these methods can be applied to examine other higher story house graphs.

Temperature: Bridging the Gap Between Satellite Products and Human Comfort In the Urban Environment

Mohammad Masud, Ivan Boamah, Carolien Mossel, New York City College of Technology
Advisors: Reginald Blake, Hamid Norouzi

Air temperature is an important factor in the comfort level of humans, and currently there are no adequate satellite air temperature datasets for the urban environment, although surface temperature is often used as a proxy. Air temperature can vary greatly within the urban environment and given that one of the impacts of redlining and under-investment in the infrastructure of certain areas is higher temperatures, there is a need to better understand the variables that impact urban temperature. This is important for temperature modeling as well as heat mitigation strategies, all in the pursuit of making a more livable environment for all. In this
project, we will work with satellite temperature products and ground weather measurements. Students will gain experience in wrangling and analyzing multiple spatiotemporal temperature datasets as we develop a methodology for predicting air temperature and validating those predictions with ground measurements.

Microwave Remote Sensing and Land Surface Emissivity from Satellite Observations

Isatu Jalloh, Angel Vargas, Zahra Sharif, New York City College of Technology, CUNY
Advisors: Hamid Norouzi, Reginald Blake

Satellite-based remote sensing observations at different wavelengths and frequencies are used for various climate, environmental, meteorological, and water resources studies. Among different bands, microwave remote sensing data are crucial for the retrieval of several atmospheric quantities related to land surface processes, to monitor vegetation phenology and surface properties, and for numerical weather prediction (NWP) data assimilation. They can predict rainfall, snowfall amount, soil moisture, etc. Land surface emissivity which is related to the earth surface characteristics is derived from microwave brightness temperature data. In this project, students will learn about microwave data from sensors such as the Advanced Microwave Radiometer-2 (AMSR2), infrared temperature data from Moderate Resolution Imaging Spectroradiometer (MODIS) and how to derive land surface emissivity at the global scale. Students will be engaged in downloading data from NASA website and will process them.

A Geographic Study for Landfill Sites and Emission Control Technology for Reducing Greenhouse Gasses

Windiana Georges, Mark Stewart, New York City College of Technology, CUNY
Advisor: Masato Nakamura

The landfill waste will increase over the next few decades as the population of developing cities around the world will increase by a significant amount and methane, known as one of the greenhouse gasses. The purpose of this research project is to explore the different ways that methane can mitigate the effect of increasing greenhouse gas emissions and be utilized as an alternative resource as well as alterations in landfill management techniques based on related knowledge in geoscience to promote more efficient operations to support the diversion of an organic waste stream besides landfills.

Validation of Global Lake Surface Water Temperature

Mamadou Balde, Pascal Kouogang, New York City College of Technology, CUNY
Advisors: Abdou Bah, Hamid Norouzi, Reginald Blake

The project will be focused on validating and mapping surface water temperature in lakes around the world. The idea would be to leverage lakes with multiple years of buoy data to investigate the accuracy of the remotely sensed lake surface water temperature data obtained from the Moderate Resolution Imaging Spectroradiometer.

Mathematical Analysis on the Harmonic Overtone Series

Cadee Lee, Bergen County Academies and Juilliard Pre-College
Advisor: Dr. JungHang Lee

Music is often stereotyped as being abstract and not tangible. This research focuses on using combinatorics and sequences to model music, specifically the overtone series, as a precise art form defined by formulas and percentages. Pythagorus is attributed with discovering the relationship between the length of a string and the pitch that is heard when the string is plucked. Splitting a string into half produces a note an octave higher, thirds produce notes that are a fifth higher, and so on. This concept is known today as the overtone series. Arithmetic sequences will be used to model and produce the overtone series for each note in a C Major triad. Combinatorics will be used to find the percentage of triads produced from randomly picking r notes from n overtones produced. Since chords are defined by the distance between each of its notes, the percentage of major, minor, diminished, and augmented chords can be calculated using combinatorics. The percentage of three note combinations that do not create triads can also be derived. This method can be applied to triads, r = 3, seventh chords, r = 4, up to and including thirteenth chords, r = 7. Since the intervals between the notes in a triad are its identifying factor, the data retrieved from this research is relevant to all major triads, not just C Major. This research will elucidate the intricate relationship between mathematics and music in the overtone series and prove that music in fact consists of formulas and percentages at its core.

Temporal Analyses of Drought in the Northeast: Case Studies for New Jersey and Delaware

Rabeca Mohammed, Leulaye Maskal
Advisor: Nir Krakauer, The City College of New York, CUNY

Drought is water shortage typically associated with below-average precipitation. Low soil moisture during drought negatively impacts agriculture and natural ecosystems, while water stores in lakes and reservoirs, streams, and aquifers may also dry up. Compared to other natural disasters, drought onset may not be noticeable, while its consequences are often long lasting. Though the Northeast United States is considered a well-watered region, it is predicted that the frequency of droughts will increase as temperatures warm and precipitation patterns fluctuate. Previous droughts in the Northeast have led to agricultural losses, fire hazards, and shortages for municipal and industrial water uses. For effective drought monitoring and response, better understanding of the patterns of drought onset, persistence, and impacts across the Northeast is needed. In this research, frequency and severity of droughts reported in the Northeast climate region was analyzed on a state-by-state basis. Two databases—NOAA's Storm Event Database (SED) and the United States Drought Monitor (USDM)—were compared and correlated to identify their sensitivity to drought across years and seasons specifically for the Northeast. Analysis of news articles and editorials was also used to bring context to the quantitative drought measures and correlated drought locations and timing with societal and ecological impacts.

Anthropogenic, Climatic Trends and their effect on Regional Farms

Fambougouri Diane, Bronx Community College, CUNY;
MD Karim, New York City College of Technology, CUNY;
Advisors: Caroline Schwab, Tarendra Lakhankar, The City College of New York, CUNY

As climate change persists, the frequency of drought is expected to increase, which will have significant impacts on food, water, and energy security. While use of irrigation is commonly thought of as a means of mitigating drought, anthropogenic decisions of water use have the potential to exacerbate drought. Thus, it is important to incorporate anthropogenic farm decisions in drought projections. This study examined farms on the regional scale across the contiguous USA to understand the statistical relationships between water deficit and climate, corn yield and climate, and water deficit and corn yield. Anthropogenic mechanisms were incorporated using a demand-based perspective of deficit. Global ENSO values were used to represent warming and moisture trends. A qualitative analysis of farm and water use policy was also conducted in an attempt to understand these statistical relationships. The study found correlation coefficient, alpha, and beta values of the three relationships. Results showed little to no correlation of climate warming with deficit and yield, but there was moderate correlation in eastern regions between deficit and corn yield alone. Western farms had much smaller correlations. The stronger correlation between deficit and yield leads to the conclusion that deficit and yield trends are more dependent on local climate phenomena, like rainfall, as opposed to global warming and moisture trends. Anthropogenic decisions on farms, like water-use and irrigation, led to a smaller correlation of deficit and yield as the farms are more dependent upon irrigation and less so on climate. These relationships will be helpful in further developing drought forecasts

Effects of Riverine Inputs on Long Island Sound Water Quality

Syeda Mehjabin, New York City College of Technology, CUNY
Advisors: Alana Menendez, Maria Tzortziou, The City College of New York, CUNY

The Long Island Sound (LIS) supports a population of 23 million people in a 50-mile radius and its watershed extends as far as Quebec, Canada. Natural and anthropogenic factors influence LIS water quality and what is delivered into the coastal zone from its river systems. Historically, excess nitrogen has been a water quality issue in LIS and has led to summertime hypoxia events. Discharge data from the United States Geological Survey (USGS) were analyzed from 2010 to 2020 for five Connecticut sites, including the Connecticut River, the largest freshwater source to LIS, and the Housatonic River, the second largest freshwater source. Seasonal and inter-annual trends in river discharge were analyzed alongside National Oceanic and Atmospheric Administration (NOAA) Connecticut precipitation data. These data were compared to monthly composites of colored dissolved organic matter retrieved over LIS using satellite ocean color Sentinel-3 OLIC imagery, in order to better connect precipitation, discharge, and water quality.

A Method to Downscale Satellite Land Surface Temperature Data in Urban Areas

Naved Khan, Hostos Community College, CUNY;
Serigne Mbaye, New York City College of Technology, CUNY;
Nadia Sultana, New York City College of Technology, CUNY
Advisors: Abdou Bah, Reginald Blake, Hamid Norouzi, New York City College of Technology, CUNY

Areas with dense populations are breeding grounds for numerous environmental issues. The existence of Urban Heat Islands (UHI) are common occurrences that can signal the occupation of other health issues. To predict the behavior of UHI and its effect on high-density urban environments, better understanding of the surface energy balance is inevitable. The objective of this study is to use multiple satellite data sources to improve the spatio-temporal resolution of the land surface temperature (LST) estimates, which can be used for a more complete understanding of UHI. Using a linear regression model, LST data from the GOES-16 satellite (with a spatial resolution of 2km and temporal resolution of 5 minutes) were downscaled to the resolution of Landsat-8 satellite (with a spatial resolution of 30m and temporal resolution of 16 days). The combination resulted in a high spatio-temporal resolution of 30m every 5 minutes LST data. When validated against independent Landsat images, the downscaled estimates showed a reasonable agreement (-0.09K to +3.30K) over New York City.

Correlation between Gentrification Patterns in NYC derived from Gas Outage Data and Reports Using Data Science and Geographic Information System (GIS) Tools

Itay Rubin, Md Rahman, New York City College of Technology, CUNY
Advisors: Ronak Etemadpour

We seek to determine whether there is a correlation between socioeconomic levels across NYCHA's five boroughs, and the willingness of the residents to report gas leakages. More specifically, we will examine if those in lower socioeconomic neighborhoods may be less likely to report gas outages because they experience extended shutoffs and delays in resolving the leakages. First, we utilize Application

Programming Interfaces (APIs) to glean data from public sources such as NYC Housing Authority (NYCHA) and local news about gas-related reports and complaints. Then we use Python coding to create scripts to sort the data. The data obtained is presented visually on maps using software such as QGIS. Ultimately, we aim to use data science tools and statistical approaches to highlight how gas leak reporting patterns of residents across differing socioeconomic groups are related to gentrification in NYC. This research may be beneficial for municipal policy makers and gas companies.

Green Hybrid Renewable VAWT Energy Systems

Sherene Moore, New York City College of Technology, CUNY
Advisor: Masato Nakamura

Green hybrid renewable energy systems that create a smart electrical grid and sustainable power are necessary to achieve carbon footprint reduction. To achieve this goal, small, compact, urban friendly wind turbines are necessary. A design deficit of conventional Horizontal Axis wind turbines (HAWT) in urban environments is continuous vibrations, which impact soil-structure stability; resulting in pressure uplift of the foundation. A modified compact design of vertically aligned turbine blades, along with reinforced cone-shape concrete foundation, can decrease the resonance of soil-structure interaction. Smaller energy efficient hybrid solar wind systems create an effective solution for metropolises where space is an issue. This study shows that it is not only possible, but beneficial to incorporate small, compact, and efficient vertical axis wind turbine (VAWT) hybrid systems into the infrastructures of metropolitan settings, as they are invaluable resources for urban smart grid sustainability practices.

Housing Comorbidities of NYC

Terrence Tunnock, Manhattan College; Anthony Albanese, St Francis College
Advisor: Alin Tomoiaga, Manhattan College

Covid-19 exposed many of New York City's structural problems that aggravated the pandemic. This research identifies crowding, housing, and other demographic factors that caused Covid to impact some regions of the city more than others. Using data from the Furman Center, Google Mobility, and other public sources, the current research models Covid-19 rates based on the factors above, as well as discusses the financial hardships that constrain housing availability for the average New Yorker. Analyzing housing and COVID is a multifaceted discussion that may have emotional and political implications. The only way to discern fact from rhetoric is to look at the data. Data is essential for our analysis, our investigations and conclusions are solely data driven and fortunately, reliable and abundant information is available online.

Reduction Algorithms in Volterra Integral Equations

Sarah Rosen, 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 integral equation into an equivalent one in operator-linear form, i.e. one that only contains iterated integrals. This serves to formalize a method of simplifying integral equations to a form that has a more direct process of being solved. We use the algebraic object of the integral operator, the twisted Rota-Baxter identity, and vertex-edge decorated trees to construct and prove the validity of our algorithm.

Modeling COVID-19 Data in New York City using an SIR Model

Hamnah Teli, Samantha Gervasi, Juan Orellana, Michael Campbell, Farmingdale State College, SUNY
Advisor: Chunhui Yu

We discuss and expound on the spread of Covid-19 in New York City by modeling with an SIR model.

529 or IUL for College Fund Planning

Michal Piekarski, Michael Brandon, John Aguano, Brandon Stryska, Farmingdale State College, SUNY
Advisor: Chunhui Yu

We present a case study simulating the performance of a 529 and an IUL fund account using the Monte Carlo method.

A Review of Multiple Proofs for Multinomial Theorem

Michael Storm, Christian Farkash, Thomas Palmeri, Farmingdale State College, SUNY
Advisor: Chunhui Yu

We present a few proofs of the multinomial theorem including the traditional combinatorial proof, a proof by induction, a probabilistic proof, and a proof by differential calculus.

Robotic Manipulation: A Practical Application of Linear Algebra in Perception and Path Planning

\Akhil Sankar, New York City College of Technology, CUNY
Advisor: Ariane Masuda

In this project, we describe the mathematics that informs the decision making of a 3- degree-of-freedom robotic manipulator by performing a simple pick-and-place operation within a controlled workspace. The implementation of transformations on the coordinate reference frames in the perception step of the control loop allows the controller to infer the location of the target object within the workspace. Additionally, it describes the use of inverse kinematics and proportional control to facilitate the actuation step of the control loop, used to set the joint angles of the revolute and linear joints, respectively, to navigate the span of the workspace. The intent behind this project is to showcase a practical implementation of concepts within linear algebra, differential equations and trigonometry as the basis of this type of robotic control algorithm, allowing the reader to build a more intuitive understanding of these disciplines.

Genotype Distribution in a Population

Adrian Guin Rizzo, New York City College of Technology, CUNY
Advisor: Ariane Masuda

Genetic adaptations occur over many generations as a result of a mix of subtle, random changes in features and natural selection of the variations that are best adapted for their environment. The purpose of this study is to analyze the propagation of inherited traits in autosomal dominant and recessive inheritance in a farmer's population of plants and animal breeder population of animals by computing the powers of a matrix. We create a matrix with entries representing the probability of potential offspring genotypes based on all possible combinations of the parents' genotypes. Then, by the use of the SageMath on the CoCalc platform, we compute the power of the matrix to estimate how inherited traits are transmitted down through the generations. When the matrix is diagonalizable, these calculations may be done more efficiently. Using the concept of limits, we are able to estimate the probability of inherited traits in the future. The approach allows us to forecast in which generation a genotype will be the only one left or when the other genotypes will vanish from the family's pedigree inheritance patterns. Finally , we are able to examine the pattern in a population and determine the frequency of the trait after each generation in the farmers' large population of plants and the animal breeder population of animals as well as the likelihood that the trait will be passed down to the next generation.

Bézier Curves

Qing Chen, New York City College of Technology, CUNY
Advisor: Ariane Masuda

Drawing on a computer using a mouse is quite different than drawing by hand. It can be challenging to use a mouse to even simply trace a line. If the drawing involves several lines and curves, the task becomes more complicated. The goal of this project is to show how to design beautiful artworks using Bézier Curves. A Bézier Curve is a smooth parametric curve produced by the coordinates of certain points. To draw a specific curve, one needs to select multiple control points positioned in strategic places. By changing these positions, one can draw different curves to produce the desired pattern. We use Krita, which is a professional free, and open-source painting program made by artists to create digital art. We demonstrate how the Bézier curve pen tool in Krita can be used to trace over images by selecting the control points. We also explore the mathematics behind Bézier curves.

The Leslie Matrix Model

Angie Zumba, New York City College of Technology, CUNY
Advisor: Ariane Masuda

The three main biological processes are birth, death, and aging. The objective of this project is to investigate how these processes impact the distribution of the female population over time. We employ the Leslie Matrix Model, which was developed by demographers in the 1940s to study the growth of the female portion of a human or animal population. In this model the females are divided into n age classes (intervals) of equal duration. In order to perform matrix calculations, we use SageMath in the CoCalc platform. We consider several initial age distribution vectors and observe how they influence the future female population. Based on our examinations we determine the limiting age distribution and growth rate of the female population under different hypotheses.

CONTRIBUTED PAPER SESSIONS II

1:30 PM – 2:45 PM

RESEARCH SESSION: APPLIED MATHEMATICS II

Presider: Boyan Kostadinov

1:30 p.m. **Cancer incidence as the sum of hypo-exponential distributions**
Josh Hiller, Adelphi University

We find necessary and sufficient conditions for a finite state Markov Chain to exhibit an early power law of degree n in its time to absorption. This is done by expressing the time to absorption as a mixture distribution of hypo-exponential distributions. Our result generalizes the classic 1954 Armitage and Doll model of carcinogenesis.

1:45 p.m. **Reducing Heating Energy Demand with Optimization and Co-Simulation**
Joseph Bostick, United States Military Academy, West Point

A method of decreasing heating load of HVAC systems in a single-dwelling model of a multifamily building, by controlling movable insulation through the optimization of flux, time, surface incident solar radiation, and temperature thresholds. Simulations are completed using a co-simulation between EnergyPlus and MATLAB as an optimization tool to find optimal control thresholds.

Optimization of the control thresholds leads to a significant decrease in total heating energy expenditure.

2:00 p.m. **Predicting Army Post-IET Attrition using Time-varying Covariates**
Josephine Cammack, United States Military Academy, West Point

The Army is trying to reach a force of 500,000 by 2030. The Army needs to play a balancing act of figuring out how many soldiers will retire, attrit, or not reenlist; how many will leave for medical or other reasons; and determine how many soldiers need to be recruited every year. Military leaders need to know why and which factors cause soldiers to attrit before their first term is complete. This presentation uses multiple logistic regressions to determine if a soldier will attrit. Soldiers who attrit have more variables in common by year in contract than by their contract duration. Thus, the models are by year in contract due to the changing nature of time-varying covariates. As the year in contract increases, the effects of demographic indicators generally decrease, and the effects of medical-related indicators largely increase. This model can help leaders determine how to prevent attrition and increase the likelihood of success for soldiers.

2:15 p.m. **Nonlinear Pseudorandom Bit Generation By Combining Blum Blum Shub and Linear Feedback Shift Register Sequences**
MAJ Andrew Cammack, United States Military Academy, West Point
Dr. Pantelimon Stanica, Naval Postgraduate School

Pseudorandom bit generators play an important role in key generation for encryption. This research analyzes the cryptographic properties of a pseudorandom bit generator that combines Blum Blum Shub and linear feedback shift register sequences using a shrinking generator configuration. We sought to answer the questions: (1) What are the strengths and weaknesses of this type of combiner? (2) What constraints must be placed on the input parameters to ensure good cryptographic properties of the output sequence? We evaluated the cryptographic suitability of sequences generated by this method with the National Institute of Standards and Technology (NIST) statistical test suite. Our scheme produced excellent results under NIST testing but is computationally too slow for some practical uses as a stream cipher. Future work could focus on methods to increase the speed of the generator without a loss of excellent cryptographic properties.

2:30 p.m. **Modeling two competing pathogen strains with infection history and partial immunity**

Susana Pinheiro, Queensborough Community College, CUNY

We will introduce and discuss a compartmental model describing the competition between two strains of the same pathogen such as is the case, for instance, of two co-circulating variants of the coronavirus. Our preliminary 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.

RESEARCH SESSION: MISCELLANEOUS II

Presider: Johann Thiel

1:30 p.m. **Modeling a Rocket's Path**
Satyanand Singh, New York City College of Technology, CUNY

Come experience a modeling approach to a problem that was inspired by NASA. Students were required to model a rocket's path by using differential equations using open-source software in a remote setting. This presentation is accessible to someone teaching calculus and/or differential equations.

1:45 p.m. **Preferential and k-Zone Parking Functions**
Parneet Gill, California State University, Fresno
Pamela Vargas, Smith College
Christopher Soto, Queens College, Columbia University
Advisor: Pamela E. Harris, Williams College

Parking functions are vectors that describe the parking preferences of n cars that enter a one-way street containing n parking spots numbered 1 through n. A list of each car's preferences is also compiled into vectors in which we denote as (a_{1}, ... , a_{n}), such that a_i is the parking preference for car i. The classical parking rule allows cars to enter the street one at a time going to their preferred parking spot and parking, if that space is unoccupied. If it is occupied, they then proceed down the one-way street and park in the first available parking spot. If all cars can park, we say the vector (a_{1}, ... , a_{n}) is a parking function. We introduce new variants of parking function rules with backward movement called k-Zone, preferential, and inverse preferential functions. We study the relationship between k-Zone parking functions and k-Naples parking functions and count the number of parking functions under these new parking rules which allow cars that find their preferred spot occupied to back up a certain parameter. One of our main results establishes that the set of non-increasing preference vectors are k-Naples if and only if they are k-Zone. For one of our findings we provide a table of values enumerating these new combinatorial objects in which we discover a unique relationship to the order of the alternating group A_{n+1}, number of Hamiltonian cycles on the complete graph, K_n, and the number of necklaces with n distinct beads for n! bead permutations.

2:00 p.m. **Fun With Infinity**
Steven Gottlieb, SUNY/CUNY, Retired

We will look at a problem involving infinity that has a surprising result. Plan on leaving this talk feeling a bit dizzy.

2:15 p.m. **Math Anxiety**
Justine Dowling, Molloy College
Colleen Moulder, Molloy College
Kayla Strigaro, Molloy College
Advisor: Elizabeth Vidaurre, Molloy College

School can place an immense amount of pressure on students. This can lead to an overall increase in stress and general academic anxiety in students. Math anxiety is noted as a separate form of academic anxiety, as it is specifically linked to specific difficulties in processing mathematics or number-related tasks. Math anxiety is an epidemic that is sweeping the nation and impacting many of our students today. Students with math anxiety tend to have low perceptions of their math skills and perform poorly in tasks involving math reasoning, processing numeric information, and evaluative situations connected to math. This paper will provide an in-depth analysis of math anxiety, where it comes from, how current events have amplified its effects, and how to combat it inside and outside of the classroom.

2:30 p.m. **Using Dynamic Geometry Software to Solve Converse Geometric Problems**
Jose Contreras, Ball State University

In this presentation, I illustrate how my students and I use GeoGebra to explore geometric converse problems. In particular, I will show how I have used GeoGebra to reach the solutions of three problems.

PEDAGOGY SESSION: MATHEMATICS EDUCATION II

Presider: Nadia Benakli

1:30 p.m. **Analysis of Selection Criteria for Students to be placed into West Point's Advanced Math Program**

John C. Lucero, United States Military Academy

When new students first arrive at West Point, they soon find out what classes they will take during the upcoming Fall semester. Some cadets with strong mathematical backgrounds discover they have been placed into the Advanced Mathematics Program (AMP). Over the years, AMP course directors have used a variety of techniques to identify the best candidates for AMP which figures out to the top 30% of the incoming class. Most of these techniques considered the same variables ranging from West Point's college entrance examination rank (CEER) score, which factors in SAT/ACT scores among several other scores, to their Fundamental Concepts Exam (FCE) and Calculus Placement Exam (CPE) scores. The CEER score has been a reliable metric since its inclusion, but further inspection reveals some critical concerns. Recently, the FCE and CPE have both been remotely administered during the Summer before students attend West Point to allow for expedited placement. There is cause for concern since some students might resort to cheating in order to inflate their scores and increase their chances of being admitted into AMP. Through the use of data analysis, we examine which metrics successfully predict cadet performance among the many complexities of today's society.

1:45 p.m. **City Tech Summer Math Camps: Supporting Calculus and Algebra 2 High School Brooklyn Students through Summer Enrichment Programs**

Nadia Kennedy[1], Ariane Masuda[1], Armando Cosme[2]
New York City College of Technology, CUNY[1]
Science Skills Center High School, Brooklyn[2]

This presentation describes two-week enrichment math programs for diverse and under-represented high school students in the Brooklyn (NY) School Districts during the months of August and September. The programs are designed for high school students eligible to take AP Calculus or Algebra 2 and will help them prepare for taking these classes next school year. This will be accomplished by creating a learning environment that focuses on inquiry, mathematical reasoning, and collaborative group work. The program activities will be facilitated by prospective mathematics teachers. The project includes training for the prospective teachers and opportunity for them to engage with diverse high school students in equitable and inclusive teaching.

2:00 p.m. **The Effects of Spaced Recall in a Precalculus Classroom**

Diane Lindquist, USMAPS; Brenda Sparrow, USMAPS; Joseph Lindquist, USMA

The retention of fundamental mathematical skills is imperative in order to provide a foundation on which to build new mathematics skills. It has often been observed at the end of an academic year that students did not retain the math skills they learned at the beginning of the year. Educators and cognitive scientists have explored teaching methods, including spaced recall, that may produce learning that sticks. In a Precalculus course, we used spaced recall in the form of quizzing to determine if this method would improve students' long-term retention in a classroom setting. The goal was to identify an effective classroom strategy that led to student recall of fundamental math concepts through the end of the academic year. The concepts that were considered were 12, which were identified by the United States Military Academy mathematics department as being fundamental mathematics concepts for entering cadets. These 12 concepts are taught in quarter one of the Precalculus with Introduction to Calculus course at the United States Military Academy Preparatory School. There is an expectation that students will be able to remember those fundamental concepts when they are assessed on the post-test exam six months later. Our research suggests that spaced recall in the form of quizzing had a statistically significant positive impact on the retention of these fundamental concepts resulting in higher scores on the post-test.

2:15 p.m. Educating with Compassion

Shamita Dutta Gupta, Pace University

In the wake of the pandemic, with two years of online education, many challenges are surfacing in the classroom. Teaching mathematics post-pandemic has become more challenging due to the emergence of a new group of under prepared students. In this talk, we will discuss several models that we have created to cope with these issues. It is truly the era of educating with compassion.

2:30 p.m. Learning Mathematics During the COVID-19 Pandemic

Jessica Poole and Thomas Farragher, Molloy College

Learning math in school has been somewhat similar every year until the Covid19 pandemic arrived in 2020. The unpredictability presented new challenges that affected the teaching of mathematics. Challenges for students, teachers, and parents, included using new strategies and technologies to adapt to, and new ways of educating children. Students from different socioeconomic status were impacted by new stress at home and in school, and had to find a way to manage all new responsibilities.

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METROPOLITAN NEW YORK SECTION OF THE MAA
TREASURER'S REPORT

ASSETS	BALANCE		BALANCE
	05/01/21		04/30/22
Chase Business Classic	$8,352.25		$9,123.27
Chase Business Select High Yield Savings	$13,091.24		$13,092.88
NY Metro Section Total Assets	$21,443.49		$22,216.15

CHASE BUSINESS SELECT HIGH YIELD SAVINGS (0366)			
Credits			
Date		Description	Amount
05/01/21-04/30/22		Interest (does not include 04/22)	$1.64
Total Credits			$1.64

CHASE BUSINESS CLASSIC CHECKING (0365)

Deposits/Credits

	Date		Description	Amount
	06/07/21		Annual Meeting registration	$740.00
	03/11/22		2021 Subvention	$1039.00

Total Credits				$1779.00
Debits				
Check #	Date			
953	05/09/21		Annual Meeting Honorarium for Melvyn Nathanson	$300.00
954	05/09/21		Janet Liou-Mark Scholarship to Nadine Meister	$250.00
	06/07/21		Annual Meeting PayPal fees	$33.98
955	09/05/21		Mathfest Registration for Johanna Franklin	$199.00
956	09/24/21		Abraham Mantell (plaques for 2020 award winners)	$125.00
957	11/13/21		MetroNext Workshop Honorarium for Pamela Harris	$100.00
Total Debits				$1,007.98

JANET LIOU-MARK SCHOLARSHIP FUND						
Deposits/Credits						
	Date		**Description**			**Amount**
Total Credits						**$0.00**
Checks Paid/Debits						
Check #	**Date**		**Description**			**Amount**
954	**05/09/21**		**Award to Nadine Meister**			**$250.00**
Total Debits						
					BALANCE	**BALANCE**
					05/01/21	**04/30/22**
Fund Total					**$2,000.00**	**$1,750.00**

GRAPH THEORY DAY FUND (CONTAINED WITHIN 0365)				
			BALANCE	BALANCE
			05/01/21	04/30/22
Fund Total			**$2,172.41**	**$2,172.41**

Thank you for participating!