MAA SECTION METRO NEW YORK

MATHEMATICAL ASSOCIATION OF AMERICA

ANNUAL MEETING

April 28, 2024

THE METROPOLITAN NEW YORK SECTION MEETING 2024

Dear MAA Metro New York Conference Participants,

It is my privilege and honor to welcome you to our 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 in this virtual setting. We have a wide range of presentations that promise to inspire you. I would like to express my gratitude to our MAA committee members 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. Joaquin Carbonara, Dr. Anastasia Chavez and Dr. Johann Thiel, 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 sponsor, 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 presenters showcasing a wide variety of topics, some of which highlight research in mathematics, pedagogy, technology, data science, machine learning, and allied topics. We hope that you will interact with our Metro NExT panel and the panel from Pearson.

We also invite you to match wits with our Section's problem of the month which has a strong local and international following.

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 secti

WELCOME

METROPOLITAN NEW YORK SECTION

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CONTRIBUTED PAPER AND POSTER SESSIONS ORGANIZING COMMITTEE

Bora Ferlengez, Ezra Halleck, Bruce Kan, Boyan Kostadinov (Chair), Andrew Vaughn

THE MAA ANNUAL MEETING OF THE METROPOLITAN NEW YORK SECTION

APRIL 28, 2024

AGENDA

7:55-8:00 AM	**Welcome** Dr. Satyanand Singh, *Chair of the Metropolitan New York Section of the MAA*
8:05-8:50 AM	**Invited Speaker: The Secret Life of Data: Mathematics in the context of AI** Dr. Joaquin Carbonara, *Buffalo State University, SUNY*
9:05-9:50 AM	**Invited Speaker: Matroids, Positroids and Beyond!** Dr. Anastasia Chavez, *Saint Mary's College of California*
10:05-10:35 AM	**Sponsor Presentation: Pearson Publishers** **Pearson's Interactive Series & Latest Advancements in AI** **Presenter**: Bonnie Rosenblatt
10:45-10:55 AM	**Coffee Break**
11:00-12:30 PM	**Contributed Paper Sessions** Research Session: Applied Mathematics (Presider: Dr. Johanna Franklin) Research Session: Pure Mathematics (Presider: Dr. Brad Isaacson) Research Session: Data Science and Miscellaneous (Presider: Dr. Boyan Kostadinov) Pedagogy Session: Mathematics Education (Presider: Dr. Shamita Dutta Gupta) Student/Faculty Session (Presider: Dr. Emad Alfar)
12:35-1:25 PM	**Lunch Break and Contributed Poster Session (**Supervisor: Dr. Benjamin Gaines)
1:30-2:15 PM	**Invited Speaker: Arrangements of Stars on the American Flag** Dr. Johann Thiel, *New York City College of Technology, CUNY*
2:30-3:00 PM	**Metro NExT Meeting**: **"A Conversation on AI in the Math Classroom"** **(**Presider: Dr. Benjamin Gaines) **Featured Speaker**: Dr. Lew Ludwig, *Denison University*

2:30-3:00 PM **Workshops**

Using Digital Online Graphing Calculators to Enhance Learning in STEM
(Presider: Prof. Andrew Vaughn)
Organizer: Lucie Mingla, *La Guardia CC*

Comparing the variability in GPAs between participants of the Mathematics and Computer Science Scholars MACSS program and regular computer science and mathematics majors. (Presider: Dr. Ezra Halleck)
Organizers: Moise Koffi, Nieves Angulo, Diandra Jugmohan, Reginald Dorcely, *Hostos CC*

3:10-4:00 PM **Business Meeting** (Presider: Dr. Satyanand Singh, Chair of the MAA Metro NY Section)

INVITED SPEAKERS

Dr. Joaquin Carbonara, Buffalo State University, SUNY

The Secret Life of Data: Mathematics in the context of AI

Abstract: In this presentation we will embark on a thrilling exploration of the essence and future of Mathematics, a crowning jewel of human intellect. Is mathematics an inherent human instinct akin to language, a clever mnemonic device for our cognitive processes, a powerful medium for modeling and compressing information that revolutionizes fields like Physics, a mysterious, independent force of symbolic manipulation in nature, or a practical tool like a fulcrum and lever, that we use to shape our physical world?

As mathematicians, we often immerse ourselves in the intricacies of numbers and theories, rarely pausing to contemplate the nature of our craft. So, why pause now?

The plot thickens with the advent of an AI marvel – ChatGPT (a Large Language Model or LLM), released on November 30, 2022. This AI, a linguistic prodigy, blurs the lines between human intelligence and digital prowess, especially in the realm of reasoning, which is the foundation of mathematics. Trained on a wealth of digital data through advanced Data Science and Analytics, LLM's abilities are not just mimicry; they are a leap into a new era of intellectual synergy.

Join us as we unveil compelling evidence and insights, pondering how AI, driven by Digital Data and Computation (DDC), is set to redefine the landscape of Mathematics and the daily lives of Mathematicians. It is not just a presentation – it is a glimpse into the future, where numbers, data, and human intellect intertwine in fascinating ways.

Bio: Dr. Joaquin Carbonara has led a successful Data Science and Analytics (DSA) MS at SUNY Buffalo State University from its inception in 2018. Born in Venezuela, his first passion was music (he was part of the initial generation of musicians in the world-renowned social justice and music movement called El Systema). He came to San Diego, CA, after high school and completed a PhD in Mathematics from UCSD in 1992. He has taught thousands of students, obtained and managed large grants in higher education and published articles in a wide range of applications of mathematics (Combinatorics, Fractals, Pharmacology, Ecology, Material Science, Geoinformatics, and more recently in Material Science). He is an Associate Director of the Center for Integrated Studies in Nanoscience and Nanotechnology at Buffalo State. Currently Joaquin spends time biking, traveling, doing research in Data Science, teaching, and managing all aspects of the DSA MS.

INVITED SPEAKERS

Dr. Anastasia Chavez, Saint Mary's College of California

Matroids, Positroids and Beyond!

Abstract: Matroids are a fundamental combinatorial object with connections to many areas of mathematics: algebraic geometry, cluster algebra, coding theory, polytopes, physics ... just to name a few. Introduced in the 1930's, Whitney defined matroids with the desire to abstract linear and graphical dependence. In fact, every graph is associated with a matroid (called *graphical*) and from every vector configuration arises a *representable* matroid *(over some field F)*. It has been shown that most matroids are neither graphical or representable, making these two matroid properties rare and highly desired.

A particularly well-behaved family of representable matroids, called positroids, was introduced by Postnikov and shown to have deep connections to the totally nonnegative Grassmannian and particle physics. Moreover, he described several combinatorial objects in bijection with positroids that compactly encode matroidal data and have been shown to characterize many matroidal properties. With just a few definitions and examples revealing their connections to a variety of fields, you too can begin searching for the matroids living among us.

Bio: Anastasia Chavez is an Assistant Professor of Mathematics at Saint Mary's College of California. Born and raised in California, she transferred from the Santa Rosa Junior College and earned a bachelors in applied mathematics and master's in mathematics from San Francisco State University. After earning her Ph.D. in enumerative and algebraic combinatorics with an emphasis in matroid theory from the University of California, Berkeley, Anastasia was a Huneke Fellow at the Mathematical Sciences Research Institute and Presidents' Postdoctoral Fellow, NSF Mathematical Sciences Research Postdoctoral Fellow, and Krener Assistant professor at the University of California, Davis.

As a math educator and researcher, Anastasia aims to nurture the math ability that exists in every person. In and out of the classroom, she hopes to inspire the confidence to be curious, explore the unknown, and search for solutions that lead to even more meaningful questions. When Anastasia puts the math books down, you will most likely find her hiking, camping, and exploring nature with her partner, two kids, and two rambunctious pups.

INVITED SPEAKERS

Dr. Johann Thiel, New York City College of Technology, CUNY

Arrangements of Stars on the American Flag

Abstract: We examine the existence of nice arrangements of stars on the American flag. Using a connection to a problem due to Erdős and some tools from analytic number theory, we show that despite the existence of such arrangements for any number of stars from 1 to 100, with the exception of 29, 69 and 87, they are rare as the number of stars increases. This talk is based on joint work with Dimitris Koukoulopoulos.

Bio: Dr. Johann Thiel is an Associate Professor of Mathematics at the New York City College of Technology in Brooklyn, NY. He completed his Ph.D. in 2011 at the University of Illinois at Urbana-Champaign under the supervision of A.J. Hildebrand. Before coming to NYCCT, he worked for two years at the United States Military Academy in West Point, NY. His main research interests are in number theory (mostly analytic) and its applications.

SPONSOR PRESENTATION

Pearson

Pearson's Interactive Series & Latest Advancements in AI

10:05 AM – 10:35 AM

Faculty Adviser Bonnie Rosenblatt will dive into the latest advancements of our Interactive Series, including enhanced ways of organizing assignments, new UI/UX design, and explore upcoming AI features at the ebook, homework, and assignment creating process enhance the student learning experience.

METRO NExT NEW EXPERIENCES IN TEACHING:
A CONVERSATION ON AI IN THE MATH CLASSROOM

2:30 PM – 3:00 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.

In this session, we will discuss how AI has already begun to reshape the way college math courses are taught. Featured speaker Lew Ludwig is Professor of Mathematics and the Director of the Center for Teaching and Learning at Denison University and is one of the presenters at the upcoming MAA OPEN Math workshop on generative AI. He also authors a monthly column on the MAA Math Values blog on using generative AI that can be found here. He will share some of his own experiences with using AI in the classroom and be part of a discussion on both the opportunities and potential challenges it presents.

Presider: Dr. Benjamin Gaines

Featured Speaker: Dr. Lew Ludwig, ***Denison University***

Organizers: **Dr. Benjamin Gaines,** ***Iona University***
Dr. Elena Goloubeva, ***Webb Institute***
Monica Morales Hernandez, ***Adelphi University***
Dr. Andrew Lee, ***St. Thomas Aquinas College***

WORKSHOPS
2:30-3:00 PM

2:30-3:00 pm Using Digital Online Graphing Calculators to Enhance Learning in STEM

Presider: Prof. Andrew Vaughn

Organizer: Lucie Mingla, ***LaGuardia CC***

Using online graphing calculator as a digital platform helps faculty design curriculum and activities that are based on student-centered approach of learning. As Mathematics educators, we have the power, and the opportunity to challenge ourselves and apply the qualities, characteristics, and abilities to engage with the world, but also aspire our students to become globally competent. As we strive to equip our students with core concepts, values, behaviors, and skills there is an increasing demand for using digital communication tools. Online graphing calculators are one of the tools that can make an enormous impact. This presentation is focused on equipping faculty with some knowledge and skills for exploring, discovering, and implementing new ways of using advanced online graphing calculator. As faculty, we know that the most significant gap for our students is the struggle to understand concepts related to real-life application problems, and translating them into equations that use computations, graphing, tables, etc. It is especially important that our students know how to use multi-media tools to represent their thoughts in STEM courses and broader, and most importantly, to understand those concepts, explore and communicate their ideas through computations, visualizations, and manipulations. In this presentation I will leverage some methods and tips of using such tools to enhance learning in a more meaningful and purposeful way. I will introduce some of the experiences, examples, and findings using these types of activities. Participants will experience the benefits, challenges and share some ideas of using these tools through some engagement and interaction.

2:30-3:00 pm Comparing the variability in GPAs between participants of the Mathematics and Computer Science Scholars MACSS program and regular computer science and mathematics majors.

Presider: Dr. Ezra Halleck

Organizers: Moise Koffi, Nieves Angulo, Diandra Jugmohan, Reginald Dorcely,
Hostos Community College

The Mathematics and Computer Science Scholars (MACSS) program is a project that aims to increase the number of low-income and high-achieving undergraduate students completing a degree in mathematics or computer science at a two-year institution. To assess the program's impact, researchers conducted a study to compare the consistency of grade point averages (GPAs) between MACSS participants and non-participants. The study analyzed the GPAs of approximately 180 math and computer science students from fall 2022 to fall 2023 using the coefficient of variation (CV) to measure reliability within the archival data. The results showed that MACSS students had CVs ranging from 3% to 7% for math majors and 10% to 17% for computer science majors over time. In comparison, non-MACSS students had CVs ranging from 25% to 37% for both majors during the same period. These results indicate that the GPA of MACSS students was more consistent and reliable than that of non-MACSS students, making it a good predictor of academic success, retention, and graduation in response to the national need for economic competitiveness and security of the skilled workforce in STEM professions. Overall, these findings contribute to our understanding of improving academic performance, retention, and graduation rates among undergraduate mathematics and computer science undergraduate students, particularly those from low-income backgrounds.

DISTINGUISHED TEACHING AWARD

Dr. Benjamin Gaines, *Iona University*

Dr. Benjamin Gaines is Associate Professor and Chair of the Department of Mathematics and Physics at Iona University, in New Rochelle, NY. He received his PhD from the Mathematics Department at Duke University in May 2015, and received his BA in Mathematics and Physics from the University of Pennsylvania in 2009. Since arriving at Iona in Fall 2015, he has taught nearly every mathematics course offered by the department and advised 15 undergraduate students on research projects that they have presented at institutional, local, and regional conferences. In 2022 he was presented Iona's Brother Arthur A. Loftus Outstanding Student Research Award in recognition of his research work with students.

Dr. Gaines is passionate about helping students of all backgrounds to recognize and realize their own capability to do and enjoy mathematics, in spite of any previous attitudes they may have had. He does this by focusing on the problem-solving process, and by utilizing discovery-based learning, frequent participation and feedback, and group-based activities. He has worked to revise existing courses and to create new courses that emphasize active learning methods, which allows students to develop both a deeper appreciation for and better understanding of mathematics.

Dr. Gaines has a wide variety of research interests, which have extended far beyond his graduate work in toric geometry and mathematical physics. His current interests fall broadly into three main areas: combinatorial games, data analysis, and research on undergraduate mathematics education. In each of these he has striven to include students as collaborators. He currently has papers published, under review, and in preparation, which have all been co-authored with different students.

Dr. Gaines also considers service an important part of his role as an educator. Some of his roles at Iona have included co-organizer of the annual Scholars Day, moderator of the Math Honors Society, and member of various university committees including the Budget Committee, Faculty Senate, and Honors Council. Beyond Iona, he has been active in the MAA Metro NY section, serving as Vice-Chair for Four-Year Colleges, Co-coordinator of Metro NExT, and Speakers Bureau Chair. He also has given presentations on mathematical games to students and teachers from local high schools, helping them see the ways math can be used beyond what students are typically taught in class.

Dr. Gaines is honored to receive the MAA Metro NY 2024 Award for Distinguished Teaching, and he hopes to continue to help students at Iona and throughout the section to learn and appreciate mathematics for many years to come.

JANET LIOU-MARK STUDENT AWARD

TOBIAS HILD, ***United States Military Academy***

Tobias Hild is majoring in Applied Statistics and Data Science at the United States Military Academy. While at USMA, Tobias has focused his research efforts on data fusion with an emphasis on biometric security. His extracurricular efforts have included significant leadership responsibilities for the Sandhurst military skills competition as well as a semester abroad at the German Armed Forces University. Upon graduation this year, he will commission as a US Army Officer and serve as an Aeromedical Evacuation Officer (MEDEVAC Helicopter Pilot)

CONTRIBUTED PAPER SESSIONS

11:00 AM – 12:30 PM

RESEARCH SESSION: APPLIED MATHEMATICS

Presider: Dr. Johanna Franklin

11:00 a.m. **The Allure of Problem Solving!**
Satyanand Singh, New York City College of Technology

In this presentation, we illustrate a set of alluring problems with elementary solutions. They appeal to both students and faculty. These problems highlight the allure of mathematics, enhance learning, are engaging and provide connections to various branches of mathematics.

11:15 a.m. **Analyzing Calculus-Based Properties of Molecular Response Curves**
Christopher Bingman, United States Military Academy

The current practice to diagnose diabetes is to find the area under the curve (AUC) of a patient's glucose levels during an oral glucose tolerance test. There is little research, however, in exploring the shape of the response curve and its link to a diabetes diagnosis. This research investigates the link between a response curve's calculus parameters (inflection points, absolute and relative maxima and minima etc.) to identify another potential indictor for classifying and predicting the development of diabetes in a patient. Results suggest that when combining AUC after 240 minutes with the time of the inflection point after the maximum glucose level, and the glucose value at that inflection point yields the best prediction of developing diabetes over a 25-year time frame. In a sample of 501 patients, 150 were eventually diagnosed with diabetes. These calculus properties were analyzed and found to predict a total 131 correct diabetic diagnoses as opposed to only 14 predicted when only considering AUC after 240 minutes.

11:30 a.m. **Relative Periodicity of Empirical Audio Samples with Application to Dissonance Perception**
Anil Venkatesh, Adelphi University, and Linden Faye, Hofstra University

The concept of dissonance in music perception has been variously associated with the physical concepts of roughness, instability, and tension by appealing to a subjective cross-sensory analogy. This concept has also been marked by affective terms such as unpleasant and sad. For all the subjectivity around the term, it is noteworthy that non-musical test subjects in clinical experiments have produced remarkably consistent rank-orderings of musical sounds, according to the perceived dissonance of those sounds. Taking into account the numerous studies of this kind, the variety of plausible mathematical models, and the discovery of neuronal systems that are theoretically capable of realizing these models, it seems likely that consonance perception is influenced not only by convention and culture but by the psychoacoustics of tone perception. One of the leading theories of consonance perception is Stolzenburg's relative periodicity metric, which measures the extent to which the overtones produce a harmonic sound wave. This theory has only been demonstrated on pure sine waves and has yet to be applied to real audio samples. In this talk, we present and extension of the concept of relative periodicity to empirical audio signals, complete with non-rational frequency relationships, dozens of partials, and

inharmonicity. Our results lend support to relative periodicity as a mechanism of consonance perception while also underscoring some major flaws in this model.

11:45 a.m. **Dynamics of the charged Euler's three-body problem with a magnetic field**
Lise Augustin, Brooklyn College
Adviser: Dr. Diogo Pinhierio, Brooklyn College

We study the dynamics of a charged particle moving in a plane under the influence of two fixed centers and a magnetic field orthogonal to the plane of motion. Such a system can be written as a Hamiltonian system with two degrees of freedom. We employ confocal elliptic coordinates to prove that the system is completely integrable whenever the magnetic field is uniform. Furthermore, we provide numerical evidence for the existence of chaotic behavior in the case of a magnetic field with periodically oscillating magnitude.

RESEARCH SESSION: PURE MATHEMATICS

Presider: Dr. Brad Isaacson

11:00 a.m. **Reciprocity formulae for generalized Dedekind–Rademacher sums attached to three Dirichlet characters**
Brad Isaacson, New York City College of Technology

We define a three-character analogue of the generalized Dedekind–Rademacher sum introduced by Hall, Wilson and Zagier and state its reciprocity formula which contains all of the reciprocity formulas in the literature for generalized Dedekind–Rademacher sums attached (and not attached) to Dirichlet characters as special cases. We also review some of the generalized Dedekind–Rademacher sums in the literature to motivate our results.

11:15 a.m. **The Game of Cycles on Wheel Graphs**
Benjamin Gaines, Iona University

The Game of Cycles is a combinatorial game played on any simple connected planar graph, introduced by Su (2020). In recent years, there has been work done to determine which player has a winning strategy on various classes of boards (i.e. graphs), and how exactly that winning strategy can be played. In this talk I will describe the rules for the Game of Cycles, and share results obtained in joint work with Alessio Campione on which player has a winning strategy on some types of wheel graphs.

11:30 a.m. **Jet Spaces: from local to global deformations**
Andrew Stout, BMCC

Auto-arc spaces are a particular type of generalized jet space. The major advance in this work is obtained by considering auto-arc spaces of complete intersection varieties which allows us to begin to obtain some results for non-trivial deformations. For example, it is shown that the auto-arc space of a flat deformation $X_n \to \operatorname{Spec} k[t]/(t^{n+1})$ along $\operatorname{Spec} k[t]/(t^{n+1})$ can be viewed as a global flat deformation over $\mathbb{A}_k^n$ of the classical jet scheme of order n provided the base scheme X_0 is a complete intersection (or a locally complete intersection with vanishing obstruction). This is essentially a consequence of the Miracle of Flatness and a well-known result of Mustata on classical jet schemes of local complete intersections.

11:45 a.m. **Lucas Congruence for the Apéry Numbers Modulo p^2 Associated with $\zeta(2)$**
Najalia Singh, Hofstra University
Adviser: Eric Rowland, Hofstra University

Let p be a prime and let $A(n)$ be the sequence of Apéry numbers used by Apéry in his proof that $\zeta(3)$ is irrational. Gessel proved the Lucas Congruence $A(d+pn) \equiv A(d)A(n) mod p$ holds true for all n and for all base-p digits d. Moreover, Rowland, Yassawi, and Krattenthaler showed that this congruence holds true modulo p^2 for certain digits d. We have investigated the Apéry numbers associated with $\zeta(2)$ and discovered that the Lucas Congruence modulo p^2 holds true for certain digits d. Namely these digits satisfy a certain symmetry relation.

12:00 p.m. **Generalization of a Fixed-Point Theorem for Lipschitz Continuous Functions of a Compact Interval into Itself**
Robert Schutz, Consultant

It is well known that if f is a contraction function that maps the unit interval to itself then $|f(x) - f(y)| < K|x - y|$, where $K < 1$. Then successive iterations of $f(x)$ will converge to a fixed point X_f and $X_f = f(X_f)$. This can be generalized to any Lipschitz continuous function f so that if $|f(x) - f(y)| < K|x - y|$ for then if $K < \infty$ and K is the Lipschitz constant of f and X_0 the initial estimate, then the series of iterations $f(X_{n+1}) = X_n(1-\lambda) + \lambda f(X_n)$, where $\lambda = 1/(K+1)\}$ converges to a fixed point X_f . A short proof will be given and numerical examples to illustrate will be given.

RESEARCH SESSION: DATA SCIENCE AND MISCELLANEOUS

Presider: Dr. Boyan Kostadinov

11:00 a.m. **Use of Population Weighted Density Index for Coronavirus Spread in the U.S.**
Huseyin Yuce, New York City College of Technology

Understanding how population density affects the transmission of the coronavirus (COVID-19) become vitally important, since crowded cities were the epicenters for the disease. Human contact is the main cause of the spread of infectious diseases. Therefore, population weighted densities are a better measure than conventional densities, because the variation in density across the subareas matters more than the density in total area. This study investigates the impact of population weighted density and other demographics on the rate of COVID-19 spread in the U.S. Population weighted density index is the weighted average of density across the tracts, where tracts are weighted by population. Multivariate analysis has been used to determine the elasticity of the spread. Using U.S. County level data, we calculated the elasticity of Covid-19 spread with respect to population weighted density to be 0.085 after controlling for other factors. In addition to the density, the proportion of people over 65, the number of total health care workers, and average temperature in each county positively contributed to the case numbers, while education level and income per capita had a negative effect. For the spread, understanding the population characteristics and dynamics is as important as understanding the infectious disease itself. This will help policy makers to utilize and reallocate the resources more effectively. Our analysis suggests that population weighted density can be a useful tool to control and manage outbreaks, especially within the early stage of the spread.

11:15 a.m. **Data-Driven Pandemic Policy Analysis**

Hannah Stauss, New York City College of Technology
Adviser: Huseyin Yuce, New York City College of Technology

Our research analyzes the relationship between population-weighted density and the severity of COVID-19 on the county level for the United States through multivariate regression and graphical evidence. Studying the outbreak from January 2020 until daily reporting ceased in May 2023, we found that the relationship between weighted density and COVID-19 evolved over time, impacted by the dissemination of vaccinations, access to healthcare, and the widespread nature of the virus. In this talk, we present data-driven policy analysis of critical pandemic timeframes, policy efficacy on the state and national level, and the allocation of healthcare workers.

11:30 a.m. **Alleviating the Energy Crisis: A Novel Multi-Task Machine Learning Algorithm for Designing Efficient Nanocatalysts to Reduce Industrial Energy Impact**

Sophie D'Halleweyn, Bronx High School of Science
Adviser: Vladimir Shapovalov, Bronx High School of Science

In this project, I delineate a method for solving the scarcity of energy and cutting-edge microchip production supplies which were cut off from the US. Experts have been indicating peak oil has passed, and several recent global crises, including the war in Ukraine and the Covid-19 pandemic, have exacerbated an era of energy poverty. The White House has demonstrated commitment to bringing novel nanotechnology, specifically for the semiconductor chips, which are ingrained in the automotive, aerospace, and technology industries, where state-of-the-art production only exists overseas. I demonstrate a novel methodology in nanocatalyst and nanotechnology real-time characterization using a novel mathematical framework for machine learning algorithms. Previous research in machine learning applications to materials science did not have adapt-on-the-fly models to exploit the hidden patterns of the particular material dataset to meet adaptability requirements becoming increasingly critical as flexible manufacturing smart technology moves to the nanoscale. My multi-task algorithm for variational auto-encoding (MAVEN) creates a disentangled, interpretable latent space through my novel mathematical framework through novel loss functions and evaluation metrics. I demonstrate the power of this method through studying palladium nanoparticles, which are potent catalysts in industrial catalysis, batteries, and fuel cells. Results demonstrate algorithmic independence and real-time structural analysis, essential for efficient production. Furthermore, MAVEN's interpretable capabilities create insight into the nature of fine structure relationships in catalysts on a nanometer scale. MAVEN demonstrates efficacy in promoting a greener energy model which will bring advanced scientific and computational production back to the US.

11:45 a.m. **Synthesizing Tabular Data with Diffusion Models**

Mohammed Uddin, Hunter College
Adviser: Iordan Slavov, Hunter College

Privacy rules, access restrictions and scarcity of data are some of the reasons to search for methods to generate data with given statistical properties. Use cases include training data hungry models such as deep neural networks when real world data is not enough or creating a control group for hypotheses testing of interventions (medical, marketing etc.). Tabular data usually contains a mix of discrete and continuous columns which presents difficulties for some generative models. A large volume of modeling approaches already exists including copulas, simulations, and lately deep learning methods such as Variational Autoencoders and Generative Adversarial Networks. We compare the performance of a recently introduced generative method based on diffusion [FinDiff: T. Sattarov et.al. FinDiff: Diffusion Models for Financial Tabular Data Generation. (2023) ICAIF '23, Nov 27–29, 2023, NY, USA, 64-72] to other modeling approaches. FinDiff is benchmarked on several real-world datasets containing mixed type tabular data. Measures of model performance such as fidelity, utility and privacy are used in this analysis. All modeling is performed in PyTorch framework and evaluation metrics, and baseline algorithms are derived from the Synthetic Data Vault (SDV) Python package. As expected, overall, there is no model which is best for all tested datasets and across all measures, but FinDiff is superior in some cases

PEDAGOGY SESSION: MATHEMATICS EDUCATION

Presider: Dr. Shamita Dutta Gupta

11:00 a.m. **Experiential Learning in Mathematics**

Shamita Dutta Gupta, Pace University

Calculus is gatekeeper course to the STEM majors. Quite often we get a spectrum of students in class who are well prepared for the course all the way to those who make severe arithmetic mistakes impeding their progress in the course. To bring out the best in our students to help them to blossom into the roles of savvy math-oriented students, logical thinkers with strong analytic ability is a challenging task. In this talk we will discuss the effects of experiential learning in Calculus. We will discuss our experiential learning trip, its effect on morale and quality of work and measures taken to retain the mathematical content of the trip.

11:15 a.m. **Planning a Lesson for the Meaningful Learning of Mathematics**

Lioubov Pogorelova, NYU Tandon School of Engineering and Stern School of Business

The paper proposes lesson planning strategies that are grounded in the constructivist approach of "doing mathematics" for teachers. The guiding principle that informs these strategies is established through the relationship between mathematical knowledge for teachers (MKT) (Ball et al., 2009) and mathematical quality of instruction (MQI) (Hill et al., 2008). To facilitate exploration of mathematics, a structural framework is proposed through the juxtaposition of the two levels of the lesson planning process: (1) macro-dimensions that establish connections between goals (intentions) and activities (strategies) (Treffert-Thomas, 2015) and (2) micro-dimensions that incorporate elements of the Thinking Through a Lesson Protocol (TTLP) (Smith et al., 2008). The synthesis of macro- and micro-dimensions creates a unified lesson planning activity that guides lesson tasks and how they will be executed to facilitate meaningful learning at each stage of the goal-action macro-level approach to teaching mathematics.

11:30 a.m. **Online Homework Systems for OER Math Textbooks**

Reva Narasimhan, Kean University

In this presentation, we examine various online homework systems that complement freely accessible math textbooks. . There are many options available, and their costs range from free to a modest fee. Beyond cost, we will also compare their functionality, quality of content and coverage, and levels of support, so that instructors can make an informed decision about which system best suits their instructional needs.

11:45 a.m. **Empowering Mathematics Learning through OER at Hostos Community College: A Journey Toward Accessibility and Success**

Tanvir Prince, Hostos Community College, CUNY

At Hostos Community College, we observed that students often struggle to afford textbooks for mathematics courses. This affects their early success in these courses. To help, we started using Open Educational Resources (OER). We first created a free textbook section for MAT 100 (Introduction to College Mathematics). This was inspired by our college's earlier efforts with OER. We saw good results. So, we decided to use OER in more courses like Calculus III, Linear Algebra, and Differential Equations. We chose OpenStax for free textbooks and MyOpenMath for online homework. These resources

are free. They help students learn without the stress of paying for textbooks. OpenStax provides high-quality textbooks. MyOpenMath offers a good system for online homework. Together, they support our goal to make learning fair for all students. Looking ahead, we plan to try a new system for Calculus III in Fall 2024. We will use a D2L course cartridge from OpenStax. We want to see if it helps students learn better and get more involved in their studies. We believe using OER can make a big difference. It can make learning easier and fairer. It can help students succeed without worrying about the cost of textbooks. We want to talk more about this and work together to improve education with OER.

12:00 p.m. **Math Education in The Frozen Land: A Case Study of Political Influence and Societal Goals**

JungHang Lee, Hostos Community College

This study challenges the notion of mathematics education as a politically and socially neutral subject by examining its implementation in North Korea, one of the most closed countries in the world. North Korean secondary school mathematics education serves as an extreme example of education driven by political objectives, specifically aimed at fostering individuals who will perpetuate the socialist revolution. Unlike traditional approaches that prioritize individual learning, North Korean mathematics education emphasizes collective societal goals. Through in-depth interviews with defectors, former mathematics teachers, and students from North Korea, this research investigates the lived experiences of individuals within the North Korean education system. The influence of the Workers' Party on mathematics education is analyzed, highlighting the intertwining of political and ideological factors. This presentation aims to provide insights into the extreme case of mathematics education in North Korea, shedding light on its political and ideological underpinnings. Additionally, it seeks to broaden the understanding of mathematics education as a dynamic entity shaped by both its context and the individuals involved, inviting participants to reflect on their own educational experiences with a wider perspective.

SUDENT/FACULTY SESSION

Presider Dr. Emad Alfar

11:00 a.m. **Min-base Conditions for Various Palindromic Representations**

Avraham Alaev, CUNY Macaulay Honors College at Hunter College
Adviser: Ariane Masuda, New York City College of Technology

We consider a positive integer N written in base b, that is, $N = \sum_{i=0}^{k} c_i b^i$, where $0 \le c_i < b$ and $c_k \neq 0$. If $c_i = c_{k-i}$ for $i = 0,1,\ldots,\lfloor k/2 \rfloor$, then N is said to be palindromic in base b. The smallest such base is called min-base. In this paper, we focus on the patterns and conditions for which min-base occurs in various palindromic representations for powers of two, following Kreher and Stinson's recent work.

11:15 a.m. **Chaotic Dynamical Systems**

Elma Kastrat, New York City College of Technology
Adviser: Satyanand Singh, New York City College of Technology

In our study, we conduct a comprehensive examination of dynamical systems, focusing on the intricate behavior of orbits and their significant applications within various industrial sectors. By analyzing a diverse array of examples, our research aims to elucidate the fundamental principles governing these systems and demonstrate their practical utility in addressing complex challenges in industry. This investigation not only deepens our understanding of the theoretical underpinnings of dynamical systems but also highlights their versatility and effectiveness in real-world applications, thereby offering valuable insights for both academic research and industrial innovation.

11:30 a.m. **Progress on the Erdos-Straus Conjecture Using Congruence Classes**

Hannah Bahn, Saint Ann's School
Adviser: Nick Fiori, Saint Ann's School

The Erdös-Straus Conjecture is rooted in the Ancient Egyptian method of expressing numbers, where every positive rational number could be written as a finite sum of distinct unit fractions. For example, $\frac{4}{5}$ could be written as $\frac{1}{5}+\frac{1}{10}+\frac{1}{2}$. The Conjecture states that for every integer n greater than 2, there exist positive integers x, y, z so that $\frac{4}{n}=\frac{1}{x}+\frac{1}{y}+\frac{1}{z}$ ($\frac{4}{n}$ can always be written as the sum of three unit fractions). The three unit fractions do not have to be distinct. Because of the form of $\frac{4}{n}$, I will attempt to prove the conjecture by splitting it into different cases where $n \equiv 0,1,2,3 \pmod 4$. I will eventually examine the conjecture modulo 8 and modulo 24.

CONTRIBUTED POSTER SESSION

12:35 PM – 1:25 PM

MISCELLANEOUS RESEARCH

Supervisor: Dr. Benjamin Gaines

Crossing Probability in Uniform Random Triangulation

Kexin Zhang, New York University
Adviser: Nina Holden, New York University

Think of an infinite random triangulation (a planar graph such that each face has degree 3). We randomly select a vertex on it and call it v. We do a site percolation on it at the critical probability, meaning that we color each vertex with blue or red with probability 1/2. It is known that the probability that there exists a cluster (a simple path of the same color) in such a triangulation will be around $R^{-5/32}$, where R is the radius of a circle centered at v, but the expectation of this crossing probability will be around $R^{-1/8}$. That means the probability distribution of the crossing probability will have a long tail, and we want to have a better understanding of such distribution. We will consider the method from the paper "Critical exponents for two-dimensional percolation" such that we break the uniform random triangulation into a countable union of the disjoint annulus through a "peeling process", and we consider the probability of having a two-arm crossing in each disjoint annulus and identifying the percolation with a type of random curve called Schramm-Loewner Evolution with parameter 6. Our approximation will also be based on the results from the paper "Convergence of uniform triangulations under Cardy embedding".

Numbers in the Wild: Using Benford's Law to teach Chi-Squared Goodness of Fit

Anna Tucker, Department of Mathematical Sciences, United States Military Academy

The Newcomb-Benford's Law, recently popularized in pop culture, has drawn lots of interest and been a great teaching aide in my classroom. Early on, when we are learning about the two-sample t-test, students investigate if there is a statistically significant difference in the number of Facebook friends of male students compared to female students. Students are asked, if they were to fabricate a dataset of Facebook friends for students, how they might choose to go about it. We then introduce the Newcomb-Benford's Law and that we expect the first digits of the number of friends to behave. We continue to stoke interest in this phenomenon by discussing the surprising applications of Newcomb-Benford's Law and how it has even been used to prosecute fraud. Later in the semester, when we cover the Chi-squared Goodness of Fit test, we return to the same example and show how we can test for a Chi-squared Goodness of Fit test to identify fabricated data.

Multimodal Authentication for Increase Security and Accuracy

Tobias Hild, United States Military Academy
Adviser: Mike Powell, United States Military Academy

Multimodal authentication offers the possibility of going beyond the current standard of facial identification as a method of authentication. Currently implemented approaches relying solely on unique features of individuals' faces are vulnerable to presentation and replay attacks. Current research in lip-based biometric authentication seeks to provide additional security against these types of attacks by using Siamese neural networks that additionally consider speech content to distinguish between users. We propose a multimodal authentication system that utilizes facial recognition, automatic speech verification (ASV), automatic speech recognition (ASR), and a custom loss function comparing audio signal to face movement. This system provides security against replay attacks by requiring a new, randomly generated password for every authentication attempt. It also addresses presentation attacks by considering both audio and facial identification features of the input and through the audio-video comparison function. Using the GRID audio-visual speech corpus, we find that a multimodal authentication system provides improved security against presentation and replay attacks as well as against misidentification when compared to any single mode of authentication.

Earth's initial cooling considering the present inner core and upper mantle

Teresa Pathadan, Bronx High School of Science
Adviser: Vladimir Shapovalov, Bronx High School of Science

Extending from the first tectonic movement in the Pilbara Craton in Western Australia, dating 3.2 billion years, our understanding of the Earth's history has developed to the point where current insight is easily integrated with past studies with the leverage of computation tools. However, understanding the Earth's geological evolution is a multifaceted challenge that involves identifying key parameters, including the radius of the inner core, the temperature of the upper mantle, and radioactivity, all factors that influence Earth's cooling processes. With the use of Python to aide in modeling heat content, conductive heat transport, and radioactive heat production, first order differential equations can be used to investigate the thermal origins of the Earth, which a specific focus on determining the state of temperature in the core in relation to currently known parameters of planetary temperature and spatial measurements. By employing various numerical simulations with varying degrees of parametric measurements and isolation, this study aims to model statistics from billions of years ago, if efforts to "match" them to generally accepted measurements given the context of conservation of energy and interpretation in terms of heat reservoirs and fluxes in Earth's interior. By determining optimal bounds for these parameters within the Python framework, the research enhances the accuracy of the models. This additionally serves as a threshold for broader implications of the Earth's geophysical characteristics including seismic data and magnetic field variations. Such interdisciplinary nature integrates geophysics and computational modeling for a comprehensive investigation of Earth's geological origin and evolution.

Fibonacci Analogues of Legendre's Formula and Fine's Theorem

Arav Chand
Adviser: Eric Rowland, Hofstra University

Legendre's Formula and Fine's Theorem use number theory to analyze combinatorics functions. Legendre's formula finds the exponent of a prime p dividing the factorial of any integer n. Fine's Theorem quickly finds the number of binomial coefficients that are not divisible by a prime p. Investigating the Fibonorial, a generalized form of the factorial based on the Fibonacci sequence, this research derives Fibonacci-analogues of Legendre's Formula and Fine's Theorem for Fibonorial/Fibonomial coefficients, which previously only analyzed the factorial/binomial coefficients. The study builds on Lengyel's Theorem regarding the relationship between the exponent of prime p dividing an integer n and dividing the nth Fibonacci number. A novel Fibonorial Legendre's Formula for the exponent of p dividing the nth Fibonorial was thus developed and proved. Additionally, employing the computational software system Mathematica, programs were designed for brute-force generation of the values of the analogous Fine's theorem. Identifying patterns within the lists of values generated, a conjectured Fibonomial Fine's Theorem was proposed and subsequently proven using a correspondence argument and the developed analogous Fibonorial Legendre's Formula. The research successfully derived a formula for the exponent of p dividing the nth Fibonorial and a validated formula for Fibonomial coefficients, expanding upon existing mathematical frameworks. This study contributes to understanding Fibonorial structures and their mathematical properties. Future work may extend to other factorial generalizations, related combinatorial problems, and explore broader applications in the increased computational efficiency of my formulae, tilings, and findings in nature.

CitiBike Exploratory Analysis

Tevin Parboosingh, Iona University
Adviser: Benjamin Gaines, Iona University

We aim to investigate the behavior, trends, and characteristics of both casual riders and members of CitiBike in order to inform data-driven marketing strategies that could convert more casual riders to members. The dataset was manipulated using Python to create data and geospatial visualizations. Results showed that casual riders tend to ride for longer distances and durations than members, and the two types of riders use bikes for different purposes. For instance, we analyzed differences in what days people rode, what times they rode, and what the top five starting and ending stations were. We conclude with thoughts on how CitiBike could capitalize on the advantage of biking as a faster mode of transportation in Manhattan.

Planning a Lesson for the Meaningful Learning of Mathematics

Lioubov Pogorelova, NYU Tandon School of Engineering and Stern School of Business

The paper proposes lesson planning strategies that are grounded in the constructivist approach of "doing mathematics" for teachers. The guiding principle that informs these strategies is established through the relationship between mathematical knowledge for teachers (MKT) (Ball et al., 2009) and mathematical quality of instruction (MQI) (Hill et al., 2008). To facilitate exploration of mathematics, a structural framework is proposed through the juxtaposition of the two levels of the lesson planning process: (1) macro-dimensions that establish connections between goals (intentions) and activities (strategies) (Treffert-Thomas, 2015) and (2) micro-dimensions that incorporate elements of the Thinking Through a Lesson Protocol (TTLP) (Smith et al., 2008). The synthesis of macro- and micro-dimensions creates a unified lesson planning activity that guides lesson tasks and how they will be executed to facilitate meaningful learning at each stage of the goal-action macro-level approach to teaching mathematics.

Synthesizing Tabular Data with Diffusion Models

Mohammed Uddin, Hunter College
Adviser: Iordan Slavov, Hunter College

Privacy rules, access restrictions and scarcity of data are some of the reasons to search for methods to generate data with given statistical properties. Use cases include training data hungry models such as deep neural networks when real world data is not enough or creating a control group for hypotheses testing of interventions (medical, marketing etc.). Tabular data usually contains a mix of discrete and continuous columns which presents difficulties for some generative models. A large volume of modeling approaches already exists including copulas, simulations, and lately deep learning methods such as Variational Autoencoders and Generative Adversarial Networks. We compare the performance of a recently introduced generative method based on diffusion [FinDiff: T. Sattarov et.al. FinDiff: Diffusion Models for Financial Tabular Data Generation. (2023) ICAIF '23, Nov 27–29, 2023, NY, USA, 64-72] to other modeling approaches. FinDiff is benchmarked on several real-world datasets containing mixed type tabular data. Measures of model performance such as fidelity, utility and privacy are used in this analysis. All modeling is performed in PyTorch framework and evaluation metrics, and baseline algorithms are derived from the Synthetic Data Vault (SDV) Python package. As expected, overall, there is no model which is best for all tested datasets and across all measures, but FinDiff is superior in some cases.

SIR Model for Infectious Diseases

Evan Hayes, Sean Burns, Khadia Jenkins, Geneve Carbajal, Farmingdale State College
Adviser: Chunhui Yu, Farmingdale State College

A differential equations system known as the SIR model is frequently used to analyze the transmission of infectious illnesses. This model divides the population into three categories: susceptible, infected, and removed. In this study we use Matlab Software to simulate infectious rates of historical infectious diseases. We compare our model simulations to historical data of the Hong Kong Flu in 1968, and COVID-19 data from Pinellas Florida and Rockland New York in 2020.

Optimizing the k-Nearest Neighbors Algorithm for Bank Churn Prediction

Sonia Akakpo, Patrick Dambra, Rachell Paz, Timothy Smyth, Farmingdale State College
Adviser: Chunhui Yu, Farmingdale State College

Bank churn occurs when customers switch from one bank to another. Although some customer loss is unavoidable, banks must avoid voluntary churn as it is easier and cheaper to keep an existing customer than gain a new one. On average, it costs a bank roughly $500.00 to recruit new members. In our paper, we train and optimize a machine learning algorithm, specifically a k-nearest neighbors algorithm (KNN), to predict whether or not a customer will leave the bank using existing demographic and financial information. By giving banks a reliable method for predicting whether or not a customer will churn, they can prioritize certain groups to increase retention rates. Our experiment uses a dataset taken from Kaggle. We compare the accuracy of our algorithm to other types of machine learning algorithms. The experiment compares our optimized KNN algorithm to random forest and logistic regression models. Our paper aims to increase the accuracy of the k-nearest neighbor algorithm by optimizing the k value used in our model. Our optimization technique includes ranking and weighing the most important attributes, and utilizing k-folds cross-validation. After optimizing this model, we can input a single customer's data to predict with 82% accuracy whether or not the customer will churn.

Analyzing Performance of Equity Index Universal Life Insurance with Dynamic Stochastic Models

Valentina Colon, Darren Dawson, Sabrina D'Aulisa, Farmingdale State College
Adviser: Chunhui Yu, Farmingdale State College

In this project, we will analyze the cash flow, return and risk, protection value, and tax advantages of equity-based index universal life insurance, both as a life insurance policy and as an investment vehicle. Most of the current literature and business reviews on this topic are simply based on historical data like the S&P 500 index. We plan to do comparisons not only based on historical data but also with dynamic stochastic models. We also will do a case study comparing the S&P

500 investment fund to the equity-based indexed universal life insurance. Classical statistical methods like Monte Carlo simulation will be implemented. Using the Monte Carlo simulation, we will predict future values to calculate whether investing in the S&P 500 or purchasing an Indexed Universal Life is better by trying to find out which option maximizes return. Analyzing possible outcomes allows us to see the advantages and disadvantages of investing in the S&P 500 as well as the Indexed Universal Life Insurance Policy.

Variables Impacting Traffic Citations in New York City

Chanelle Russell, Dahiana Garcia, St. Thomas Aquinas College
Adviser: Andrew Lee, St. Thomas Aquinas College

This project delves into the multifaceted dynamics influencing the issuance of traffic tickets in Manhattan, focusing on income levels and English proficiency as primary variables. This is done with the use of data from NYC open data and US Census data and manipulated with the RStudio platform. The investigation examines whether higher income correlates with increased citations due to greater financial capacity for payment, or conversely, if lower-income areas witness higher citation rates. Additionally, it explores whether individuals with lower English proficiency face higher citation rates, potentially stemming from difficulties in interpreting signage or communicating with law enforcement. Visual representations include an analysis of ticket distribution overlaid with shades indicating concentrations of public assistance recipients. The study raises critical questions regarding the underlying purposes of traffic tickets, positing punitive measures, traffic management, and revenue generation as primary motives. Through this research, we aim to elucidate the intricate interplay between socioeconomic factors, language proficiency, and law enforcement practices in shaping traffic citation trends in Manhattan.

Food Deserts in NY State

Holger Sanchez, Olivia Gaillard, St Thomas Aquinas College
Adviser: Andrew Lee, St. Thomas Aquinas College

Our project studies low food access in New York state. This means being more than 1/2 mile from a grocery store if you are in an urban area, or 10 miles if you are in a rural area. We analyze this data using statistical tools (ANOVA and geospatial imaging) in the R programming language to understand why this occurs. We are also investigating how circumstances like income, poverty rate, and SNAP benefits affect food access using US Census data. With all this data we will analyze each map and explain the possible factors that come into play to have a better understanding of this phenomenon.

Worth a Shot? A Mathematical Model for Dual Vaccination

Shelby Brage, Queensborough Community College
Adviser: Susana Pinheiro, Queensborough Community College

The summer of 2023 saw a 21.6% increase in weekly COVID-19 hospitalizations nationwide, yet again stretching hospitals beyond their capacities and sparking natural fears around future outbreaks. Two pathogens circulating simultaneously and spreading so easily through the air is cause for alarm; surges in hospitalizations from SARS-CoV-2 and influenza infections take valuable resources away from critically ill patients who need them. While vaccines are one of the tools available to protect against severe outcomes, staggering gaps still exist in the research around vaccination against SARS-CoV-2 (the virus that causes COVID-19), and its impact as it circulates amongst other seasonal respiratory viruses like influenza. The aim of this work is to understand the interaction between two such diseases for which vaccination is available. To this end, we adapt an SIR model to include two co-circulating pathogens with vaccination. We start by finding the basic reproduction numbers for the two co-circulating pathogens, using the next generation method, and then use numerical simulations to explore the multiple equilibria of such system and the corresponding stability.

Employing Transfer Learning for PINNS

Moses Molina, Hunter College
Adviser: Iordan Slavov, Hunter College

Physics Informed Neural Networks (PINNS) have emerged as a potential tool for solving stiff ordinary differential equations (ODEs) and nonlinear partial differential equations (PDEs). Since PINNS in theory can reduce the computational costs inherent with other ODE and PDE solvers, we hope to improve on that. This work attempts to leverage the application of transfer learning on a collection of similar stiff ODEs and nonlinear PDEs in order to further reduce the computational costs of having to build a neural network model for each of these differential equations. The efficacy of this transfer learning is assessed on a range of sample problems which include stiff ODEs and nonlinear PDEs. Our results indicate that transfer learning can significantly reduce the training time to achieve solutions. Overall, this work demonstrates the potential of transfer learning in PINNS to accelerate and improve the accuracy of PINNS especially when attempting to use them to solve stiff ODEs, and nonlinear PDEs.

Studying African Great Lakes Water Temperature Variabilities using Remote Sensing Observations

Qing Chen, Amadou Diallo, New York City College of Technology
Adviser: Dr. Abdou Bah, Dr. Reginald Blake, Dr. Hamid Norouzi, New York City College of Technology

Lakes are essential components of Earth's ecosystems, regulating climate, supporting biodiversity, and sustaining human activities. However, the warming climate poses a grave threat to these fragile aquatic ecosystems. Understanding the impact of climate change on lake surface water temperatures (LSWT) is crucial for effective conservation efforts. In this research, we explore the changes of LSWT and the surrounding land surface temperature (LST) within the African Great Lakes region, utilizing level 3 daily data of land surface temperature and emissivity (MYD11A1) acquired from the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Aqua satellite. By comparing land and lake surface temperatures, we uncover significant correlations (r= 0.99 for Lake Malawi, r=0.89 for Lake Tanganyika, r=0.73 for Lake Victoria), highlighting the interconnectedness of terrestrial and aquatic environments. Over the last 21 years, we found that both Lake Malawi and Tanganyika surface water temperature has been warming, respectively, by about 0.5 K/Decade while Lake Victoria LSWT has been cooling by -1.25 K/Decade. This study contributes crucial insights for predicting the future of Africa Great Lakes marking an essential first step before identifying the drivers behind these changes.

The Social Impact of Urban Heat Islands in New York City

Dan Hong Chen, Mary Zaradich, New York City College of Technology
Adviser: Dr. Reginald Blake, Dr. Hamid Norouzi, New York City College of Technology

While the negative human health impacts of Urban Heat Islands (UHIs) are known and well documented, there is still little research that covers the sociological impacts of UHIs on communities that experience these heightened surface temperatures. Urban Heat Islands are also more likely to occur in historically redlined areas, meaning that communities composed of people of color and low-income members are disproportionately affected by UHIs. This study aims to uncover the effect of UHIs on these communities and their performance in various sociological areas, including crime, education, and sociopolitical engagement. We plan to use GIS mapping software to expose these connections between heightened urban heat and its social impact on these neighborhoods.

Advances in Remote Sensing Estimation of Secchi Disk

Johanna Rhyins, Hunter College; Carolina Perez, Bronx Community College;
Adviser: Dr. Marzieh Azarderakhsh, New York City College of Technology

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 the water quality of lakes. Chlorophyll-a (Chl-a) concentration can be a strong proxy of lake water quality and trophic state.

Therefore, many efforts are put into measuring and predicting the Chl-a concentration. The ground-based data collection for lakes is limited to only a few points and the majority are only monitored once per year. 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 small New York state lakes is far from guaranteed. In this study project, we aim to deploy machine learning techniques into ground based and satellite to estimate and predict water quality parameters. Strong background in python programing and or Geographical Information System (GIS) is essential.

Integrative Radioactive Waste Management

Jose Marte Perez, Husnain Khan, New York City College of Technology
Adviser: Dr. Masato Nakamura, New York City College of Technology

One of the most concerning issues in consumer-based societies is waste management. It is natural that as societies increase in population, wealth, and the demand for services, waste will increase as a byproduct. We are investigating how we can use and maintain different forms of energy to power smart cities. Based on the preliminary research, one of the greatest obstacles in environmental science is dealing with radioactive waste, as nuclear energy becomes more viable. The over-reliance on water resources to do so, and the increased possibilities of drought pose a great danger to life on earth. With a combination of new and old strategies, we can work with energy (heat), to produce outcomes that allow for the viability of life on earth. Particularly in presenting ways in which radioactive materials can be isolated and used to enhance soils. Of course, there is much more to be researched but for now, it is important to study the different effects of radioactive substances on the environment.

A New Dimension in Urban Climate Modeling: LiDAR and Generative AI Quantifying Greenspace

Ethan Peters, New York City College of Technology
Adviser: Dr. Patricia Medina, Dr. Reginald Blake, Dr. Hamid Norouzi, New York City College of Technology

Urbanization has triggered adverse microenvironment changes, materialized through the Urban Heat Island (UHI) effect and the deterioration of air quality. Greenspaces have become an important area of research due to the various ecological services they provide. This research explores the interplay between urban greenspace and these urban microclimate phenomena by creating a method to accurately quantify the three-dimensional (3D) aspects of urban greenspace in order to gain deeper insights into their impact. We selected Prospect Park in Brooklyn, New York, for our investigation due to its extensive field-measured tree forestry data. Our goal was to construct a detailed 3D model of tree crowns in Prospect Park leveraging LiDAR (Light Detection and Ranging) data available through NY Discover GIS Data application. Geometric-based classification algorithms combined with tree segmentation algorithms were used to segment and delineate trees from the LiDAR capture (Brodu & Laguem, 2012; Li et al., 2023). Generative A.I. was utilized to reconstruct tree canopies in order to estimate tree crown volume (Bryson et al, 2023). This improvement enabled us to gain a more precise understanding of vegetation distribution and structure in Prospect Park. The developed model can be extended to other urban parks, facilitating a comprehensive assessment of their ecological services. Our approach improved upon traditional satellite remote sensing, which lacks the necessary resolution to describe detailed tree crown structures. Additionally, while field surveys provide valuable data, they can be time-consuming and expensive. Our model enhanced the accuracy and efficiency of mapping tree crowns in urban green spaces. This approach provided us with a more precise understanding of the distribution and structure of vegetation within Prospect Park, and also generated a valuable new dataset that can be integrated into air purification and Urban Heat Island (UHI) models. This dataset can inform and improve decisions related to the preservation, management, and future design of urban greenspaces, ensuring their continued enhancement and optimization.

Assessment of Inland Lake Watercolor and Dissolved Organic Content via Satellite-Based Machine Learning

Aisha Malik, Hunter College
Adviser: Dr. Marzieh Azarderakhsh, New York City College of Technology

In the 21st century, climate change stands as a formidable threat to New York State's (NYS) natural resources, including over 3000 lakes and their watersheds. The lakes within the Adirondack Park have benefited from strict land use laws due to the Clean Air Act to control the anthropogenic impacts on the lakes' health. In the late 1990s, the Adirondack Lake Assessment Program (ALAP) took extensive field data including water chemistry to better understand the health of more than 150 represented lakes to monitor lake recovery from road salting. The impact of climate change and anthropogenic activity raises concerns about algal blooms, rising temperatures, aquatic habitats, and other threats to the lake ecosystem. However, there remains a significant data gap in monitoring beyond the selected lakes. In this study, the spatial and temporal patterns of water chemistry data are explored by leveraging current and long-term monitoring programs, and by integrating satellite remote sensing imagery to inform future research on watercolor change as an indicator of water quality beyond the selected sampling lakes through the Survey of Climate change and Adirondack Lake Ecosystems (SCALE) Pilot Program. The ALAP dataset, with sampling since 1998, is compiled for the 150 lakes, and Dissolved Organic Content (DOC) and Colored Dissolved Organic Matter (CDOM) are selected for comparison with several empirical algorithms using satellite observations. Surface reflectance data from Sentinel-2 satellite is used to compile a 7-year record to test several existing empirical algorithms as well as machine learning models to investigate the capabilities of satellites in understanding the water quality dynamics in lakes within the Adirondacks by validating trends with the existing field data. While many studies develop predictive relationships between remotely sensed surface reflectance and water parameters, these relationships are often limited to a specific geographic region and have little applicability in other areas. To remotely monitor DOC, region-based relationships must be developed. The preliminary data analysis of several algorithms does not show a strong correlation for the represented ALAP lakes. However, they exhibit consistent long-term trends from 2016-2023 using Sentinel-2 surface reflectance data, suggesting lake color change in several sampled lakes. Since different empirical algorithms performed differently for various lakes, a machine-learning approach that can learn the complex relation between the inputs and data types is applied. Several machine-learning techniques, including boosting and bagging, are employed to estimate DOC using different input features from satellite surface reflectance data. The model utilizes 70% of the data from each lake selected for training and 30% for testing performance. To find the best-performing model, we examined the impact of lake classification, atmospheric correction algorithms, and lake water depth on the model's performance. This analysis is performed on an openly accessible Python script on the Google Earth Engine Platform for processing cloud-based publicly available satellite observation data, and will allow the determination of DOC, CDOM, and water-color relationships over various lakes while also studying the impact of climate change within the larger Adirondack region.

Utilizing Land Surface Data for Air Temperature Prediction in Urban Regions through Machine Learning

Taseen Islam, CUNY Macaulay Honors College; Jacqueline Ashley Grey, NASA
Adviser: Dr. Hamid Norouzi, Dr. Reginald Blake, New York City College of Technology

Accurately forecasting air temperature is vital for gaining insights into atmospheric phenomena. However, the limited availability of air temperature data presents significant challenges for conducting comprehensive analyses and predictions. While land surface temperature (LST) and air temperature are often shown to be correlated, data for the latter is not as readily accessible as LST data, making integrated analysis and forecasting difficult. NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) satellite provides continuous global coverage of LST data. However, Automated Surface Observing Systems (ASOS) weather stations that capture air temperature data are only available at specific points, creating a lack of data between ASOS stations where only MODIS data is available, especially in urban areas. A supervised machine learning model was developed using the K-Nearest-Neighbors (KNN) regression algorithm to model air temperature trends and predict air temperature values when given land surface data from the MODIS satellite. 227 weather stations spanning multiple cities across 125 countries around the world were randomly selected. LST data was obtained from

MODIS observations at 1 km resolution at the weather station locations. The model effectively utilizes LST data from both Terra and Aqua MODIS satellites, considering both day and night observations, in conjunction with Normalized Difference Vegetation Index (NDVI) data from Terra and Aqua to produce air temperature value predictions. It performs with an average accuracy of 85%, RMSE of 4.27 °C, and a median absolute error of 3.11 °C. Notably, this model excels in accurately predicting and modeling air temperature data not only for the United States but also for other nations. It even has the capability to predict air temperature in regions lacking ASOS air temperature data, thereby bridging data gaps. This unique capability opens up new avenues for generating comprehensive air temperature forecasts for urban regions with heterogeneous land cover types. The model has the potential to continue predicting future air temperature trends and values across the world, fill in gaps in data, and provide spatial heat maps of air temperature estimates to create a more comprehensive understanding of air temperature in urban settings.

From Wealth to Wellbeing: Air Quality Analysis of Santa Cruz with Dharavi, Poverty-Stricken Neighborhood

Yeshi Dolma, New York City College of Technology
Adviser: Dr. Brian Vant-Hull, City College of New York

The National Science Foundation (NSF) funded a 3-year project to conduct micro-level investigations of pollution in Mumbai and New Delhi, India. The first set of data was collected in December 2022 – January 2023 by 13 students selected across City University of New York (CUNY) institutions. The primary focus of this research was to conduct a comparative micro-level analysis of particle count distributions between Dharavi (slum) and an upper-middle-class area (Santa Cruz). These students were equipped with mobile backpacks that have sensors to collect particulate loading and gas concentrations. We examine daily variations in average pollution levels by matching pollution histograms to sources and performing pattern analysis. Visual representation, such as plotting route averages and daily variations of average pollution levels, is used to investigate the relationship between air pollution and meteorological factors like wind and boundary layer height. An analysis was conducted to compare surface aerosol optical depth and satellite aerosol optical depth with respect to boundary layer height. Linear regression is used to extract variations in urban temperature as a function of vegetation and building spacing averages for specific days. The finding of this research demonstrates that wealthy neighborhoods like Santa Cruz typically enjoy better air quality due to investments in green spaces and pollution-reducing infrastructure while poor communities like Dharavi experience a disproportionate burden of pollution from industrial facilities and lack of green spaces, leading to adverse health effects and reduced quality of life. Access to clean air is a fundamental right, but socioeconomic factors often result in significant disparities in air quality between poor and wealthy neighborhoods. The endeavors of this project will lay the groundwork for the upcoming data collection field campaign and will provide valuable insights into the complex interplay of environmental factors, socioeconomic disparities, and their impact on the health and well-being of urban populations in Mumbai.

Weather Analysis and Visualization for Everyone (WAVE)

Kester Todd, Arhum Aamir, NYC College of Technology; Richard Rivera, City College of New York
Adviser: Dr. Reza Khanbilvardi, City College of New York

Research shows NYC coastlines are under serious risk of inundation (~2 mm) in the near future. As climate change continues to cause sea level rise (~3mm), NYC shorelines are becoming more exposed to major coastal flooding. The sea level rise, combined with the accelerated land subsidence rates caused by the weight of NYC skyscrapers leaves many coastal communities at risk. As such, Project W.A.V.E aims to bridge the gap between disadvantaged communities and their access to coastal flooding information. The purpose of this research is to inform NYC coastal communities of impending threats regarding sinkage and sea level rise. The goal is to answer: "How can we combine the impacts of sea level rise, land elevation and ground subsidence rates to display future floodplain maps in a format accessible to the general public?" The project's first phase involves obtaining and analyzing climatic, geological, and hydrological data from between 1950 and 2023 to predict flooding trends in NYC for 2050 and 2100. The second phase involves using GIS to combine InSAR data for land subsidence, a digital elevation model of NYC, and sea level rise estimates to visualize new flood zone projections. In the concluding phase, the projection models will be made available to the public. Due to the

additional subsidence from the weight of NYC buildings, our predictive models for 2050 and 2100 showed that there were more areas flooded than anticipated. The areas most affected are lower Manhattan, the Jamaica Bay area, Western Queens and parts of Eastern Staten Island. Future studies will involve collaborating with other scientists to measure how additional factors contribute to coastal flooding in New York City and methods of prevention.

Assessing Materials for Potential Use in Hydrogen Gas Storage.

Safia Abdemeziem, New York City College of Technology (City Tech)
Adviser: Dr. Diana Samaroo, Akash Kumar Burolia, Dr. Urmi Duttagupta, Dr. Swati Neogi, City Tech

The potential use of hydrogen as an energy source is very promising because of several advantages. It is considered a clean, abundant, and energy-efficient resource, with a wide range of energy applications. However, to make it a viable option, efficient hydrogen storage is important. The purpose of this research was to evaluate high-density polyethylene (HDPE) and polyamide6 (PA6) as potential materials for hydrogen gas storage, particularly in Type IV hydrogen storage vessels utilizing polymer liners. The research involved conducting a hydrogen permeation test to assess the ability of HDPE and PA6 to allow the passage of hydrogen gas. The experiment utilized a setup with a lower chamber for vacuum creation and an upper chamber for hydrogen introduction. The materials were placed in the permeation cell. The experiment was performed at room temperature with pressure ranging from 0 to 50 bar. Data were collected using a Data Logger, and permeabilities were calculated. The results indicated that PA6 exhibits a lower permeability compared to HDPE, suggesting its superior suitability as a polymer liner for Type IV hydrogen storage vessels. These findings support existing research on the hydrogen permeability of liner materials, highlighting that PA6 demonstrates higher barrier properties compared to high-density polyethylene (HDPE) due to differences in their chemical structures.

Generalization of a Fixed-Point Theorem for Lipschitz Continuous Functions of a Compact interval into itself

Robert Schutz, Consultant

It is well known that if f is a contraction function that maps the unit interval to itself then $|f(x) - f(y)| < K|x - y|$, where $K < 1$. Then successive iterations of $f(x)$ will converge to a fixed point X_f and $X_f = f(X_f)$. This can be generalized to any Lipschitz continuous function f so that if $|f(x) - f(y)| < K|x - y|$ for then if $K < \infty$ and K is the Lipschitz constant of f and X_0 the initial estimate, then the series of iterations $f(X_{n+1}) = X_n(1 - \lambda) + \lambda f(X_n)$, where $\lambda = 1/(K + 1)\}$ converges to a fixed point X_f . A short proof will be given and numerical examples to illustrate will be given.

Congressional District Standouts: Polsby Popper

Joshua Ashie, Ricardo Gonzalez, St. Thomas Aquinas College
Adviser: Andrew Lee, St. Thomas Aquinas College

Polsby Popper score is a measurement calculated by taking the ratio of the area of a district to a circle whose circumference matches the district's perimeter. Investigating these findings allows us to analyze the districts' geographical characteristics and the impartiality of redistricting in the United States of America.

On Quotients of a More General Theorem of Wilson

Ivan Morozov, The City College of New York

This work investigates integer and non–integer quotients of a slightly stronger corollary of Wilson's theorem and many of their properties. Sums, products, modular equivalences, and generating functions are discussed

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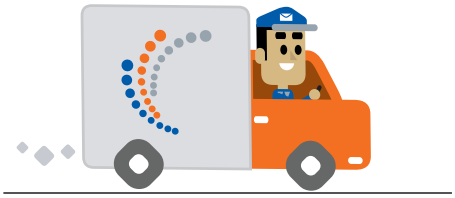

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