USTARS

underrepresented students in topology and algebra research symposium

University of Iowa
Iowa City, Iowa
April 20 - April 21, 2024

Community Agreement

USTARS aims to offer a rewarding, enlightening, supportive, and fruitful experience to every participant. We will build that rich experience together by devoting our strongest available effort to all activities. Please be prepared to take an active, patient and generous role in your own development and that of the other participants.

USTARS organizers are committed to creating a professional and welcoming environment that benefits from the diversity of experiences of all participants. We aim to offer the same respect, opportunity and value to the contributions of every participant regardless of gender, gender identity or expression, race, color, national or ethnic origin, religion or religious belief, age, marital status, sexual orientation, disabilities, or veteran status. We ask you to contribute to this positive environment, and to use extra care to ensure that your words and actions communicate respect for others.

Discriminatory or harassing behavior undermines the mission of USTARS and therefore will not be tolerated. The USTARS organizers will make every effort to maintain an environment that is free of harassment, even though we do not control the behavior of third parties. If any participant feels uncomfortable with the way they are being treated or has concerns, please contact USTARS (ustars.organizers@gmail.com) or Paige Helms (phelms@uw.edu) (anonymously, if you wish[1]). All reports will be handled in the strictest confidentiality.

Acknowledgement: This agreement is based on similar agreements by LatMath, The Encuentro Colombiano de Combinatoria (ECCO), the American Mathematical Society, the Association for Women in Mathematics, and the Mathematical Association of America.

[1]To email anonymously, one option is to create a new email account (e.g., a free Gmail or Yahoo account) that uses the name "Anonymous USTARS Attendee" instead of your actual name. Alternatively, if you happen to have a Gmail account, there is an "Alias" feature (under Settings - Accounts and Import - Send Mail As) that lets you send an email that displays a different "From" address (with some restrictions). With this setup, the recipient will not see your actual email address, but any replies still arrive to your usual inbox.

Agenda

Friday, April 19, 2024

6:00am - 10:00pm **Arrival to USTARS**
Location: Iowa House Hotel

Saturday, April 20, 2024

8:30am - 12:00pm **Registration**
Location: Adler Journalism Rotunda (First Floor, Facing Main Library)

9:00am - 9:25am **Welcome and Opening Remarks**
Location: Becker Communication Studies 101 (Auditorium)

9:30am - 9:55am **Session I**
Stranding webs and Springer fibers
Orit Tashman, Smith College
Location: Adler Journalism E205

Ricci curvature on graphs
Virginia Machado Martin, Smith College
Location: Adler Journalism E220

10:00am - 10:25am **Session II**
Arboreal Galois Representations
Daniel Tedeschi, Colorado State University
Location: Adler Journalism E205

Cyclic homology of categorical coalgebras and the free loop space
Daniel Tolosa, Purdue University
Location: Adler Journalism E220

10:30am - 10:55am **Session III**
Colorful Permutation Statistics: Cycle Type, Moments, and Group Actions
Kevin Liu, University of Washington
Location: Adler Journalism E205

Using Quandle Invariants to Distinguish Classical and Legendrian Knots
Peyton Wood, UC Davis
Location: Adler Journalism E220

11:00am - 11:15am **Networking/coffee**

11:15am - 12:10pm **Distinguished Graduate Speaker**
Using Diagrams to Describe Quantum Symmetries of Subfactors
Melody Molander, University of California, Santa Barbara
Location: Becker Communication Studies 101 (Auditorium)

12:15pm - 1:45pm **Lunch and Panel**
Location: Adler Journalism Rotunda (First Floor, Facing Main Library)
Panelists:
- Dr. Syvillia Averett, College of Coastal Georgia
- Dr. Alex Barrios, University of St. Thomas
- Dr. Robyn Brooks, University of Utah
- Kevin Liu, University of Washington

Saturday, April 20, 2024

1:45pm - 2:55pm **Poster Session and Informal Networking**
Location: Adler Journalism Building, First Floor

3:00pm - 3:55pm **Invited Faculty Speaker**
The abc conjecture and its equivalent formulation in the realm of elliptic curves
Dr. Alex Barrios, University of St. Thomas
Location: Becker Communication Studies 101 (Auditorium)

4:00pm - 4:25pm **Session IV**
Simplicial Volume Entropy of Iwahori Subgroups
Malachi Alexander, UC Santa Cruz
Location: Adler Journalism E205

Stated Skein Theory and DAHA Representations
Raymond Matson, University of California, Riverside
Location: Adler Journalism E220

4:30pm - 4:55pm **Session V**
What's in the $B^A(G)$?
Jennifer Guerrero, UC, Santa Cruz
Location: Adler Journalism E205

Persistent Diagrams, Protein Structure Analysis
Zakaria Lamine, University IBN Tofail Faculty Of Science Math Department
Location: Adler Journalism E220

5:00pm - 5:15pm **Group Photo**
Location: Stairway Up The Hill

5:15pm - 6:55pm **Social Activity Hour**
Location: Adler Journalism Building, First Floor

7:00pm - 9:00pm **Symposium Banquet**
Location: Iowa Memorial Union, Black Box Theater, Room 360

Sunday, April 21, 2023

9:00am - 9:55am **Distinguished Graduate Speaker**
Positroid Envelope Classes
Jeremy Quail, University of Vermont
Location: Becker Communication Studies 101 (Auditorium)

10:00am - 10:25am **Session VI**
Strata intersections in the $\mathsf{GU}(q-2,2)$ *Shimura variety*
Deewang Bhamidipati, UC Santa Cruz
Location: Adler Journalism E205

Symbol-Pair Distances of Constacyclic Codes of Length 2^s *over* $\mathbb{F}_{2^m}$
Manh Thang Vo, Ohio University
Location: Adler Journalism E220

10:30am - 10:55am **Session VII**
t-elasticity and other numerical semigroup invariants
James Howard, University of California, Santa Cruz
Location: Adler Journalism E205

Hopf actions of the bosonization of quantum linear space on path algebras of quivers
Kevin Del Real Ramos, University of Iowa
Location: Adler Journalism E220

11:00am - 11:15am **Networking/coffee**

11:15am - 11:40am **Session VIII**
The Posets of Numerical Semigroups
Kieran Hilmer, Purdue
Location: Adler Journalism E205

The Space of Holomorphic Differentials
Margarita Bustos Gonzalez, University of Iowa
Location: Adler Journalism E220

11:45 - 12:10pm **Session IX**
Calculating Discrete Volume via Generating Functions
Antwon Park, University of Kentucky
Location: Adler Journalism E205

Actions of Some Noetherian Hopf Algebras on Path Algebras
Elise Askelsen, University of Iowa
Location: Adler Journalism E220

12:15pm - 1:25pm **Grab and Go Lunch and Symposium Closing**
Location: Becker Communication Studies 101 (Auditorium)

USTARS 2024 Invited Faculty Speaker

Dr. Alex Barrios, University of St. Thomas

Alex Barrios is a number theorist specializing in Diophantine geometry, a branch of mathematics whose focus is on solving number-theoretic questions through techniques in algebra and geometry. Part of his research focuses on bridging the gap between our theoretical understanding of elliptic curves and the explicit construction of examples and the calculation of data pertaining to elliptic curves. Dr. Barrios is passionate about introducing undergraduates to pursuing research in number theory and algebraic geometry and has directed several undergraduate summer research projects since 2019 in his capacity as co-director of the NSF-funded Pomona Research in Mathematics Experience (PRiME).

Dr. Barrios is of Colombian descent and was raised in Miami, FL. He attended Miami Dade Community College before transferring to Brown University, where he received his Sc.B. in mathematics. He earned his M.S. and Ph.D. in mathematics from Purdue University and is currently an assistant professor of mathematics at the University of St. Thomas in St. Paul, Minnesota.

USTARS 2024 Distinguished Graduate Students

USTARS 2024 Distinguished Graduate Student in Algebra

Jeremy Quail, University of Vermont

Jeremy Quail is a fourth-year PhD student in Mathematical Sciences at the University of Vermont, advised by Puck Rombach. Jeremy received a Bachelor of Arts in Mathematics from Queens College, CUNY. His research interests are in matroids, graphs, and space networks. Jeremy studies the structural properties of positroids and open positroid variety decompositions of the Grassmannian. He works on problems in rainbow and edge-ordered extremal graph theory, and together with NASA collaborators, Jeremy explores applications of time-varying graphs to space communications. He can often be found wandering on long walks, looking for answers to his math problems, and misidentifying various animals along the way.

USTARS 2024 Distinguished Graduate Student in Topology

Melody Molander, University of California Santa Barbara

Melody Molander is a 5th year PhD candidate at the University of California, Santa Barbara, working under the supervision of Stephen Bigelow. Her research focuses on low-dimensional topology, quantum algebra, and operator algebras. She is especially interested in algebraic structures with skein-theoretic properties (such as the representation theory of quantum groups in relation to knot theory). Before UCSB she received her mathematics B.S. degree from the University of California, Davis. She then attended the University of Oklahoma and received her M.A. in mathematics. Afterwards, she worked in web development and taught night classes at Cosumnes River College in Sacramento, California, before deciding to return to graduate school.

Presentation Abstracts

Title: Actions of Some Noetherian Hopf Algebras on Path Algebras
Presenter: Elise Askelsen
Affiliation: University of Iowa
Abstract: The classical notion of symmetry can be encoded using the language of group actions. Actions of Hopf algebras encode a generalized notion of symmetry. Examples include the action of a group on a k-algebra by automorphisms and the action of a Lie algebra on a k-algebra by derivations. As the classification of Hopf algebras, more specifically Noetherian Hopf algebras, has advanced, the opportunity to study their actions on path algebras has become a natural research direction. In this talk, I will present my recent work on parameterizing Hopf actions of some Noetherian Hopf algebras of Gelfand-Kirillov dimension one and two on the path algebra.

Title: Simplicial Volume Entropy of Iwahori Subgroups
Presenter: Malachi Alexander
Affiliation: UC Santa Cruz
Abstract: Lattices are integer-like structures which sit inside K-vector spaces. If a group acts on a K-vector space, we can ask if these lattices are fixed under this action. In this talk, we are interested in counting the number of stable lattices under the Iwahori subgroup of $\mathrm{GL}_n(K)$, i.e. the class number, and how this class number changes under field extensions of K. The growth in the class number is known to be exponential for the Iwahori subgroup; however, to more precisely measure this growth, we introduce a special topological entropy called the simplicial volume entropy.

Title: The *abc* conjecture and its equivalent formulation in the realm of elliptic curves
Presenter: Dr. Alex Barrios**
Affiliation: University of St. Thomas
Abstract: Let a, b, and c be relatively prime positive integers such that $a + b = c$. How does c compare to $\mathrm{rad}(abc)$, where rad(n) denotes the product of the distinct prime factors of n? According to the explicit *abc* conjecture, it is always the case that c is less than the square of $\mathrm{rad}(abc)$. This simple statement is incredibly powerful, and as a consequence, one gets a (marginal) proof of Fermat's Last Theorem for exponent n greater than 5.

In this talk, we introduce Masser and Oesterlé's *abc* conjecture and discuss some of its consequences, as well as some of the numerical evidence for the conjecture. Along the way, we will discuss recent work from the PRiME 2022 summer research group on *abc* triples of the form $(1, c-1, c)$. We will then introduce elliptic curves and see that the *abc* conjecture has an equivalent formulation in this setting, namely, the modified Szpiro conjecture. We conclude the talk by discussing a recent result that establishes the existence of sharp lower bounds for the modified Szpiro ratio of an elliptic curve that depends only on its torsion structure.

Title: Strata intersections in the $\mathsf{GU}(q-2, 2)$ Shimura variety
Presenter: Deewang Bhamidipati
Affiliation: UC Santa Cruz
Abstract: Unitary Shimura varieties are moduli spaces of abelian varieties with certain extra structure which includes a signature condition. An effective way to understand these spaces is by stratifying them, of which two are of interest: the Ekedah-Oort (EO) stratification, defined with respect to the p-torsion group scheme structure up to isomorphism; and the Newton stratification, define with respect to the p-divisible group structure up to isogeny. We take a specific stratum in the Newton stratification - the supersingular stratum - and we study its intersection with the EO stratification in the case of signature $(q-2, 2)$. This is joint work with Maria Fox, Heidi Goodson, Steven Groen, Sandra Nair and Emerald Stacy

Title: The Space of Holomorphic Differentials
Presenter: Margarita Bustos Gonzalez
Affiliation: The University of Iowa
Abstract: Classifying the module structure of the space of holomorphic differentials is an open problem that is currently being investigated. This problem originated by the German mathematician Erich Hecke. Suppose X is a smooth projective curve over an algebraically closed field k of characteristic 2. Assume that X has a right faithful action by the alternating group on 4 letters A_4. This induces a left group action on its space of holomorphic differentials. Hence, the space has a kA_4-module structure. The goal is to be able to find the precise module structure of the space as a direct sum of indecomposable kA_4-modules.

Title: Hopf actions of the bosonization of quantum linear space on path algebras of quivers
Presenter: Kevin Del Real Ramos
Affiliation: University of Iowa
Abstract: In this talk we will investigate the necessary conditions required to have a Hopf action of a bosonization of a quantum linear space on a path algebra of a quiver. We will begin this journey with an introduction of quivers, quantum groups, and Taft algebras. These will be the building blocks for understanding a bosonization of a quantum linear space and its actions on a path algebra of a quiver.

Title: What's in the $B^A(G)$?
Presenter: Jennifer Guerrero
Affiliation: University of California, Santa Cruz
Abstract: A common theme in mathematics is to package objects into algebraic structures, for example, a ring. From there, in order to learn more about the ring, mathematicians study the group of units. We will explore $B^A(G)$, the A-Fibered Burnside Ring of a finite group G and an Abelian group A. It is a ring that is constructed to encode information about the group G; such as its subgroups, homomorphisms into A, and more. The goal of this talk will be to give a gentle introduction of what the A-Fibered Burnside Ring of a finite group is and to explore properties of its group of units. We will not assume prior knowledge of the topic, but fans of group theory will be right at home.

Title: The Posets of Numerical Semigroups
Presenter: Kieran Hilmer
Affiliation: Purdue
Abstract: A numerical semigroup is a subset of the natural numbers which includes 0, is closed under addition, and contains all but finitely many elements of $\mathbb{N}$. Numerical semigroups have been studied for hundreds of years in a variety of fields, originating from the problem of Frobenius (or its modern analog, the Chicken McNugget problem). Each numerical semigroup S has a unique minimal generating set; a factorization of $x \in S$ is a representation of x in terms of in terms of those minimal generators. Studying the structure of factorizations of elements of S is a central problem in the theory of numerical semigroups which is often challenging because, in order to answer many questions you might ask, you must already have a near-complete understanding of the factorization structure. We will investigate how studying the combinatorics of numerical semigroups gives us insight into the algebraic structure of its factorizations. In particular, we will discuss how to use the Kunz poset of S to determine the cardinality of minimal presentations of S–which captures the complexity of the factorization structure–in terms of other invariants of S.

Title: t-elasticity and other numerical semigroup invariants
Presenter: James Howard
Affiliation: University of California, Santa Cruz
Abstract: A numerical semigroup S is a co-finite subset of the non-negative integers that is closed under addition and contains zero. A *factorization* of $n \in S$ is a d-tuple encoding an expression of n as a sum of generators of S. Numerical semigroups admit non-unique factorization, which we try to better understand by studying invariants. One particularly well-studied invariant is *elasticity*, a coarse measure that describes the degree of non-uniqueness of factorization in S, defined in terms of a particular notion of factorization length. In this talk, we discuss and characterize the *t-elasticity* of a numerical semigroup, a generalization of elasticity using a parametrized length function. We also introduce a new invariant, the set of *alignments* of S, a subset of the parameter space with a surprising semigroup structure.

Title: Persistent Diagrams, Protein Structure Analysis
Presenter: Zakaria Lamine
Affiliation: University IBN Tofail, Faculty Of Science, Math Department
Abstract: Along with the manuscript we will be giving a detailed model of an example of an algebraic topological approach consisting of analysing data by reducing dimensionality, the algebraic invariant helps us to come out with a final topological signature. the data consists of a point cloud generated from the PDB Ids 2JOX and 1COS. We are interested in the two basic levels alpha helix and beta sheet of the two previously Ids. We will be detecting and giving a simple description of different patterns to make different comparisons by investigating the persistent diagrams as a convenient tool defining our algebraic topological approach.

Title: Colorful Permutation Statistics: Cycle Type, Moments, and Group Actions
Presenter: Kevin Liu
Affiliation: University of Washington
Abstract: We consider the descent, major index, and flag-major index statistics on the colored permutation groups $S_{n,r} = \mathbb{Z}_r \wr S_n$ and their conjugacy classes. Similar to the symmetric group, the latter are determined by cycle type. Using group actions, we show that on conjugacy classes without "short" cycles, certain moments align with those on $S_{n,r}$. This allows us to translate results involving the asymptotic distributions of these statistics. This talk is based on joint work with Michael Levet, Sheila Sundaram, and Mei Yin.

Title: Ricci curvature on graphs
Presenter: Virginia Machado Martin
Affiliation: Smith College
Abstract: Ricci curvature is a concept that originated in the world of Differential Geometry. In that field, Ricci curvature can constrain the diameter of a manifold, it controls the volume growth of geodesic balls, and it interacts with the natural frequencies of oscillation of a wave in that space (the eigenvalues of the Laplacian). For instance, a famous result by Obata tells us that the positively curved spaces that produce the lowest sounds are round spheres.

In recent years, new notions of Ricci curvature have been developed on metric measure spaces that are not necessarily smooth. Of particular interest are notions of curvature in discrete spaces like graphs, where these notions have applications to Network and Data Sciences. Many results from Differential Geometry involving Ricci curvature can be translated to results on Graph Theory with these new curvature notions, including diameter bounds for positively curved graphs and eigenvalue estimates. Using the Lin-Lu-Yau Ricci curvature on graphs, we explore the following question: what are the positively curved graphs that produce the lowest sounds? We will see that, contrasting with what happens in the smooth setting, there is a large family of graphs satisfying this condition.

Title: Stated Skein Theory and DAHA Representations
Presenter: Raymond Matson
Affiliation: University of California, Riverside
Abstract: The study of double affine Hecke algebras (DAHAs) has recently gained popularity due to their unexpected connections across various mathematical disciplines. However, there is still much to unravel when it comes to the representation theory of these algebraic structures. Building upon the foundational work by Morton and Samuelson, who illuminated connections between DAHAs and skein algebras of tori, we further explore topological perspectives to understand these algebras. In particular, we leverage an extension of Kauffman bracket skein theory called "stated skein theory" to gain deeper insights into their representation theory. This framework offers powerful tools for uncovering new modules and potentially extending the representation theory for DAHAs.

Title: Using Diagrams to Describe Quantum Symmetries of Subfactors
Presenter: Melody Molander*
Affiliation: University of California, Santa Barbara
Abstract: Classical objects such as vector spaces are highly symmetric, and the language of groups helps describe these symmetries. However, objects from quantum mechanics have more complex symmetries that can no longer be captured through group theory. These quantum symmetries instead require the language of 2-categories. These categories are nice because they have a diagrammatic description called a planar algebra. Planar algebras used to describe quantum symmetries of subfactors were first constructed by Vaughan Jones. The Kuperberg Program asks to find all diagrammatic presentations of planar algebras describing subfactors. In this talk, I will introduce these planar algebras, describe how they capture quantum symmetry, and give generators and relations of some planar algebras of a particular class called "index 4".

Title: Calculating Discrete Volume via Generating Functions
Presenter: Antwon Park
Affiliation: University of Kentucky
Abstract: A polyhedron $P \in \mathbb{R}^n$ is the intersection of finitely many half-spaces. The number of points in the intersection of P with the integer lattice $\mathbb{Z}^n$ is called the *discrete volume* of P. We will discuss methods, which feature rational generating functions, to find the discrete volume of a few examples of polyhedra as well as discuss attempts made to use these methods on a geometric object called the Kunz Cone.

Title: Graphic positroids, ternary positroids, and envelope classes
Presenter: Jeremy Quail*
Affiliation: University of Vermont
Abstract: Positroids are matroids realizable by real matrices with all nonnegative maximal minors. They partition the ordered matroids into equivalence classes, called positroid envelope classes. We show that the following classes of positroids are equivalent: graphic, binary, and regular. We prove that every positroid envelope class contains a graphic matroid. Finally, we characterize the ternary positroids and their positroid envelope classes.

Title: Stranding webs and Springer fibers
Presenter: Orit Tashman
Affiliation: Smith College
Abstract: Webs are a kind of graph that encodes linear transformations between representations of a quantum group, namely vector spaces with a very special kind of group action. Graph-theoretic operations on webs correspond to linear algebra operations, making it possible to solve familiar linear algebra problems — like identifying bases or matrices — just from the combinatorics. Webs arise naturally in fields like knot theory and topology, too.

We describe strandings, which are special ways to color webs. We then show how strandings can be used to identify the points in an algebraic variety called the Springer fiber. Finally, we talk about combinatorial operations on strandings like flips and rotations, and relate these to some of the classical algebraic, combinatorial, and geometric properties of the underlying objects.

Title: Arboreal Galois Representations
Presenter: Daniel Tedeschi
Affiliation: Colorado State University
Abstract: Traditional dynamics is concerned with the behavior of points $\alpha \in k$ under repeated applications of a rational map $\phi(z) \in k(z)$. Arboreal Galois representations turn this study on its head, considering successive *pre*-images of α under $\phi(z)$. This process yields an infinite rooted tree of pre-images T, each level of which has a corresponding field extension $K_n = k(\phi^{-n}(\alpha))$. The tower of extensions K_n/k has a Galois group G which acts on T; hence the arboreal Galois representation $G \to Aut(T)$. In this talk, we explore the theory behind arboreal Galois representations and investigate connections to the monodromy of self-covers of $\mathbb{P}^1_{\mathbb{C}}$.

Title: Symbol-Pair Distances of Constacyclic Codes of Length 2^s over $\mathbb{F}_{2^m}$
Presenter: Manh Thang Vo
Affiliation: Ohio University
Abstract: The class of constacyclic codes play a very significant role in the theory of error-correcting codes as they are a direct generalization of the important family of cyclic codes, which are the most studied of all codes. Many well-known codes, such as BCH, Kerdock, Golay, Reed-Muller, Preparata, Justesen, and binary Hamming codes, are either cyclic codes or constructed from cyclic codes.

We focus on the special case of codes over $\mathbb{F}_{2^m}$, i.e., $a = 1$, the Galois ring $GR(2, m)$. For any nonzero element λ of $\mathbb{F}_{2^m}$, there always exists a unit $\lambda_0 \in \mathbb{F}_{2^m}$ such that $\lambda_0^{2^s} = \lambda$, and the ambient ring $\frac{\mathbb{F}_{2^m}[x]}{\langle x^{2^s} - \lambda \rangle}$ turns out to be a chain ring with maximal ideal generated by $x - \lambda_0$, whose nilpotency index is 2^s. Thus the λ-constacyclic codes of length 2^s are the ideals $\langle (x - \lambda_0)^i \rangle$, $0 \le i \le 2^s$ of this chain ring. This structure is used to obtain the symbol-pair distance of all λ-constacyclic codes of length 2^s. We establish the symbol-pair distances of all such codes, by partitioning the set $\{0, 1, \ldots, 2^s\}$ of possible values of i into pairwise disjoint subsets and compute the symbol-pair distances of each code $\langle (x - \lambda_0)^i \rangle$, when i is in each such subset. As an application, the symbol-pair distance distribution is used to obtain all MDS symbol-pair constacyclic codes of length 2^s.

Title: Cyclic homology of categorical coalgebras and the free loop space
Presenter: Daniel Tolosa
Affiliation: Purdue University
Abstract: The free loop space of a topological space has a canonical circle action given by rotating loops, making it an S^1-space. The work of Jones, Goodwillie, and others, relates the equivariant homology of the free loop space to the cyclic homology of the algebra of singular chains on the topological monoid of based loops. One can model the free loop space in terms of the chains on the underlying space considered as a categorical coalgebra, a notion Koszul dual to a non-negatively graded dg category. This construction is "as small as possible", has no hypotheses on the underlying space and is suitable for computations in (non-simply connected) string topology. I will present a cyclic theory for categorical coalgebras and dg-categories extending the theory of cyclic homology for (dg) algebras and coalgebras. In particular, the cyclic chains of the categorical coalgebra of chains on a simplicial set provides a model for the S^1-equivariant chains on the free loop space that is suitable for computations. The proofs of these results can be understood in terms of a combinatorial model for the unit of the Bar-Cobar adjunction.

Title: Using Quandle Invariants to Distinguish Classical and Legendrian Knots
Presenter: Peyton Wood
Affiliation: UC Davis
Abstract: We will review the quandle State-Sum Invariant and discuss emerging strategies for using this invariant to distinguish knots. We will share progress made towards distinguishing all knots up to crossing number 14 using these strategies. Then, we will define Legendrian racks and show how to use them to distinguish Legendrian knots using a counting invariant defined by the number of Legendrian rack colorings of the front projection. Lastly, we will discuss how Legendrian racks give rise to a similar Sum-State Invariant that can also be used to distinguish Legendrian knots.

** Invited Faculty Speaker
* Distinguished Graduate Student

Poster Abstracts

Title: t-Delta Sets of Numerical Semigroups
Presenter: Sogol Cyrusian
Affiliation: UC Santa Barbara
Abstract: A numerical semigroup is a cofinite subset of $\mathbb{N}_0$ closed under addition. These semigroups allow for nonunique factorizations in that many elements can be written as multiple linear combinations of the minimal generators. Traditionally, the length of these factorizations has been measured using the 1-norm, with Delta sets consisting of the differences between consecutive factorization lengths of an element. We introduce a method of computing lengths using the 0-norm and ∞-norm, and identify properties of the associated Delta sets for different families of numerical semigroups. In particular, the Δ_0 sets of all semigroups with generators in generalized arithmetic progression are explicitly given, and semigroups with gaps in their Δ_∞ sets are constructed. The Δ_0 sets and 0-catenary degree of semigroups constructed with monoscopic gluings are analyzed.

Title: Random 3-Manifolds Have No Totally Geodesic Submanifolds
Presenter: Hasan El-Hasan
Affiliation: University of California, Riverside
Abstract: We show that generic closed Riemannian 3-manifolds have no non-trivial totally geodesic submanifolds. In 2017, Thomas Murphy and Frederick Wilhelm proved this for manifolds of dimension ≥ 4.

Title: Patterns in the Pisano period and entry points of linear recurrence sequences modulo m
Presenter: Morgan Fiebig
Affiliation: University of Wisconsin - Eau Claire
Abstract: The Pisano periods $\pi_F(m)$ and entry points $e_F(m)$ in the Fibonacci sequence has been a well-studied subject since the seminal paper by D. D. Wall in 1960. In this talk, we extend this study to other well-known sequences. In particular, we explore the following second-order linear recurrence sequences modulo m: Lucas, Pell, associated Pell, balancing, Lucas-balancing, cobalancing, and Lucas-cobalancing. Through data collected through programming in Mathematica, we observe a myriad of intriguing results (and conjectures) relating the Pisano periods and entry points of these sequences, and observe some intriguing group structures within the sequence terms.

Title: Optimizing Gravitational Wave Detection Using Topological Data Analysis
Presenter: Manny Lopez
Affiliation: University of Utah
Abstract: The interactions between black holes create decaying periodic "chirp" signals known as gravitational waves. The detection of gravitational waves is an important problem in physics, but this task proves difficult as the signals are embedded in background noise. We investigate the optimal topological feature extraction methods and machine learning models in detecting gravitational waves.

In 2019, Bresten and Jung determined that using persistence vectors as topological features for input to a convolutional neural network (CNN) results in a better classifier than the traditional CNN method. We evaluate persistence vectors in comparison with other topological features, including persistence landscapes, persistence images, and persistence entropy. Our aim is to determine whether a CNN is truly necessary, or if better topological features with a simpler classifier (such as logistic regression, random forest, support vector classifier, and multi-layer perceptron) can achieve similar results.

We determine that Bresten and Jung's persistence vectors feature extraction method with a support vector classifier achieved the best results without using a CNN, at 0.943 AUC. This classifier is much easier to train and interpret compared to a CNN, and is competitive even with a significantly smaller sample size.

Title: Forgetful Compositional Isogeny Schemes
Presenter: Krystal Maughan
Affiliation: University of Vermont
Abstract: There are two issues with proposed solutions to the problem of generating a supersingular elliptic curve with unknown endomorphism ring: First, parties not involved in the setup are required to trust at least one party who is involved. Secondly, verifying the proof of isogeny knowledge is linear in the number of participants to the computation, which limits the number of parties who can participate in the setup. Our proposed work addresses these issues. Specifically, this research aims to develop **distributed techniques** that scale to very large numbers of parties for finding supersingular elliptic curves with unknown endomorphism ring. Additionally, some post-quantum isogeny-based cryptographic protocols require sequential computation over a series of nodes, called a *proof of isogeny knowledge*. For each proceeding node, the correctness of a local computation is verified, as well as every preceding computation along the path. Our proposed solution computes a recursive proof via an incrementally verifiable folding scheme, such that a *single proof proves the whole chain*, while maintaining that the protocol is secure from potential quantum attacks. To our knowledge, no such current solution exists in current post-quantum isogeny-based protocols.

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Sessions Chairs and Panelists