USTARS

underrepresented students in topology and algebra research symposium

University of California, Berkeley

Berkeley, California

April 11-13 2014

Symposium Agenda

Friday, April 11

6:00am-10:00pm Arrival to USTARS 2014

Saturday, April 12

8:00-12:00pm **Registration**
Durant Hall Atrium

9:00-9:30am **Welcome and Opening Remarks**
Dr. Candice Price, United States Military Academy, West Point
Dr. David Eisenbud, Director of MSRI, University of California, Berkeley
Location: Durant Hall Atrium

9:30-10:00am **Session I**
Graded modules over free algebras
Guatam Sisodia, University of Washington
Location: Durant Hall Room 9

Graph Theoretical Analysis of Knot Distances
Annette Honken, University of Iowa
Location: Durant Hall Room 120

Example of representation stability phenomena
Dr. Rita Jimenez Rolland, Northeastern University
Location: Durant Hall Atrium

10:15-10:45am **Session II**
A Family of Multi-Rees Koszul Cohen-Macaulay Normal Algebras
Gabriel Sosa, Purdue University
Location: Durant Hall Room 9

Equivariant Homotopy Theory
Mychael Sanchez, University of Illinois
Location: Durant Hall Room 120

MAPPER as a tool for analyzing data obtained from flow cytometry
Leyda Almodovar, University of Iowa
Location: Durant Hall Atrium

10:45-11:15am **Coffee Break**
Location: Durant Hall Atrium

11:15-12:30pm **Invited Faculty Speaker**
When Algebra Meets Optimization, And My Journey Through Grad School
Dr. Mohamed Omar, Harvey Mudd College
Location: Durant Hall Atrium

12:30-1:30pm **Lunch**
Location: Durant Hall Atrium

Saturday, April 12

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

A generating function for Weyl Dimension Formula
Wayne Johnson, University of Wisconsin, Milwaukee
Location: Durant Hall Room 9

On the Dubrovnik polynomial of rational knots
Katherine Urabe, California State University, Fresno
Location: Durant Hall Room 120

Radicals of Extensions
Jessica Williams, University of Iowa
Location: Durant Hall Atrium

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

On filtered representations of quivers with at most two pathways and on the generalized Grothendieck-Springer resolution.
Mee Seong Im, University of Illinois, Urbana-Champaign
Location: Durant Hall Room 9

Classification of tight contact structures using convex surface theory
Marcos Ortiz, University of Iowa
Location: Durant Hall Room 120

A quantitative lower bound theorem for face numbers of polytopes
Jose Alejandro Samper Casas, University of Washington
Location: Durant Hall Atrium

2:45-3:00pm **Coffee Break & Conference Photo**
Location: Durant Hall Atrium

3:00-4:00pm **Poster Session**
Location: Durant Hall Atrium

4:15-5:30pm **Distinguished Graduate Student**
Loop groups, embeddings and moduli spaces
Pablo Solis, University of California, Berkeley
Location: Durant Hall Atrium

7:00-8:30pm **Symposium Banquet**
Location: Dwinelle Hall Room 370

Sunday, April 13

9:00-9:30am	**Session V** *Computing Peak Set Probabilities in Coxeter Groups* Darleen Perez-Lavin, Florida Gulf Coast University Location: Durant Hall Room 9 *A bound for the number of disjoint genus one surfaces bounded by a hyperbolic knot in the 3-sphere.* Dr. Luis Valdez-Sanchez, University of Texas at El Paso Location: Durant Hall Room 120 *Shi Arrangements, Parking Functions and Mixed Graphs* Ana Berrizbeitia, University of Iowa Location: Durant Hall Atrium
9:40-10:10am	**Session VI** *Representations of Non-commutative W-Graphs* Alexander Diaz-Lopez, University of Notre Dame Location: Durant Hall Room 9 *Intrinsic Linking in Directed Graphs* Natalie Rich, University of Nebraska Location: Durant Hall Room 120 *On (t, r) Domination Numbers of Grids* David Blessing, Florida Gulf Coast University Location: Durant Hall Atrium
10:20-11:30am	**Distinguished Graduate Student** *Galois module structure of abelian extensions* Cindy (Sin Yi) Tsang, University of California, Santa Barbara Location: Durant Hall Atrium
11:45am- 1:15pm	**Networking Lunch and Symposium Closing** Location: Dwinelle Hall Room 370 **Panelists:** Anastasia Chavez, University of California, Berkeley Dr. Emille D. Lawrence, University of San Francisco Dr. Stephen Mendez-Diez, University of Alberta Samuel Ivy, North Carolina State University Dr. Amanda Ruiz, Harvey Mudd College **Moderator:** Dr. Syvillia Averett, Central State University

Special thanks to the following sponsors, partners, and supporters:

The National Science Foundation
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Oral Presentation Abstracts

Title: MAPPER as a tool for analyzing data obtained from flow cytometry
Presenter: Leyda Almodovar
Affiliation: University of Iowa
Abstract: MAPPER is a computational method for the analysis, simplification and visualization of high dimensional data sets, based on topological ideas created by Gurjeet Singh, Facundo Mémoli and Gunnar Carlsson. It outputs a graph, which captures topological information and can help to visualize specific properties of the data. We used topological methods such as MAPPER as tools for analyzing data collected from flow cytometers.

Title: Shi Arrangements, Parking Functions and Mixed Graphs
Presenter: Ana Berrizbeitia
Affiliation: University of Iowa
Abstract: A Shi arrangement is a hyperplane arrangement in R^n consisting of all planes of the form $x_i = x_j$ and $x_i = x_j + 1$ for $1 \leq i < j \leq n$. A parking function is an n-tuple such that once ordered, $a_i \leq i$. The two objects seem completely unrelated, but the regions of a Shi arrangement are actually in 1-1 correspondence with the n-tuples which are parking functions. In this talk, I will motivate the definition of both objects and exhibit an explicit bijection using the aid of mixed graphs. It is a cute and unique solution to an old problem originally solved by Pak and Stanley.

Title: On (t, r) Domination Numbers of Grids
Presenter: David Blessing
Affiliation: Florida Gulf Coast University
Abstract: We find a generalization of domination theory which includes classic domination theory as a special case. (t, r) Broadcast Domination is such a theory. Each selected vertex in a grid G, v, emits a signal of strength t to nearby vertices, u, which decays proportionally to the minimal path connecting v to u. A collection of vertices is a (t, r) Broadcast domination set if all vertices in G receive a total signal of r or more. We derive closed form formulas for grids and upper bounds for large grids in $(2, 2)$, $(3, 1)$, and $(3, 2)$ Broadcast Domination.

Title: Representations of Non-commutative W-Graphs
Presenter: Alexander Diaz-Lopez
Affiliation: University of Notre Dame
Abstract: In 1979, Kazhdan and Lusztig studied Hecke algebras, which arise as endomorphism algebras of representations of groups induced by representations of subgroups. Later, they define representations of Hecke algebras indexed by left cells of Coxeter groups. In my talk, I will construct representations of Hecke algebras on quotient path algebras over suitable quivers, and discuss their relation with the representations indexed by left cells.

Title: Graph Theoretical Analysis of Knot Distances
Presenter: Annette Honken
Affiliation: University of Iowa
Abstract: A knot is the embedding of S^1 in three dimensional space up to ambient isotopy. We define the distance between two knots, K and L, to be the minimum number of crossing changes required to obtain L from a sequence of crossing changes on K. Then, using rational knots as vertices and placing an edge between two vertices if they are of distance one, we have knot distances graphs. Thus far, we have studied knot distance graphs of rational knots with up to ten crossings. We aim to classify these knots as random, small-world, or scale-free networks through taking measurements of degree, degree distribution, distance statistics, clustering coefficient, and scale-freeness. Additionally, we look at what aligning graphs with different maximum crossing number may tell us. Knots model DNA as well as locally knotted protein, and a crossing change models the action of a type II topoisomerase on double stranded circular DNA. Therefore, we will work to find new patterns and properties among knots via crossing changes and hope to extract biological information as well.

Title: On filtered representations of quivers with at most two pathways and on the generalized Grothendieck-Springer resolution
Presenter: Mee Seong Im
Affiliation: University of Illinois, Urbana-Champaign
Abstract Given a group action on a topological space, one studies and classifies the structure of orbits on the space. Using techniques in multilinear algebra, geometric invariant theory, algebraic geometry, homological algebra, and symplectic geometry, representations of quivers with the natural group action generalize classical results, such as Procesi and Donkin's study of Lie group actions on Lie algebras and the Kronecker problem. A world of interesting problems arises, leading us to Nakajima's quiver varieties, Gan and Ginzburg's almost-commuting variety in representation theory, optimization and control in compactification of moduli of linear dynamical systems, etc. I will discuss the history of equivariant geometry, introduce the notion of filtered quiver varieties, and explain their relation to an important object in representation theory called the Grothendieck-Springer resolution. New definitions will be introduced which will give us an algebraic condition that if $\mathbb{U}$-invariants for filtered representations of nonframed quivers only come from diagonal blocks of representations (i.e., the semisimple part), then Q has at most two pathways between any two vertices. I will then discuss how to obtain the Hamiltonian reduction of the cotangent bundle of the Grothendieck-Springer resolution from a filtered quiver variety and I will give some results. I will conclude with some open problems and conjectures relating to filtered representations of quivers and on the generalized Grothendieck-Springer resolution.

Title: Examples of representation stability phenomena
Presenter: Dr. Rita Jimenez Rolland
Affiliation: Northeastern University
Abstract: We will focus on examples of sequences of spaces or groups X_n whose rational cohomology carries an action of the symmetric group S_n. We will see that these S_n -representations "stabilize" when the parameter n is sufficiently large.

Title: A generating function for the Weyl Dimension Formula
Presenter: Wayne Johnson
Affiliation: University of Wisconsin, Milwaukee
Abstract: In 2011, Gross and Wallach published a closed form for the Hilbert series of an equivariantly embedded projective variety. In this talk, we present a generalization of their result that gives a generating function for the dimensions of the irreducible representations of a semi-simple, simply connected complex linear algebraic group whose highest weight is in any lattice cone in the dominant chamber.

Title: When Algebra Meets Optimization, And My Journey Through Grad School
Presenter: Dr. Mohamed Omar **
Affiliation: Harvey Mudd College
Abstract: In recent years, algebraic tools have played a fundamental role in understanding theory and algorithms in optimization. In this talk, we showcase some particular examples where the interplay between these areas comes to light. We focus on results that came to fruition during the speaker's graduate school experience.

Title: Classification of tight contact structures using convex surface theory
Presenter: Marcos Ortiz
Affiliation: University of Iowa
Abstract: Every 3-manifold supports a contact structure but the classification of such structures is largely incomplete outside of a relatively small collection of manifolds. For example, little is known about contact structures on thickened surfaces. One strategy we can employ towards the goal of classifying these structures is to prescribed a dividing set on the boundary of such a manifold and use convex surface theory techniques to find bounds the number of possibly distinct contact structures that give rise to the chosen dividing set. If a reasonably small bound can be found, one can try to explicitly construct the contract structures supported by those manifolds, completing the classification in these cases. In this talk I will describe several of the techniques employed in finding a bound on the number of contact structures. I will summarize some known results and include some original results from my research.

Title: Computing Peak Set Probabilities in Coxeter Groups
Presenter: Darleen Perez-Lavin
Affiliation: Florida Gulf Coast University
Abstract: In this talk we explore the question: What is the probability that a random element of a Coxeter group has a given peak set? This question was first explored in type A Coxeter groups by Billey, Burdzy, Pal, and Sagan in 2013. We will discuss results in other Lie types.

Title: Intrinsic Linking in Directed Graphs
Presenter: Natalie Rich
Affiliation: University of Nebraska
Abstract: We extend the notion of intrinsic linking to directed graphs. We give methods of constructing intrinsically linked directed graphs, as well as directed graphs with arbitrarily large numbers of edges that are not intrinsically linked. We give a simple construction that takes a graph G and doubles it to get a directed graph Γ with twice as many edges as G, proving that it gives an intrinsically linked directed graph if and only if G is intrinsically linked. One corollary is that J_6, the complete directed graph on six vertices (with 30 directed edges), is intrinsically linked.

Title: A quantitative lower bound theorem for face numbers of polytopes
Presenter: Jose Alejandro Samper Casas
Affiliation: University of Washington
Abstract: The face numbers of simplicial polytopes that approximate C^1-convex bodies in the Hausdorff metric is studied. We use several techniques from differential/algebraic topology to prove structural results about the skeleta of such polytopes are studied and used to derive a lower bound theorem for this class of polytopes. This partially resolves a conjecture made by Kalai in 1994: if a sequence $\{P_n\}_{n=0}^{\infty}$ of simplicial polytopes converges to a C^1-convex body in the Hausdorff distance, then the entries of the g-vector of P_n converge to infinity.

Title: Equivariant homotopy theory
Presenter: Mychael Sanchez
Affiliation: University of Illinois
Abstract: This will be a general talk on equivariant homotopy theory with the goal of introducing equivariant K-theory.

Title: Graded modules over free algebras
Presenter: Gautam Sisodia
Affiliation: University of Washington
Abstract: Let F be a finitely generated N-graded free algebra over a field. The Hilbert series of a graded vector space V is a formal power series that encodes the dimensions of the homogeneous components of V. We give an answer to the following question: what are the possible Hilbert series of finitely presented graded F-modules? We use our answer to compute the Grothendieck group (as an ordered abelian group) of the quotient category of finitely presented graded F-modules modulo those that are finite dimensional. This work is joint with S. Paul Smith.

Title: Loop groups, embeddings and moduli spaces
Presenter: Pablo Solis*
Affiliation: University of California, Berkeley
Abstract: This talk is about three things: infinite dimensional Lie groups, representation theory and moduli problems. The group in question is called the loop group; it is the space of maps from a circle into a topological group. The loop group has a class of representations -those of positive energy- that generalize the highest weight representations of semisimple groups over the complex numbers. These representations allow one to construct an infinite dimensional space that one can relate to the finite dimensional moduli problem of parametrizing vector bundles on a compact Riemann surface. I'll explain this setup and show how it can be used to compactify this moduli space of vector bundles when the Riemann surface is allowed to develop singularities. Over the last 30 years other compactifications have been presented by Caparoso, Gieseker, Pandharipande, Seshadri and Nagaraj of varying generality but this is the first construction that provides a compactification not just for vector bundles but

for principal G bundles for an arbitrary simple group over the complex numbers.

Title: A Family of Multi-Rees Koszul Cohen-Macaulay Normal
Presenter: Gabriel Sosa
Affiliation: Purdue University
Abstract: Generalizing techniques that prove that Veronese subrings are Koszul, we show that Rees and multi-Rees algebras corresponding to sets that are closed under comparability are Koszul. We provide Grobner basis for the defining ideals of these multi-Rees algebras with squarefree initial monomials, to show that they are also normal Cohen-Macaulay domains. The talk will be based on results from a paper that I will submit to the arxiv later this month (January)

Title: Galois module structure of abelian extensions
Presenter: Cindy (Sin Yi) Tsang*
Affiliation: University of California, Santa Barbara
Abstract: Let K be a number field with ring of integers $\mathcal{O}$ and G a finite group. If L/K is a Galois extension with group G, then L has a K-basis of the form $\{\sigma a \mid \sigma \in G\}$, called a normal basis. Equivalently, this means that L is free as a KG-module. A natural question to ask is whether one can generalize this to the ring of integers, i.e. is $\mathcal{O}_L$ free over $\mathcal{O}G$? It turns out that the global and local freeness of $\mathcal{O}_L$ is closely is related to the ramification of L/K. Furthermore, when $\mathcal{O}_L$ is locally free over $\mathcal{O}G$, it defines a class in the locally free class group $\mathrm{Cl}(\mathcal{O}G)$ of $\mathcal{O}G$. A natural question to ask is whether the collection of all these classes form a group. In this talk, I will discuss results that have been known to these two questions; I will also briefly explain how one can generalize all of these to the square root of the inverse different.

Title: On the Dubrovnik polynomial of rational knots
Presenter: Katherine Urabe
Affiliation: California State University, Fresno
Abstract: Rational knots and links arise as numerator closures of rational tangles, which form a basis for their classification. A rational tangle is the result of consecutive twists on neighboring endpoints of two trivial arcs, and is associated in a canonical manner with a unique, reduced rational number or infinity. This number equals a continued fraction with all numerators equal to one and all denominators of the same sign, that can be read from a particular diagram of the tangle. Equivalently, one can associate to a rational tangle diagram (in standard form) a vector of integers. In this work, we find a closed formula for the Dubrovnik polynomial of a rational knot/link diagram in terms of the entries of its associated vector.

Title: A bound for the number of disjoint genus one surfaces bounded by a hyperbolic knot in the 3-sphere.
Presenter: Dr. Luis Valdez-Sanchez
Affiliation: University of Texas at El Paso
Abstract: A genus one knot in the 3-sphere is a knot which bounds a once-punctured torus in its exterior but does not bound a disk. It is known that a hyperbolic knot can have at most 7 disjoint such surfaces in its exterior, and in this talk we will show that in fact at most 6 such surfaces may exist. The proof makes use of combinatorial arguments applied to the graphs obtained by the transverse intersection of suitable surfaces properly embedded in the exterior of a hyperbolic knot, and of the connections between the algebra and the topology of genus 2 handlebodies. Examples of genus one hyperbolic knots whose exterior contain up to 5 disjoint once-punctured tori will also be presented.

Title: Radicals of Extensions
Presenter: Jessica Williams
Affiliation: University of Iowa
Abstract: The Jacobson radical of an extension of one module by another is something about which little appears to be known. Victor Camillo, Miodrag Iovanov, and I have been working towards finding properties of this radical. We have been able to prove some injectivity properties under various different conditions for the modules in the sequence and the underlying ring structure. Specifically, we have results for principal ideal domains and Dedekind domains.

Poster Presentation Abstracts

Title: Invariants for Spatial Graphs
Presenter: Elaina Aceves and Jennifer Elder
Affiliation: California State University, Fresno
Abstract: A spatial graph is an embedding of a graph in three-dimensional space. We construct an invariant for spatial graphs by performing certain replacements at the vertices of a graph diagram, which results in a collection C of arcs and knot/link diagrams. After discarding the arcs, we use known polynomial invariants for knots and links to evaluate the objects in the collection C, and obtain a Laurent polynomial associated with our original spatial graph, which is independent on the embedding type of the graph. Thus our approach yields an invariant for spatial graphs. We discuss some properties of this invariant, including a relationship between the resulting invariant of a spatial graph G and the invariants associated with the two graphs obtained from G by applying the contraction-deletion move in a neighborhood of a vertex of the graph G.

Title: Permutation Patterns for Real-Valued Functions
Presenters: Alicia Arrua, Gustavo Meléndez Ríos, and Lynesia Taylor
Affiliation: California State Polytechnic University, Pomona; University of Puerto Rico, Rio Piedras; Spelman College
Abstract: Let $[x, f(x), f(f(x)) = f^2(x), ..., f^{(n-1)}(x)]$ be the sequence where f is a real-valued function and $n \geq 2$. We can associate a permutation to every such sequence by comparing it with $x_1 < x_2 < \ldots < x_n$, where $x_i = f^{(j-1)}(x)$ for some $j = 1, 2, \ldots, n$. Permutations that occur are allowed permutations; otherwise they are called forbidden permutations. We focus on enumerating and identifying permutations of real-valued functions such as the logistic map ($L_r(x) = rx(1-x)$ with $0 < r \leq 4$), the half-circle map ($H(x) = \sqrt{x - x^2}$), the sine map ($S(x) = sin(\pi x)$), the castle map ($C(x) = -16x^4 + 32x^3 - 24x^2 + 8x$), and variations of the logistic map ($L_r(x^k) = rx^k(1 - x^k)$ where $k \geq 2$). In the case of the half-circle map, we completely enumerated all of its permutations. Furthermore, we have conjectured that the sine and castle maps are order isomorphic to the $L_4(x)$, i.e., they have the same allowed and forbidden permutations. We have also conjectured that several variations of the logistic map are order isomorphic to each other.

Title: Computations In The Relative Skein Algebra of a Local Annulus
Presenter: Nelson Colon
Affiliation: University of Iowa
Abstract: Let M be a compact, oriented, 3-manifold of the form $F \times [0, 1]$ where F is an oriented surface of genus g and b boundary components. $K_A(M)$ is the skein algebra of M for A an N-th root of unity. The purpose of this poster is to present tools to reduced a skein in $K_A(M)$ by finding an annulus in F and simplifying the skein locally in such annulus.

Title: The Algebra of Block Permutations
Presenters: Ryan Contreras and Isabel Corona
Affiliation: Columbia University; Metropolitan State University of Denver
Abstract: A *block permutation* of $[n] = \{1, 2, \ldots, n\}$ consists of two set partitions $\mathcal{A}, \mathcal{B} \vdash [n]$ having the same number of blocks and a bijection $f : \mathcal{A} \to \mathcal{B}$. We show that the set of block permutations of $[n]$, BP_n, is closed under multiplication and hence is a monoid. We define a Hopf algebra of block permutations, which is a generalization of the Hopf algebra of uniform block permutations. The algebra BP_n is a subalgebra of the partition algebra and is therefore a diagram algebra. Furthermore, we study the subalgebra of planar diagrams, P_n, and give a presentation for both P_n and BP_n. We consider the planar rook algebra RP_n and show that it is isomorphic to P_{n+1}. Using this isomorphism we can give all the irreducible representations for P_{n+1}. In addition, we are in the process of constructing the irreducible representations for BP_n, which will be indexed by Young diagrams with $1, 2, \ldots, n$ boxes. We conjecture as to the degree of the irreducible representations and investigate the induction of representations of BP_n to BP_{n+1}.

Title: On the Schur Positivity of Differences of Products of Schur Functions
Presenter: Jeremiah Emidih and Nadine Jansen
Affiliation: University of California, Riverside; North Carolina A&T State University
Abstract: The Schur functions are a basis for the ring of symmetric functions indexed by partitions of nonnegative integers. A symmetric function f is called Schur positive if when expressed as a linear combination of Schur functions

$$f = \sum_{\lambda} c_{\lambda} s_{\lambda}$$

each coefficient c_{λ} is nonnegative. We wish to investigate expressions of the form

$$s_{\lambda} s_{\lambda^c} - s_{\mu} s_{\mu^c}$$

where λ partitions n and μ partitions $n-1$ and the complements λ^c, μ^c are taken over a sufficiently large $m \times m$ square. We give a necessary condition that if $s_{\lambda} s_{\lambda^c} - s_{\mu} s_{\mu^c}$ is Schur positive, then μ is contained in λ. Furthermore, we show how both increasing the size of our box and conjugating partitions preserves Schur positivity. Lastly, we incorporate the Littlewood Richardson rule to conjecture a full characterization of when $s_{\lambda} s_{\lambda^c} - s_{\mu} s_{\mu^c}$ is Schur positive.

Title: Understand Ultrafilters, Understand Schur's Theorem
Presenter: Joseph Foss
Affiliation: United States Military Academy, West Point
Abstract: Looking at a finite partition of the natural numbers, Schur's Theorem states there exists a cell of the partition such that x, y, and z are all members of said cell where $z = x + y$. This is an important theoretical result of Ramsey Theory and combinatorics in general. A filter is a set of sets that is closed under finite intersections, closed under supersets, and does not have the empty set as one of its members. An ultrafilter is a maximum filter. By studying semigroups, namely the set of ultrafilters on the natural numbers, we can produce an algebraic proof of Schur's Theorem.

Title: Invariants for Virtual Singular Links
Presenter: Kelsey Friesen and Thoa Tran
Affiliation: California State University, Fresno
Abstract: A singular link is an immersion of a disjoint union of circles into three-dimensional space, which admits only finitely many singularities that are all transverse double points. A singular link diagram is a projection of a singular link into a plane, and contains two types of crossings, namely classical crossings and singular crossings.

Virtual knot theory, introduced by Lou Kauffman in 1996, can be regarded as a projection of classical knot theory in thickened surfaces. We take one step further by studying virtual singular links, which can be thought as immersions of disjoint unions of circles into thickened surfaces. A virtual singular link diagram contains then three types of crossings: classical, singular, and virtual crossings.

We focus on constructing invariants for virtual singular links, by means of extending known invariants for classical knots and links.

Title: $(4, 1)$- Broadcast Domination of an $m \times n$ Grid
Presenter: Armando Grez
Affiliation: Florida Gulf Coast University
Abstract: In graph theory a dominating set is a subset of vertices S such that all vertices in the graph is either in S or adjacent to some vertex in S. The domination number is the cardinality of the smallest dominating set of G. This study examines grid graphs given a broadcast center has a transmission of weight 4 and we wish for all the vertices in the graph have a weight no less than 1 or be covered by more than a single center. We go further to discover an upper bound for reducing (4,1) dominating sets by a determined construction from a perfectly dominated grid in $Z \times Z$. In addition, from this construction we derive several other properties for (4,1) graph grids. We also discuss consequences of this construction for (4,1) in finding smaller dominating sets to better approximate the domination number for large grids.

Title: Finitary rings, Modules, and orbits of the regular action
Presenter: Gerard Koffi
Affiliation: University of Iowa
Abstract: Given a ring R with 1, let M be a left R-module. We denote the group of units of R by G. Then G acts naturally on M as follows: $g * m = gm$ for all g in G and m in M. This action is called the left regular action. When M is the left regular module R, Y. Hirano showed that a ring with finitely many orbits under the regular action is a direct sum of finitely many uniserial rings and a finite ring. The purpose of this paper is to examine the situation when M is a left R-module with finitely many orbits under the left regular action. Specifically, the problem is to describe the left R-modules with finitely many orbits under the left regular action. We prove that when R is a semilocal ring, such modules have finite length and cannot have a subfactor isomorphic to $T + T$ where T is simple and $\mathrm{End}_R(T)$ is infinite. We use this Theorem to give a module theoretical proof of Hirano's result which was proved using ring theoretical approach.

Title: Redefining Patrol Areas: Minimizing Numbers, Maximizing Results
Presenter: Victoria Markow
Affiliation: United States Military Academy, Westpoint
Abstract: During my summer training in 2013, I shadowed a platoon leader at Fort Bragg, North Carolina for three weeks. During this short time period, I witnessed several Military Police platoon leaders struggle to meet the minimum requirements for the number of soldiers patrolling the roads. As one may imagine this problem is not unique to this specific company or even to us, the Army. In fact, as the national budget shrinks, so do the budgets of all the different law enforcement entities. After speaking to my hometown police chief in New Britain, Connecticut, I learned that currently in order to achieve an effective amount of patrols on the roads, superiors are relying on experience and guess work to develop patrol schedules. Although this strategy may be effective, it may not be the most efficient. Due to continuing budgetary constraints, now more than ever it is critical to develop mathematical methods to ensure that police patrols are set in the most optimal way.

Title: (2,2)-Broadcast Domination Number of Directed and Undirected grids
Presenter: Christie Mauretour
Affiliation: Florida Gulf Coast University
Abstract: In this presentation, we explore the double domination numbers grids. For an $m \times n$ grid Gm, n, suppose that a police ocer can protect the vertex she is stationed at with weight 2 and every neighboring vertex with weight one. The double domination number of Gm,n is the minimum number of police ocers needed to protect the grid with a weight of at least 2 at each vertex. We present closed formulas for the double domination number of grids Gm, n when $m =$ 3,4,5, and $n \geq m$. We also present closed formulas for the double domination number of directed mn grids that model one-way street grids.

Title: The Colorability of Crease Patterns
Presenter Esther Oh
Affiliation United States Military Academy, West Point
Abstract: We explore graph theory to explain geometric structures of origami and color patterns. Our goal is to demonstrate the colorability of one, two, and three-dimensional origami. First, we examine vertex-degree and how it affects our ability to color each vertex such that no two vertices connected by an edge are colored by the same color. Then, we color crease patterns so that no adjacent regions have the same color. Lastly, by folding three-dimensional origami, we explore how edge-coloring is related to Hamiltonian circuits. Through showing the colorability of origami structures, this research highlights the relationship between the mathematics and folding paper.

Title: Number of Permutations with Same Peak Set for Signed Permutations
Presenter: Jose Pastrana and Rita Zevallos
Affiliation: University of Puerto Rico, Rio Piedras; Swarthmore College
Abstract: A signed permutation in the hyperoctalhedral group B_n is a sequence $\pi_1\pi_2\ldots\pi_n$ such that each $\pi_i \in \{-n, \ldots, -1, 1, \ldots, n\}$ and $\{|\pi_1|, |\pi_2|, \ldots, |\pi_n|\} = [n] = \{1, 2, ..., n\}$. A signed permutation has a peak in a position $i = 2, \ldots, n-1$ if $\pi_{i-1} < \pi_i > \pi_{i+1}$. Let $P(\pi)$ be the set of peaks of π, $P_B(S, n)$ be the set of signed permutations $\pi \in B_n$ such that $P(\pi) = S$, and $\#P_B(S, n)$ be the cardinality of $P_B(S, n)$. In [**?**], Billey, et. al. find

a method for computing the number of permutations with a given peak set S when working in S_n. We extend these results to B_n by showing $\#P_B(S,n) = p(n)2^{2n-|S|-1}$ where $p(n)$ is the same polynomial as that given by Billey et. al., and find polynomials for various special cases of S. In addition, we extend these results both in B_n and S_n to the assumption that $\pi_0 = 0$, which allows the possibility of a peak at 1.

Title: Chromatic Symmetric Functions and Graph Gluing
Presenter: Caprice Stanley
Affiliation: The George Washington University
Abstract: Graph coloring has been and continues to be an active area of study. For a graph G there is an associated chromatic polynomial, $\chi(G,x)$, which gives information about the number of proper colorings for G if we limit the number of labels to be used. In 1995, Richard Stanley introduced a generalization of the chromatic polynomial. For a graph G, he defined the chromatic symmetric function as follows,

$$X_G = X_G(x_1, x_2, \dots) = \sum_{\kappa} \left(\prod_{v \in V} x_{\kappa(v)} \right)$$

where the sum is over all proper colorings κ and V is the set of vertices in G. From X_G, there is some information that can be obtained about G that is not available from $\chi(G,x)$. Further, it is possible for two non-isomorphic graphs to share a chromatic polynomial but have different chromatic symmetric functions. It has been a goal to provide sufficient conditions under which two graphs will have the same chromatic symmetric function. We will present some ways to construct graphs that have the same chromatic symmetric functions using the operation of gluing two graphs together at a vertex.