USTARS

underrepresented students in topology and algebra research symposium

Purdue University
West Lafayette, IN
April 19-21, 2013

Symposium Agenda

Friday, April 19

6:00am-10:00pm Arrival to USTARS 2013

Saturday, April 20

8:00-12:00pm **Registration**
Lawson Building

9:00-9:30am **Welcome and Opening Remarks**
1142 Lawson Building

9:30-10:00am **Session I**
Robinson-Schensted correspondence between complex reflection groups $G(r, p, n)$ *and pairs of multitableaux*
Dr. Aba Mbirika, Bowdoin College
B134 Lawson Building

The Search for an Elliptic Curve with Mordell-Weil group $\mathbb{Z}/2\mathbb{Z} \times \mathbb{Z}/8\mathbb{Z} \times \mathbb{Z}^4$
Jamie Weigandt, Purdue University
B151 Lawson Building

Classifying tight contact structures using convex decomposition
Marcos Ortiz, The University of Iowa
B155 Lawson Building

10:15-10:45am **Session II**
The primes that Euclid forgot
Dr. Enrique Treviño, Swarthmore College
B134 Lawson Building

The probability that a polynomial with integer coefficients has all real roots
Lirong Yuan, Purdue University
B151 Lawson Building

Unknotting Moves of Virtual Knots
Melanie DeVries, University of Nebraska- Lincoln
B155 Lawson Building

10:45-11:15am **Coffee Break**
Lawson Commons 1130

11:15-12:30pm **Invited Faculty Speaker**
Games, the Braid Group, and a Short Exact Sequence
Dr. Jennifer Vasquez, University of Scranton
1142 Lawson Building

12:30-1:30pm **Lunch**
Lawson Commons 1130

Saturday, April 20

1:30-2:00pm **Session III**

Graded Group Schemes
Camil Aponte Román, University of Washington
B134 Lawson Building

On the programming of representations of finite dimensional path algebras corresponding to a quiver with zero relations
Pedro Díaz Navarro, Central Michigan University
B151 Lawson Building

Compactifications and their Boundaries
Molly Moran, University of Wisconsin-Milwaukee
B155 Lawson Building

2:15-2:45pm **Session IV**

The Tropical Laplacian of Polytopes and Bergman Complexes
Alyssa Palfreyman, San Francisco State University
B134 Lawson Building

Hochschild Cohomology of Algebras
Cris Negron, University of Washington
B151 Lawson Building

A State Model for the $SO(2n)$ Kauffman Polynomial
Dionne Ibarra, California State University, Fresno
B155 Lawson Building

2:45-3:00pm **Coffee Break**
Lawson Commons 1130

3:00-4:00pm **Poster Session**
Lawson Commons 1130

4:15-5:30pm **Distinguished Graduate Student**
Hopf Random Walk on Generalized Permutohedra
Servando Pineda Carranza, San Francisco State University
1142 Lawson Building

6:00-8:30pm **Symposium Banquet**
Purdue Memorial Union West Faculty Lounge

Sunday, April 21

8:00-8:30am	**Session V** *The Hope of a Geometric Action of Courant and Gauge Algebras* Heather Bruch, New Mexico State University B134 Lawson Building *A Filtration of Totally Reflexive Modules* Denise Rangel, University of Texas Arlington B151 Lawson Building *Groups acting on the circle with dense invariant laminations* Hyungrul (Harry) Baik, Cornell University B155 Lawson Building
8:40-9:10am	**Session VI** *Notes on Limits of the Cartan Subgroup in* $SL_3(\mathbb{R})$ Arielle Leitner, University of California, Santa Barbara B134 Lawson Building *Dominating the Bruhat graphs of quotient groups of the Symmetric Group* David Blessing, Florida Gulf Coast University B151 Lawson Building *Properties and Applications of Monomial Orders* Gabriel Sosa, Purdue University B155 Lawson Building
9:10-9:25am	**Coffee Break and Conference Photo** Lawson Commons 1130
9:25-10:35am	**Distinguished Graduate Student** *You could've invented* **tmf** Aaron Mazel-Gee, University of California, Berkeley 1142 Lawson Building
11:00am- 12:30pm	**Networking Lunch and Symposium Closing** Purdue Memorial Union West Faculty Lounge **Panelists:** Dr. Cindy Weyls, California State University, Channel Island Dr. Dandrielle Lewis, University of Wisconsin-Eau Claire Dr. Maria Vega, North Carolina State University Alexander Barrios, Purdue University **Moderator:** Dr. Syvillia Averett, Central State University
12:30-1:00pm	**Closing Remarks**

Oral Presentation Abstracts

Title: Graded Group Schemes
Presenter: Camil Ivette Aponte Román
Affiliation: University of Washington
Abstract: Group schemes are very well studied algebraic and geometric objects. In the algebraic approach they are representable functors from commutative algebras to groups and they are in correspondence with commutative Hopf algebras. The main purpose of this talk is to define the concept of graded group schemes using the correspondence in the case of commutative graded Hopf algebras. This innocent idea of adding the grading can pose some difficulties and subtleties arising from the fact not all graded Hopf algebras come from ungraded Hopf algebras.

Title: Groups acting on the circle with dense invariant laminations
Presenter: Hyungrul Baik
Affiliation: Cornell University
Abstract: I propose a new way to look at the group actions on the circle via the number of transverse dense invariant laminations. As a motivational example, we characterize the Fuchsian groups in terms of the invariant laminations. Having infinitely many invariant laminations with some additional assumptions on the laminations guarantees that the given group is Fuchsian. From the ideas developed in the proof, we can also prove that having three invariant laminations with stronger assumptions gives the same result. The key ingredient is the convergence group theorem. The development of the theory was motivated by Thurston's universal circle construction for tautly foliated 3-manifold groups.

Title: Dominating the Bruhat graphs of quotient groups of the Symmetric Group
Presenter: David Blessing
Affiliation: Florida Gulf Coast University
Abstract: Finding the domination number of a nxm grid was an open problem for over 30 years. A closed formula was finally proven in 2011 by Goncalves, Pinlou, Rao, and Thomasse. We will discuss the domination number of some Bruhat graphs of various quotient groups of the Symmetric group. We show that these graphs can sometimes be embedded into an $n \times m$ grid, and find a recursive formula for their domination numbers.

Title: The Hope of a Geometric Action of Courant and Gauge Algebras
Presenter: Heather Bruch
Affiliation: New Mexico State University
Abstract: String Theory is a mathematically consistent description of all known forces of nature. It works in 10 dimensions - space-time and a 3-dimensional, compact, complex manifold. This project lies in the attempt to find a manifold more general than that coming from the Calabi-Yau theory. It consists of a generalized Lie Derivative that uses Courant and gauge algebras. The ultimate goal is to build a geometric action, but the current project focuses on the associator.

Title: Unknotting Moves of Virtual Knots
Presenter: Melanie DeVries
Affiliation: University of Nebraska-Lincoln
Abstract: Virtual knot theory is an extension of knot theory originated by Louis Kauffman that gives a framework to study knots embedded in spaces of higher genus and examine the field in a more purely combinatorial sense. Unknotting moves - operations that can transform any knot into the unknot - have been a subject of interest in classical knot theory for many years as they can help create and calculate invariants. As every knot is a virtual knot, virtual knot theory gives us avenues to find new unknotting moves through combinatorial rather topological proofs. This talk will look at some unknotting moves of virtual knots and how to find them.

Title: On the programming of representations of finite dimensional path algebras corresponding to a quiver with zero relations
Presenter: Pedro Díaz Navarro
Affiliation: Central Michigan University
Abstract: On the decade of 70's, Peter Gabriel developed an algorithm to classify finite-dimensional path algebras by using almost split sequences, also called Auslander-Reiten sequences. Given a quiver Q it is possible to classify its corresponding path algebra $\Lambda(Q)$ by constructing its Auslander-Reiten quiver. The vertices of the Auslander-Reiten quiver are the dimension type of the indecomposable modules of the path algebra $\Lambda(Q)$. In the general theory, if the quiver Q has not zero relations it is possible to obtain the projective component of the Auslander Reiten quiver by using the Coxeter matrix $\Phi_\Lambda = -C_\Lambda^t \cdot C_\Lambda^{-1}$, where C_Λ is the Cartan matrix corresponding to the quiver Q. However, if we introduce zero relations to the quiver Q, this method fails.

Title: A State Model for the $SO(2n)$ Kauffman Polynomial
Presenter: Dionne Ibarra
Affiliation: California State University, Fresno
Abstract: Francois Jaeger presented the two-variable Kauffman polynomial of an unoriented link L as a weighted sum of HOMFLY-PT polynomials of oriented links associated with L. Murakami, Ohtsuki and Yamada (MOY) used planar graphs and a recursive evaluation of these graphs to construct a state model for the $sl(n)$-link invariant (a one-variable specialization of the HOMFLY-PT polynomial). We apply the MOY framework to Jaeger's work, and construct a state summation model for the $SO(2n)$ Kauffman polynomial.

Title: Notes on Limits of the Cartan Subgroup in $SL_3(\mathbb{R})$
Presenter: Arielle Leitner
Affiliation: University of California, Santa Barbara
Abstract: A limit group is the limit under a sequence of conjugations of the Cartan subgroup in $SL_3(\mathbb{R})$. We show there are 5 limit groups up to conjugacy. Each limit group is determined by a degenerate triangle. We give a criterion for a sequence to converge to each of these 5 types.

Title: You could've invented *tmf*
Presenter: Aaron Mazel-Gee*
Affiliation: University of California, Berkeley
Abstract: The cohomology theory known as *topological modular forms* was first introduced as the target of a topological lift of the Witten genus, an invariant of String manifolds taking values in modular forms. However, it also arises quite naturally in the search for a "global height-2 cohomology theory", i.e. a higher analog of rational cohomology (at height 0) and complex K-theory (at height 1). In this talk, I'll explain what all this means, show how it fits into the bigger picture of stable homotopy theory, and give a step-by-step account of how you, too, could've invented *tmf*.

Title: Robinson-Schensted correspondence between complex reflection groups $G(r,p,n)$ and pairs of multitableaux
Presenter: Aba Mbirika
Affiliation: Bowdin College
Abstract: The classical Robinson-Schensted algorithm establishes a bijection between permutations in the symmetric group $\mathfrak{S}_n$ and ordered pairs of same-shape standard Young tableaux of size n. This map has proven particularly well-suited to certain questions in the representation theory of both $\mathfrak{S}_n$ and the semisimple Lie groups of type A. For instance, Kazhdan-Lusztig cells as well as the primitive spectra of semisimple Lie algebras can be readily described in terms of images of this correspondence.

Other sometimes more elementary representation-theoretic information requires more work to extract from standard Young tableaux. For instance, in independent work, Reifegerste and Sjöstrand developed a method for reading the value of the sign representation of a permutation in $\mathfrak{S}_n$. In this talk, we extend this result to the imprimitive complex reflection groups $G(r,p,n)$ via a generalized Robinson-Schensted algorithm.

Title: Compactifications and their Boundaries
Presenter: Molly Moran
Affiliation: University of Wisconsin-Milwaukee
Abstract: When working in the world of contractible noncompact spaces, we often need tools beyond the scope of algebraic topology in order to distinguish one space from another. One such tool is to find compactifications of the space and then examine the boundary. We will discuss examples of different ways to compactify a given space, including $\mathcal{Z}$-compactifications. Working with $\mathcal{Z}$-compactifications has its advantages as it leaves the space the same up to homotopy. We will also apply the concept of $\mathcal{Z}$-compactifications to geometric group theory using $\mathcal{Z}$-structures to gain more insight into groups that admit these types of structures.

Title: Hochschild Cohomology of Algebras
Presenter: Cris Negron
Affiliation: University of Washington
Abstract: The Hochschild cohomology of an associative algebra is a fundamental cohomology that appears in a number of areas of mathematics. I will give a concrete definition of Hochschild cohomology and some interpretations via deformation theory and group cohomology. If time permits, I will discuss the algebraic structures this cohomology supports and my recent work on calculating the "cup product" on Hochschild cohomology.

Title: Classifying tight contact structures using convex decomposition
Presenter: Marcos Ortiz
Affiliation: University of Iowa
Abstract: Contact structures on 3-manifolds have been an area of interest to topologists since Martinet (1971) proved that every 3-manifold admits a contact structure. Since then such contact structures have been partitioned into tight and overtwisted. Overtwisted contact structures were classified relatively early on (Eliashberg, 1991) while the classification of tight contact structures turned out to be more elusive. One method used to classify tight contact structures on some 3-manifolds is convex decomposition. This talk aims to briefly introduce this method and present an example.

Title: The Tropical Laplacian of Polytopes and Bergman Complexes
Presenter: Alyssa Palfreyman
Affiliation: San Francisco State University
Abstract: If for every vertex v of a polytope P, the coordinate sum of the vertices that are adjacent to v is equal to a multiple a_v of v, then the polytope P gives rise to a tropical surface. Examples of polytopes that satisfy this special balanced condition include the regular polygon, hypercube, simplex, hypersimplex, and crosspolytope. The tropical Laplacian is a symmetric square matrix associated to these polytopes. The diagonal entries correspond to the multiple a_v for each vertex v of P, and non-diagonal entries a_{ij} are -1 if vertex i is adjacent to vertex j and 0 otherwise. It is conjectured that the spectrum of the tropical Laplacian contains exactly one negative root. I give the tropical Laplacian spectrum for some polytopes that satisfy the vertex-balanced condition, as well as show work toward understanding the tropical Laplacian spectra of Bergman complexes.

Title: Hopf Random Walk on Generalized Permutohedra
Presenter: Servando Pineda Carranza*
Affiliation: San Francisco State University
Abstract: Recently, Diaconis, Pang, and Ram defined a random walk on the elements of a Hopf algebra. Aguiar and Ardila defined a Hopf algebra of certain polytopes called 'generalized permutahedra'. This gives rise to a random walk on the faces of such a polytope. We study this random walk, showing and applying its connections to other objects in computer science, statistics, and algebraic combinatorics. For instance, we prove that if the polytope is an n-cube, then the random walk ends at a vertex after approximately log n steps. The talk will assume no previous knowledge of these objects.

Title: A Filtration of Totally Reflexive Modules
Presenter: Denise Rangel
Affiliation: University of Texas, Arlington
Abstract: Representation theory of maximal Cohen-Macaulay modules over commutative local Gorenstein rings has been well-developed. The analog of maximal Cohen-Macaulay modules over commutative local non-Gorenstein rings are called totally reflexive modules. In this case, their representation theory is very limited. What is known is that if there is one non-free totally reflexive module, then there are infinitely many non-isomorphic indecomposable ones. In this talk, we will discuss the background of totally reflexive modules as well as some preliminary representation theory results over commutative local non-Gorenstein rings.

Title: Properties and Applications of Monomial Orders
Presenter: Gabriel Sosa
Affiliation: Purdue University
Abstract: The purpose of the talk is to define monomial orders, show local properties of certain monomial orders, find bounds on these properties. And show applications of monomial orders and Grobner Basis to advanced research problems in Koszul Algebras.

Title: The primes that Euclid forgot
Presenter: Enrique Treviño
Affiliation: Swarthmore College
Abstract: Let $q_1 = 2$. Supposing that we have defined q_j for all $1 \leq j \leq k$, let q_{k+1} be a prime factor of $1+\prod_{j=1}^{k} q_j$. As was shown by Euclid over two thousand years ago, $q_1, q_2, q_3, \ldots$ is then an infinite sequence of distinct primes. The sequence $\{q_i\}$ is not unique, since there is flexibility in the choice of the prime q_{k+1} dividing $1+\prod_{j=1}^{k} q_j$. Mullin suggested studying the two sequences formed by (1) always taking q_{k+1} as small as possible, and (2) always taking q_{k+1} as large as possible. For each of these sequences, he asked whether every prime eventually appears. Recently, Booker showed that the second sequence omits infinitely many primes. We give a completely elementary proof of Booker's result, suitable for presentation in a first course in number theory.

Title: Games, the Braid Group, and a Short Exact Sequence
Presenter: Dr. Jennifer Vasquez
Affiliation: University of Scranton
Abstract: In this talk, we will make a connection between the braid group and permutations using a visual representation of permutations as Japanese ladders. We will briefly explore different games based on these ladders and some of the mathematics behind them. Using this link, we establish a new short exact sequence and relate it to the fundamental sequence for the braid group.

Title: Hunting Bigfoot: The Search for an Elliptic Curve with $E(\mathbb{Q}) \simeq \mathbb{Z}/2\mathbb{Z} \times \mathbb{Z}/8\mathbb{Z} \times \mathbb{Z}^4$
Presenter: Jamie Weigandt
Affiliation: Purdue University
Abstract: The Mordell-Weil theorem asserts that the group of rational points on an elliptic curve is a finitely generated abelian group. That is, $E(\mathbb{Q}) \simeq T \times \mathbb{Z}^r$ for some finite abelian group T and some non-negative integer r, called the Mordell-Weil rank of E over $\mathbb{Q}$. A deep theorem of Mazur assures that only 15 isomorphism classes of finite abelian groups T can occur. The behavior of the rank, r, is much more mysterious. It is not even known whether or not r can be uniformly bounded for all elliptic curves E over $\mathbb{Q}$.

In this talk, we focus attention on those elliptic curves E over $\mathbb{Q}$ for which T is as large as possible. The largest value which r is know to attain in this family is 3. There are 28 such examples known, the first of which was discovered independently by Connell and Dujella in 2000.

We review the search for an example in this family with $r = 4$, discussing some the the computational methods used. We also describe a heuristic which suggests the expectation that the Mordell-Weil rank is bounded in this family of elliptic curves.

Title: The probability that a polynomial with integer coefficients has all real roots
Presenter: Lirong Yuan
Affiliation: Purdue University
Abstract: It is natural to use polynomials with integer coefficients for examples and exercises in an algebra course. However, not all such polynomials have all real roots. We ask a question: what is the probability that a random polynomial with integer coefficients has all real roots? We use some tools from probability theory and complex analysis to reduce the problem to studying the roots of random polynomials with real-valued coefficients instead. We discover that the probability that a polynomial of degree n with integer coefficients has real roots is equal to the probability that a polynomial of degree $n-1$ over real coefficients has real roots. In certain cases this allows us to use calculus to obtain an exact answer.

** Invited Faculty Speaker
* Distinguished Graduate Student

Poster Presentation Abstracts

Title: Heegaard Floer Homology
Presenter: Sayonita Ghosh Hajra
Affiliation: University of Georgia
Abstract: I will briefly describe what is Heegaard Diagram for a 3-manifold and then I will define Heegaard Floer homology and I will demonstrate various examples with S^3

Title: Representations with a Finite Number of orbits
Presenter: Gerard D. Koffi
Affiliation: University of Iowa
Abstract: Let R be a ring with 1 and M be a left R-module (i.e. a representation of R). Let G be the group of units of R. We define the left(resp. right) regular action of G on M to be the map $\varphi : G \times M \to M$ given by $\varphi(g, m) = gm$. We investigate the left regular action of G on M. We show that if M has finitely many orbits under the left regular action, then M has finite length. In particular, M is left artinian and has a composition series. If the action of G on M is not transitive, we prove that M has at least three orbits. Finally, we show that if M has finitely many orbits and the x_i's are orbit representatives with $i = 1, 2, \ldots, n$, then for some subset F of $\{1, 2, \ldots, n\}$, the submodule $\cap_{i \in F} Rx_i$ of M is cofinite.

Title: Weighted-sum domination of one-way street grids
Presenter: Christie Mauretour
Affiliation: Florida Gulf Coast University
Abstract: Finding domination number of grids has been studied for the past 30 years.In 2011, mathematicians such as Goncalves, Pinlou, Rao, Thomasse found a general formula. In this poster presentation , we will explore domination number of directed grids, and present a closed formula for weighted domination number of directed and undirected grids.

Title: Propagation Time for Zero Forcing of a Graph
Presenter: Shanise Walker
Affiliation: Iowa State University
Abstract: Zero forcing (also called graph infection) on a simple, undirected graph G is based on the color-change rule. The color-change rule states that if each vertex of G is colored either white or black, and vertex v is a black vertex with only one white neighbor u, then v forces u to become black. A zero forcing set is a set of black vertices that can force all vertices of G black using the color change rule. A minimum zero forcing set of G is a zero forcing set of minimum cardinality. The propagation time of a graph G is the minimum number of steps that it takes to force all the vertices of G black. The study of propagation times of graphs is related to the study of control quantum systems. Examples that demonstrate various features of the propagation time of a graph are introduced; in particular, minimum zero forcing sets having different propagation times are given. Bounds on the propagation time in terms of various graph parameters are presented. Graphs having extreme propagation times $|G| - 1$, $|G| - 2$, and 0 are characterized, and results regarding graphs having propagation time 1 are discussed.

Title: Examining Radicals of Extensions of Divisible Modules by Torsion Modules Over Commutative Rings
Presenter: Jessica Williams
Affiliation: University of Iowa
Abstract: Over a commutative ring, the radical of an extension of one module by another module is something about which little appears to be known. A collaborative effort bewteen Miodgrad Iovanov, Victor Camillo, and myself is being made to discover more information. It has been shown that if X is an extension of $\mathbb{Q}$ by a semisimple abelian group, then its Jacobson radical is either $\mathbb{Q}$ if it splits, or 0 otherwise. These results have been expanded to show that an image of the Jacobson radical of an extension of a divisible abelian group by a torsion abelian group is injective. A natural next step is to find more information about objects similar to the Jacobson radical of R-module extensions where R is a commutative ring, perhaps with special properties. We will examine the findings thus far obtained, specifically over Dedekind domains.