WIMIN 2023 - Abstracts of Student Talks

Morning Talks

Topology - Burton 209

11:15 am - 11:30 am: Political Structures and the Topology of Hypergraphs

Speaker: Zixu Wang (Wellesley College)

Abstract: My research employs hypergraphs to model political structures. In this framework, agents are represented as vertices, and hyperedges signify viable agent configurations. Hypergraphs outperform some previously used models, such as simplicial complexes, due to their lack of closure property under subset operations. This allows them to capture complex situations, such as when two agents are unwilling to cooperate directly but are open to collaborating simultaneously with a third agent. We apply various topological operations, such as wedge, cone, collapse, and homology, to hypergraphs, enabling the representation of merging structures, the introduction of mediators, and delegation within political systems. We evaluate the effects of these operations on the viability, stability, and local stability of hypergraphs to measure their influence on stability, power concentration, and other features in political structures. Furthermore, we explore the application of concepts like clustering coefficients and homology within hypergraphs and propose possible future research directions.

11:35 am - 11:50 am: Algebraic Topology of Dihedral Branched Covers

Speaker: Emma Illig (Smith College), Tilila Karani (Smith College), and Heng Song (Smith College)

Abstract: A knot in topology is the positioning of a circle in 3D space, and one invariant that distinguishes knots from each other is colorability. The fundamental group of a knot is a group that corresponds to the complement of the knot in 3-space, and measures holes in that space. By creating a homomorphism from the fundamental group of the knot to a symmetric group, we can label knots by transpositions (derived from the notion of colorability) and obtain the fundamental group of the branched cover of the labeled knot through finding three types of relations: claw, branch, and lifted relations. The fundamental group of the branched cover is also a knot invariant, and appears in a formula related to the Slice-Ribbon conjecture.

11:55 am - 12:10 pm: Symmetries of Augmented Links: On Chain Links and their FAL-Equivalent Counterparts

Speaker: Annette Belleman (Wellesley College)

Abstract: We address symmetry groups of augmented links. We will focus on FALs and related links with a complement homeomorphic to that of an FAL. Our main focus will be on chain links which are flat FALs and links FAL-equivalent to chain links. Our overarching goal is to examine the relationship between the symmetry groups of links and links FAL-equivalent to them along with how disparate those two symmetry groups may be.

Keywords: symmetry group, augmented link, fully augmented link, crushtacean, FAL-equivalent, flat FAL, homeomorphic link complements, Dehn twists

Biomathematics - Burton 219

11:15 am - 11:30 am: Algorithmic Generation of DNA Self-Assembly Graphs

Speaker: Iris Horng (University of Pennsylvania)

Abstract: With recent advancements in the field of nanotechnology, there has been increasing interest in self-assembling nanostructures. These are constructed through the process of branched junction DNA molecules bonding with each other without external guidance. Using a flexible tile-based model, we represent molecules as vertices of a graph and cohesive ends of DNA strands as complementary half-edges allowing the molecules to bond with each other. Due to the unpredictability of DNA self-assembly in a laboratory setting and the risk of undesirable products being incidentally constructed, predicting what structures can be produced from a given list of components, referred to as a "pot of tiles," is useful but has been proven NP-hard. This project introduces an algorithm to computationally generate and visualize at least one valid graph and for smaller cases, all non-isomorphic graphs, given a pot of tiles. By adjusting a number of construction parameters, we can produce graphs of various orders and proportions of tiles.

11:35 am - 11:50 am: Multi-Dimensional Graphs Modeling Self-Assembling DNA Nanostructures

Speaker: Catherine Jacobs (Wellesley College)

Abstract: Employing tools from graph theory and linear algebra, we model the biological process of the creation of nanostructures from self-assembling DNA complexes. We represent k-armed branch junction molecules with tiles which are vertices in a graph with half-edges. The half-edges depict the cohesive-end types of a DNA strand. We aim to determine the minimum number of tiles and cohesive-end types necessary to form the complete complex of a given multi-dimensional graph structure. The problem of modeling DNA self-assembly is particularly challenging when considering graph families which change in multiple dimensions. In this research, we present the minimum number of tiles and cohesive-end types necessary to create the stacked book graphs, the square lattice graphs, and the Mongolian tent graphs, under different laboratory constraints.

11:55 am - 12:10 pm: Immuno-epidemiological Model for Transient Immune Protection

Speaker: Yicheng Liu (Mount Holyoke College), Sophie Su (Mount Holyoke College)

Abstract: This study explores the effects of re-exposure on individuals previously infected during disease outbreaks. Using a modified differential equations model (called a flow-kick system), it considers the roles of both innate and adaptive immunity in the face of random re-exposure events. Monte Carlo simulations approximate reinfection probabilities and timeframes for different distribution parameters of re-exposure. Findings indicate that reinfection risk increases with greater exposure size, and longer intervals between exposures prolong the time to potential reinfection. These insights might aid in refining infectious disease models and control strategies.

Graph Theory and Algebra - Burton 301

11:15 am - 11:30 am: Graph Constructions of Nilpotent Lie Algebras

Speaker: Jordan Martino (Northeastern University)

Abstract: In this presentation, I will talk about my joint research on finite dimensional nilpotent Lie algebras during my REU at Northeastern this summer. Our goal was to generalize a combinatorial construction of 2-step nilpotent Lie algebras to arbitrary n-step nilpotent Lie algebras. I will go through our attempts at this and will present the construction we landed upon. We use simplicial complexes and complete directed acyclic graphs to combinatorially generate the positive nilpotent part of the special linear Lie algebra.

11:35 am - 11:50 am: Prime Graphs of Groups with K_4 composition factors

Speaker: Saskia Solotko (Tufts University)

Abstract: We continue the study of the prime graph (Gruenberg-Kegel graph) of finite groups. The prime graph $\Gamma(G)$ of a group G has the prime divisors of $|G|$ as vertices, and there is an edge between p and q if there is an element of order pq. Primes graphs of solvable groups as well as prime graphs of groups with K_3-groups as composition factors have been completely classified. In this paper, we classify many prime graphs of groups with K_4-groups as composition factors. In particular, we completely classify prime graphs of A_7-solvable groups, which motivates the development of general techniques for other K_4 groups. Furthermore, we give partial classifications that allow us to demonstrate that prime graphs of these groups are 3-colorable and triangle-free in almost all cases.

11:55 am - 12:10 pm: Arithmetical Structures on Canoe Paddle Graphs

Speaker: Ailie Wood (Wellesley College)

Abstract: Given a connected graph G with n vertices, an arithmetical structure on G is a pair of vectors $(\mathbf{d}, \mathbf{r}) \in \mathbb{Z}^n_{>0} \times \mathbb{Z}^n_{>0}$ satisfying $(\text{diag}(d) - A)r = 0$, where A is the adjacency matrix of G. These arithmetical structures originally arose in the work of Lorenzini on degenerations of curves in algebraic geometry. In his work, Lorenzini proved there are finitely many arithmetical structures on any connected graph. This raises the natural question of counting how many arithmetical structures there are on a particular graph G. The number of arithmetical structures on paths, cycles, and trees have been counted in previous work. In our work, we investigate methods of obtaining and counting arithmetical structures on canoe paddle graphs, i.e., on graphs containing a cycle of n vertices connecting to the start of a path containing m vertices.

Algebraic Combinatorics - Burton 302

11:15 am - 11:30 am: Drawing Circuits to Bypass Calculations

Speaker: Orit Tashman (Smith College)

Abstract: The Springer fiber is a geometric object such that every point can be thought of as a matrix that satisfies certain conditions. By looking at all matrices with the same pivots and as many free variables as possible, we can partition the Springer fiber into pieces. The linear algebra work to find the entries for these matrices can be extremely complex and prone to mistakes. This talk will present findings on how these Springer fiber pieces correspond to well-known combinatorial objects (such as balanced Yamanouchi words, noncrossing matchings, and webs), and how we can draw straight-edged webs ("circuits") to easily fill out the complicated matrix entries.

11:35 am - 11:50 am: Rotations of Balanced Yamanouchi Words

Speaker: Emily Hafken (Smith College)

Abstract: A balanced Yamanouchi word of b's, m's, and t's is a sequence of letters with an equal number of each letter such that when reading from left to right, there are always as many b's as there are m's and as many m's as there are t's. We can classify these words by the number n of unique letters in a word, which is three for the bmt case.

What makes these words interesting to study are the several bijections we can describe between them and other mathematical objects. A few such sets we study are standard Young tableaux, multicolored non-crossing matchings, and a type of planar graphs called webs.

Because of the connections between these sets, it is of interest as well to compare how operations on one set can be translated to equivalent operations on another set. An example of this we will talk about is the connection between promotion on standard Young tableau and rotation of both non crossing matchings and balanced Yamanouchi words. We will also discuss a new method of performing these rotations called the "leading thread" method.

11:55 am - 12:10 pm: Root Word Fixation and Arc Sliding

Speaker: Eleanor Gallay (Smith College) and Kerry Seekamp (Smith College)

Abstract: Many classical objects in combinatorics can be described in different ways: Young tableaux (numbers in boxes), multicolored noncrossing arcs, balanced Yamanouchi words (balanced strings of letters that correspond to noncrossing arcs or matchings). These arise in different important contexts, including combinatorics, representation theory, mathematical biology, and many others. We explore a classical operation on Young tableaux: promotion, which is a sliding operation on numbers in boxes. We define an operation on balanced Yamanouchi words that corresponds to promotion, which we call root word fixation. To prove they are the same, we use another natural operation: rotation of the arcs, and define an algorithm called arc sliding.

Statistics - Burton 307

11:15 am - 11:30 am: A Comparison of Nonparametric Tests for Interaction in Two-way ANOVA with Balanced Replications

Speaker: Khue Tran (Kenyon College)

Abstract: While the F-test is the recommended method for detecting interaction in two-way ANOVA when the data are normally distributed, nonparametric procedures are shown to be more powerful in the cases of non-normal distributions. We computed extensive null critical values for the aligned rank-based tests (APCSSA/APCSSM) in additional settings where the numbers of levels of the factors are between 2 and 6. The performance of these new procedures, the ANOVA F-test for interaction, the adjusted rank transform test (ART), Conover's rank transform procedure, and the raov function in the Rfit package were compared using Monte Carlo simulations. There is no single dominant test in detecting interaction effects for non-normal data, but nonparametric procedures APCSSM and ART are definitely more powerful than the F-test for Cauchy data. Our hope is that these recently developed nonparametric methods will be more widely considered.

11:35 am - 11:50 am: Estimating Probability of True 'Hits'

Speaker: Cathryn Barbour (Mount Holyoke College)

Abstract: A crime has been committed and firearms examiners have recovered a bullet from the scene. To generate investigative leads, examiners look for a "hit" or a match between the crime scene bullet and a known source. The current practice is to deploy NIBIN: a large proprietary database consisting of documented firearms cases. Third party validation of the accuracy of NIBIN's algorithm that returns a list of potentially similar bullets to the one submitted as a query is not possible at this time. We seek to explore the probability of a true "hit" and risk of a false positive. The density of similarity scores of pairs of bullets fired from different guns (DS) and by the same gun (SS) are modeled by beta distributions. Assuming a single true match is in the database, we then simulate a search by sampling n items: n-1 from the DS density and one from the SS density. We discover that false positives increase dramatically with the size of the database; our simulated databases containing 1,000 to 10,000 items. As of July 14th, 2023, NIBIN contains 5.7 million items.

Machine Learning and Network Science - Sabin Reed 220

11:15 am - 11:30 am: System identification with neural networks in Smith's Geothermal Project

Speaker: Abi Bowering (Smith College)

Abstract: Artificial neural networks are a type of machine learning. A neural network has an input and an output layer, often with numerous hidden layers - leading to the term "deep learning". Each layer performs a basic function (Wa+b), adding and rescaling the network's weights and biases, otherwise known as the network parameters. To train a network, we optimize a loss function of the parameters so that it reaches a minimum.

System identification is an application of neural networks to approximate a system's governing equations only using observed data. There are two problems associated with the ordinary differential equation dxdt(t)=F(x(t),t): the forward problem, in which we are given F and x0 and want to find x(t), and the inverse problem, in which we have solutions xi(t) for i = 1,...M associated with t values, and want to find F. Both problems can be solved using a neural network by designing a specified loss function.

This project utilized the inverse problem to recreate an equation which describes the change in temperature over time in a borehole for the Smith Geothermal Project. Borehole temperature data were collected each foot for 1000 feet of depth, every hour for over a year. We stored these data as NumPy arrays and coded a feedforward neural network using PyTorch software. The observation arrays were our training data inputs, and their spline-smoothed derivatives were the target data. Differential equation reconstruction was used to validate our results. Currently, the network is not accurately matching data throughout the trajectory. Future work will include altering weight initialization and the optimizer's weight decay, including a learning rate scheduler, and investigating the effect of different activation functions.

References:

Negrini, E., Citti, G., Capogna, L. System identification through Lipschitz regularized deep neural networks, (2021). Journal of Computational Physics, (444), https://doi.org/10.1016/j.jcp.2021.110549

11:35 am - 11:50 am: What is Normal Network Traffic? Benign Clustering Improves Network Intrusion Detection Performance

Speaker: Meghan French (Mount Holyoke College)

Abstract: Intrusion Detection Systems (IDS) play a pivotal role in safeguarding network security by distinguishing normal from malicious network traffic. Leveraging machine learning algorithms for IDS training on network data has been a promising approach, but challenges arise when categorizing benign traffic. Typically, benign traffic is assigned a universal label, while attack traffic is subdivided into distinct categories, creating an imbalance in data representation. We investigate whether generating sub-categories of benign traffic using clustering algorithms can enhance machine learning classification performance.

We utilize the UNSW-NB15 and CIC-IDS2017 datasets for training and testing. Clustering algorithms, including OPTICS, HDBSCAN, and Mean Shift, are applied to create sub-categories of benign traffic. Machine learning classifiers, such as Random Forest, Extra Trees, and Gradient Boost, are employed to evaluate the impact of clustered benign data on performance.

Results demonstrate diverse outcomes, with clustering algorithms yielding variable numbers of clusters. In binary classification, improvements are observed in accuracy, precision, recall, and F1-score when machine learning models are trained on clustered benign data, particularly with HDBSCAN. Random Forest consistently outperforms other classifiers. In multi-classification, performance enhancements are detected for specific classifiers. OPTICS and HDBSCAN emerge as robust clustering options.

However, results differ substantially for the CIC-IDS2017 subset we made, indicating inherent dataset dissimilarities. The data's complexity, feature differences, and creation methodology suggest time-related confounding variables.

In conclusion, clustering-based feature engineering enhances IDS performance, with OPTICS and HDBSCAN as promising options. However, dataset characteristics significantly impact results, warranting careful consideration when selecting clustering techniques. This research contributes valuable insights into improving IDS efficacy in network security.

Keywords: Intrusion Detection System (IDS), Clustering Algorithms, Machine Learning, Network Traffic Data.

Afternoon Talks

Differential Geometry - Burton 209

2:30 pm - 2:45 pm: Curvature of Higher Dimensional Embeddings of Surfaces

Speaker: Chloë Boatright (Skidmore College/Yale University)

Abstract: The Whitney Embedding Theorem is best known for demonstrating that any n-manifold can be embedded in $\mathbb{R}^{2n}$. However, it can also be used to construct higher dimensional embeddings, as detailed in Lee's "Introduction to Smooth Manifolds" (Lee 134). In this talk I will explore the properties of these higher-dimensional embeddings, particularly how their curvature changes as the number of dimensions increases to infinity.

2:50 pm - 3:05 pm: Discontinuities in the Curvature of a Thin Elastic Ribbon

Speaker: Alexandra Carr (Vassar College)

Abstract: The energy of thin elastic ribbon can be simulated using a model derived by Sadowsky. Through optimal control theory, bifurcations may occur along the length of the ribbon. Using this model, we examine the solutions to the Möbius band and the bifurcations that occur during this transformation. We also consider spherical ribbons and the conditions under which discontinuities occur.

3:10 pm - 3:25 pm: Compactification and Schwartz Functions

Speaker: Molly Sager (Northeastern University)

Abstract: Compactification has long been a useful tool when working with non-compact spaces. In this talk, we explore Schwartz Functions, define transition functions, and explain their role in a new compactification using the real projective space as a compactification of Euclidean space.

Algebra - Burton 219

2:30 pm - 2:45 pm: An Improved Lower Bound for $GL_2(\mathbb{F}_\ell)$ Number Fields

Speaker: Vittoria Cristante (Tufts University)

Abstract: A conjecture of Malle predicts an asymptotic for the number of fields with discriminant bounded by X with a given Galois group, G. In this talk, we consider the case when G is the general linear group of dimension 2 over a finite field, $GL_2(\mathbb{F}_\ell)$.

2:50 pm - 3:05 pm: A gentle intro to functoriality: exploring TQFT's

Speaker: Sophia Marx (University of Massachusetts Amherst)

Abstract: In this talk, students with little to no knowledge of category theory will be gently introduced to the concept of a functor. Using an illustrative example, and lots of pictures, we will give an example of a functor, and will hint at some of the exciting applications of the concept of functoriality as a way to connect ideas from algebra, topology, and mathematical physics.

3:10 pm - 3:25 pm: Cluster algebra structure on the classical (and quantum) Grassmannian

Speaker: Zach Greenfield (Northeastern University)

Abstract: A cluster algebra is a type of commutative ring, where instead of having an explicit set of generators, the generators are obtained combinatorially from a starting "seed" of data. An important example of an object with a cluster structure is the homogeneous coordinate ring of a space called the Grassmannian.

In this talk, I will introduce the concept of a cluster algebra, as well as some combinatorial techniques used to study the cluster structure on the general Grassmannian. Time permitting, I will then briefly discuss the idea of the quantum Grassmannian, the noncommutative analog of the classical structure, as well as its corresponding cluster structure.

Graph Theory - Burton 301

2:30 pm - 2:45 pm: The Number of Independent Sets of Trees, N-gons, and Benzenoids

Speaker: Rachel Schmidt (Williams College)

Abstract: Given a graph G, a set $S \subseteq V(G)$ is called independent if no pair of vertices in S are adjacent in G. Let $i(G)$ represent the number of independent sets in G, which is often referred to as either the Fibonacci number of a graph or the Merrifield-Simmons index of a graph. In this talk, I discuss calculating $i(G)$ when G is a subgraph of the hexagonal lattice and provide exact values for $i(G)$ when looking at specific types of benzenoid hydrocarbons, a family of molecules of particular interest in mathematical chemistry. I then expand these results to general polygonal lattices. In addition, I will define a natural number k as constructible if there exists a tree T such that $i(T) = k$. It is well known that all natural numbers are constructible on graphs, but this is not the case when we restrict to trees. I present an algorithm to generate the tree-constructible numbers as well as numerical ways to write the constructible numbers and discuss how these results give weight to the conjecture that there are infinitely many non-constructible numbers.

2:50 pm - 3:05 pm: On the hyperbolicity of the arc and curve graphs of surfaces

Speaker: Darrion Thornburgh (Bard College)

Abstract: Hyperbolic metric spaces, as introduced by Gromov, have proven to be useful in geometric group theory. The arc graph $\mathcal{A}(S)$ (and curve graph $\mathcal{C}(S)$) of a surface S is the graph in which vertices represent arcs or curves, respectively, and the edges indicate disjointedness between them. It was proven by Hensel, Przytycki, and Webb in 2015 that $\mathcal{A}(S)$ and $\mathcal{C}(S)$ are at worst 7-hyperbolic and 17-hyperbolic, respectively. In this talk, we introduce lower-bounds for the hyperbolicity constant for both $\mathcal{A}(S)$ and $\mathcal{C}(S)$, and we prove the curve graph of the 5-punctured sphere is not 1-hyperbolic. This research was done in collaboration with Sami Aurin at the Georgia Tech Math REU. We give many thanks to our mentors Wade Bloomquist and Dan Margalit.

Discrete Mathematics - Burton 302

2:30 pm - 2:45 pm: Parking Garage Functions

Speaker: Felicia Flores (Smith College)

Abstract: This project is about a generalization of parking functions called parking garage functions. Parking functions have been well studied, but the concept of parking garage functions is new and introduced in this project. Parking garage functions are sequences that represent the parking garage level preferences of cars which lead to all cars parking on a level after a systematic placement. We found a recursive formula for the number of sequences that are a parking garage function. We also found a closed formula for a subset of parking garage functions, descending parking garage functions, via a bijection between descending parking garage functions and Dyck paths which are paths on a rectangular grid which only take right and upward steps starting at the origin and remain under a positively sloped diagonal that goes through the origin.

2:50 pm - 3:05 pm: Avoiding Triples in the Card Game Spot It!

Speaker: Shay Spitzer (Bard College), Oliver Vanderploeg (Bard College), and Minshi Yang (Bard College)

Abstract: Spot It! is a card game where each card has 8 symbols and shares exactly one symbol with every other card. A standard Spot It! deck can be viewed as a projective plane of order 7. We created Spot It! decks for projective planes of order $n \leq 16$. The goal of this project was to study sets of cards where each symbol appears at most twice. We will present results, work in progress, and open problems.

2:30 pm - 2:45 pm: Quantum Error Correcting Codes from Multidimensional Circulant Graphs

Speaker: Kerry Seekamp (Smith College)

Abstract: Two new qubit stabilizer codes with parameters $[\![77, 0, 19]\!]_2$ and $[\![90, 0, 22]\!]_2$ are constructed for the first time by employing additive symplectic self-dual $\mathbb{F}_4$ codes from multidimensional circulant (MDC) graphs. We completely classify MDC graph codes for lengths $4 \leq n \leq 40$ and show that many optimal $[\![\ell, 0, d]\!]$ qubit codes can be obtained from MDC construction.

Moreover, we prove that adjacency matrices of MDC graphs have nested block circulant structure and determine isomorphism properties of MDC graphs.

Click here for the pdf of the LaTeX code.

2:50 pm - 3:05 pm: Cool-lex Order for Triangulations of Polygons

Speaker: Emily Downing (Massachusetts College of Liberal Arts)

Abstract: Cool-lex order is a successor rule that generates all objects of a given type. The Catalan numbers are a sequence of numbers that count numerous types of objects: binary trees, stacks of coins in a plane, balanced parenthesis, etc. An open question is which types of objects can be generated by Cool-lex order so that there is little change from one object to the next. One Catalan object we focused on was triangulations of polygons, where the nth term of the Catalan sequence counts the number of different triangulations of an (n+2)-gon. Using python programming and computation by hand, we explored the bijection between balanced parenthesis and triangulations of polygons as well as their generation in Cool-lex order to observe the change from one triangulation to another and determine whether the Cool-lex generation produces little change between them. This research was conducted jointly with Elizabeth Hartung (MCLA) and Aaron Williams (Williams College).

Artificial Intelligence - Sabin Reed 220

2:30 pm - 2:45 pm: An Analysis of Lyme Disease Data with Machine Learning Tools

Speaker: Nika Jafar Nia (Amherst College, UCLA)

Abstract: We present an exploration of Lyme disease data using diverse machine learning techniques mainly focused on Non-negative Matrix Factorization (NMF). Our study employs a survey data set collected from individuals who have been affected by Lyme disease. Leveraging NMF, we uncovered underlying patterns that contribute to a better understanding of the disease's symptoms, including indicators that lead to neurological manifestations of the disease. In addition, by employing classification techniques such as logistic regression and SVM, we achieve accurate differentiation between chronic and early lyme individuals, as well as accurately predict whether someone was diagnosed before or after a year prior to onset of symptoms. We also leveraged anomaly detection methods to uncover patients with symptoms that may lead to extreme, or uncommon symptoms and manifestations, which we then analyzed with semi-supervised NMF. We developed two helper functions based on feature similarity to improve upon Neural NMF and a multiplex community detection algorithm implemented on the patient network with decent interpretability. Moreover, we propose a Fair NMF algorithm where different subgroups converge on lower rank and result in fairer low dimensional representation. This talk will be mainly on Fair NMF and different techniques and approaches used to develop it. Through our various mathematical methods, our study enhances our knowledge of Lyme disease and various mathematical techniques.

2:50 pm - 3:05 pm: Enhanced Reliability Predictions: An AI-based Framework for Performing Failure Modes, Effects, and Criticality Analysis in Industrial Environments

Speaker: Nicholas Grabill (University of Michigan), Stephanie Wang (University of Rochester)

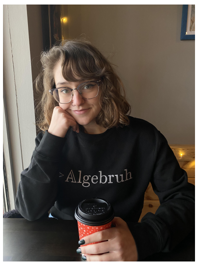
Abstract: Reliability engineering grapples with the imperative task of predicting and comprehending product failures across an array of sectors. Although traditional approaches like Failure Mode Effects and Analysis (FMEA) and Failure Mode, Effects, and Criticality Analysis (FMECA) have substantially bolstered product safety and quality, their inherent manual intensity and reliance on expert insights introduce limitations. As today's systems surge in complexity, a more holistic approach becomes paramount. In response, we introduce an AI-driven risk assessment tool that guides the user to a host of failure modes and their effects for each component contained in a bigger system. Through a user-friendly graphical interface and a robust statistical modeling backend, the AI-driven tool streamlines the risk assessment process by prompting users to input a system's name and subsequently generating an extensive array of failure modes and associated effects for each constituent component, including Weibull, Rayleigh, and Bathtub distribution curves. By automating this aspect of FMEA/FMECA, the AI-based solution seeks to not only enhance reliability analyses but also optimize development timelines, improve resource allocation, and provide valuable educational avenues for junior across sectors, including chemical, automotive, aerospace, and beyond.

3:10 pm - 3:25 pm: Bridging the Gap Between Data Science and Social Justice: Practices in Disrupting AI Bias

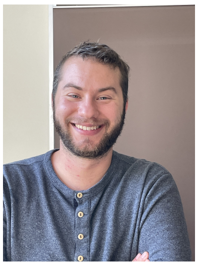
Speaker: Savana Paciulli (Smith College)

Abstract: Corporations and institutions use data analysis and in particular artificial intelligence, methods to make decisions in today's increasingly complex world. These practices are automated and reiterated by artificial intelligence and algorithms. Although these algorithms claim to be objective, they are created by people and many are inherently biased to favor the Western European patriarchal cultures. According to recent research, as a result of biased methodological practices for obtaining, mining, and analyzing data, marginalized populations in the US experience even more socioeconomic barriers. The goal of this project is twofold.

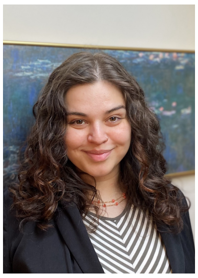
Graduate School Panel



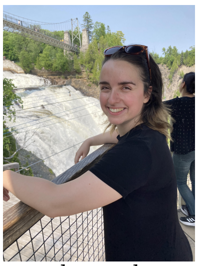
Vittoria Cristante: Vittoria Cristante (she/her) is a first-year PhD Student at Tufts University. She completed her Master's from Tufts University in May 2023 and her B.A. in Math at Southern Connecticut State University (SCSU) in May 2021. In addition to her Math B.A., she holds a B.A. in Theatre from SCSU, completed in May 2020. Her research interests, general speaking, lie in algebraic number theory but her current research is in Arithmetic Statistics.



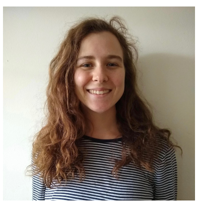
Liam Gammel: Liam Gammel is currently an employee of the Los Alamos National Laboratory, after joining the laboratory as a student in their postbaccalaureate program. Liam is also about to finish a PhD in applied mathematics at the University of Arizona. Liam graduated from Smith College as an undergraduate student in Mathematics and Physics.



Miriam Kuzbary: Miriam Kuzbary is an NSF Postdoctoral Fellow and Visiting Assistant Professor of Mathematics at Amherst College, and will begin an appointment as an Assistant Professor next year. Her research interests lie in low-dimensional topology and group theory, where she focuses on link concordance and groups related to the study of 3- and 4-manifolds. She is originally from Garland, TX and received her Ph.D. from Rice University.



Sophia Marx: Sophia Marx is in her third year of the PhD program at UMASS Amherst. Previously, she was a postbacc at Smith, and completed her undergraduate work at Columbia University and Bennington College. Sophia's road to math has been highly non-traditional; as a high school student, she excelled in the arts and humanities, and initially pursued a career as a dancer. Sophia's current primary mathematical interests are in Algebraic Topology and Topological Quantum Field Theories, and she is particularly excited by problems in so-called "pure" math with applications to physics. Sophia identifies as queer, uses she/her pronouns, and is particularly passionate about transforming the intersecting worlds of research mathematics and math pedagogy into a less patriarchal, more inclusive space— especially for those students who may have been raised or conditioned to believe that they are incapable of mathematical success.



Porter Morgan: Porter is in her fourth year of a math PhD at the University of Massachusetts, Amherst. She studies low-dimension topology under the supervision of Inanc Baykur. Her research focuses on non-orientable 3- and 4-manifolds, but she enjoys learning about a variety of topics in algebraic topology and differential geometry. She graduated from Kenyon College in 2018, then taught math at a small high school in New Hampshire for two years before coming to UMass. In her free time, she enjoys cooking and riding her bike.