2012

NCUWM Talk Abstracts 2012

The Fourteenth Annual Nebraska Conference for Undergraduate Women in Mathematics

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TALK ABSTRACTS

PLENARY TALKS

Dr. Sara Billey
Professor of Mathematics
University of Washington, Seattle
An Introduction to the Combinatorics and Geometry of Schubert Varieties

The study of Schubert varieties has grown out of questions in enumerate geometry from the 19th century. This field has flourished over the past fifty years and now has applications in algebraic geometry, representation theory, combinatorics, physics, computer graphics, and economics. We will define Schubert varieties in the context of Grassmannians and flag varieties. These varieties have many interesting properties determined by combinatorial data like partitions, permutations, posets, and graphs. We present five fun facts on Schubert varieties and some open problems in the field.

Dr. Ingrid Daubechies
Professor of Mathematics
Duke University
Animation, Teeth and Skeletons

We describe new distances between pairs of two-dimensional surfaces (embedded in three-dimensional space) that use both local structures and global information in the surfaces.

These are motivated by the need of biological morphologists to compare different phenotypical structures. At present, scientists using physical traits to study evolutionary relationships among living and extinct animals analyze data extracted from carefully defined anatomical correspondence points (landmarks). Identifying and recording these landmarks is time consuming and can be done accurately only by trained morphologists. This necessity renders these studies inaccessible to non-morphologists and causes phenomics to lag behind genomics in elucidating evolutionary patterns.

Unlike other algorithms presented for morphological correspondences, our approach does not require any preliminary marking of special features or landmarks by the user. It also differs from other seminal work in computational geometry in that our algorithms are polynomial in nature and thus faster, making pairwise comparisons feasible for significantly larger numbers of digitized surfaces.

We illustrate our approach using three datasets representing teeth and different bones of primates and humans, and show that it leads to highly accurate results.

Talks by Undergraduate Students

Lani Abels, Humboldt State University
Conquering Math Anxiety

Say the word "Math" and most students will run away screaming. Math anxiety plagues most of the population, but in her book, *Conquering Math Anxiety*, Cynthia Arem breaks down the psychology of math anxiety from whether or not you really have math anxiety to the strategies to overcoming it. Positive thinking, visualizations, and attitudes are a few of the strategies that this talk will cover as we find ways to encourage students of all ages to conquer their math anxiety.

Alisa Arnold, Metropolitan State College of Denver
FOILing Girls Into Mathematics

Today, more young girls are involved in mathematics than ever before. However, there are still many socio-cultural, parental, and educational system factors that prevent young girls from embracing the study of mathematics. This talk will present findings from the research literature about the factors that discourage young girls from pursuing mathematics from early childhood through high school. This talk will also suggest actions that can be taken by parents and teachers to encourage girls to pursue mathematics as a field of study.

Holly Arrowood, Furman University
A Metacalibration Proof of the Isoperimetric Inequality on Constant Gaussian Curvature Surfaces

A new proof of the isoperimetric inequality on spheres and hyperbolic planes. We use a new method of optimization proof called metacalibration, in which competitors are compared directly to the proposed minimizer via vector fields and the divergence theorem. This approach paves the way to solve open problems such as multiple bubbles and isoperimetric problems with boundary on constant Gaussian curvature surfaces.

Kassandra Averill, SUNY Potsdam
Mary Russell, Canisius College
Anna Weigandt, Illinois State University
Everyday We Shufflin': Analyzing Circular Decks and Probability Transition Matrices

We consider shuffling strategies for a circular deck of cards. This is a deck that does not have either a top or bottom, but rather treats each card as having a card above and below it. It is interesting to examine decks with this different structure as well as varying size of decks. We will analyze two methods of shuffling on a circular deck and prove the surprising fact that they are equivalent. Additionally, we will analyze the probabilities of transitioning between decks of cards that differ in size by a single card.

Crystal Bennett, North Carolina Agricultural & Technical State
CO-Mediated HbS Polymer Melting

Sickle cell anemia is a disorder caused by a mutation in DNA that replaces the nucleic acid Glutamic with Valine. This replacement causes a change in the characteristics of hemoglobin that allows the monomers, the simplest units of chemically binding molecules, to stick together. These chains of monomers, called polymers, distort the shape and properties of the red blood cell. The malformed cells do not efficiently pass through capillaries or transport oxygen to the bodys tissues. In order to make these cells more effective, the polymers must be broken apart. The process of breaking polymers apart is called melting. In the referenced study, the melting was induced by immersing the polymers in a buffer solution containing carbon monoxide. The mathematical model of this process was produced in a separate study. The purpose of this paper is to analyze and reproduce the current mathematical model using various computational and numerical tools.

Elisabeth Berg, Seattle Pacific University
Special Cases of the Steinhaus Problem

A set is said to be Steinhaus if it intersects any isometry of the integer lattice at one and only one point. This definition can also be generalized to sets other than the lattice. In particular, we disprove the existence of Steinhaus sets for the points of a regular hexagon and finite integer lattices of size $m \times n$, where $m \neq n$. We also explore the existence of Steinhaus sets for finite sets of points with equivalent distance sets.

Ashley Bezio, Northern Arizona University
Allison Loesl, Northern Arizona University
Trees of Irreducible Numerical Semigroups

A recent paper by Blanco and Rosales describes an algorithm for constructing a directed graph of irreducible numerical semigroups with fixed Frobenius number. After presenting background information, we will explain the algorithm and construct specific examples.

Dubravka Bodiroga, Hood College
The Cubic Formula in Characteristic 3

Cardano's formulas express solutions of a cubic equation $x^3 - a_1x^2 + a_2x - a_3 = 0$ in terms of its coefficients a_1, a_2, and a_3 by extracting square root and cube roots. However, Cardano's method does not work in characteristic 3, where $3 = 0$, because the formulas require dividing by 3 and because cube roots behave badly in characteristic 3. The proper replacements for cube roots in characteristic 3 are solutions y to "Artin-Schreier" equations $y^3 = y + b$. I will explain how to construct a characteristic 3 replacement for Cardano's formulas that solves cubics in terms of Artin-Schreier equations. I use the method of Euler and Bézout, and analyze the solution in the style of Lagrange.

Jessalyn Bolkema, Hope College
Non-real zeros of derivatives of a class of real entire functions

In 1943, G. Polya conjectured that the number of non-real zeros the kth derivative of a real entire function of order greater than 2, with finitely many non-real zeros, tends to infinity as $k \to \infty$. This was verified in 2005 by A. Eremenko and W. Bergweiler. A natural extension is whether the number of non-real zeros of the kth derivative increases monotonically as $k \to \infty$. We show that the number of non-real zeros of $f^{(k)}(z)$ increases monotonically with differentiation when $f(z) = z^m e^{K(z)}$ where $m \in$ and K is in one of several special classes of real polynomials.

Andrea Brown, Cedarville University
Space Filling Curves

This presentation looks at the basic properties of Space-Filling Curves, a function of a given spatial dimension that takes up space in a higher dimension. Specifically, we will discuss the methods for determining the correspondence of points in a space filling curve from the unit interval, $[0, 1]$, to the unit square $[0, 1] \times [0, 1]$. These methods include percentages, nested squares, and transformations in the complex plane.

Jessica Burow, University of Nebraska-Lincoln
City of Lincoln Investments: Optimizing Benefits and Risk

This talk is based on our research project, which involves maximizing the profit and minimizing the risk in the investment portfolio of the City of Lincoln. This would be beneficial to the city, as we would potentially be increasing the value of their portfolio so that they can have more spending money and/or more money to reinvest. Our approach is to use data from the City Treasurer, on Lincoln's past investments to write multiple linear optimization programs using the Sage software. In writing these programs we use statistical applications from concepts of Modern Portfolio Theory. This project stems from a UNL class called "Math in the City" and is joint work with Ben Hoffman and Phil Onyeforo.

Suzanne Carter, University of Iowa
Data Analysis Techniques for Optical Waveforms

This presentation discusses analysis techniques applied to data collected while working at the Center for Research and Restoration of the French Museums. Using various waveform analyses, we were tasked with identifying Iron oxide pigments underneath plaster samples for use in imaging covered frescos. Successful application of these techniques enabled us to view several covered pigments and to observe surface features of our samples as well.

Justina Cline, Coe College
Where's Waldo? An application of image processing

Using MATLAB, we created a series of image processing filters, that, along with eigenfaces and invariant moments, allowed us to search a digital image from the "Where's Waldo books to find Waldo. We used the image processing filters to find potential locations for Waldo in the image, and applied eigenfaces and invariant moments at those locations to determine the most likely location of Waldo. After testing various images, the success rate of our algorithm was approximately 80%.

Susannah Coates, Metropolitan State College of Denver
Alees Seehausen, Metropolitan State College of Denver
Investigation of 7-Edge Polygonal Chains, Stuck Unknots and Stuck Trivial Chains

The space of all polygonal chains, Ch_n, without length restrictions is trivial, that is all knotted chains may be un-knotted and straightened. However, when length restrictions are included, the space $\mathrm{Ch}_n(l_1, ..., l_n)$ has a variety of interesting topological properties. Using physical modeling and topological methods, we investigate the equivalence classes and properties of the space of 7-edge chains, $\mathrm{Ch}_7(l_1, ...l_7)$. We also investigate "stuck" unknots, loops which contain no knots and yet are not isotopic to a convex polygon; and "stuck" trivial chains, chains which contain no knots and yet are not isotopic to a straight trivial chain.

Sara Cohen, University of California Davis
Bistellar Equivalences of Two Families of Simplicial Complexes

In our paper, we study a pair of simplicial complexes, which we denote by $B(k,d)$ and $ST(k+1,d-k-1)$, for all nonnegative integers k and d with $0 \leq k \leq d-2$. We conjecture that their underlying topological spaces $|B(k,d)|$ and $|ST(k+1,d-k-1)|$ are homeomorphic for all such k and d. We attempt to answer this question by trying to relate the complexes through a series of well studied combinatorial operations that transform a combinatorial manifold while preserving its homeomorphism type.

Jessica DeSilva, California State University Stanislaus
Karen Murata, California State University Stanislaus
The Alignment of Arbitrary Contours Using Area Difference Distance Measurement

Innovation in the process of medical imaging relies heavily on the metric function that outputs the distance between a fixed and arbitrary set of anatomical contours. The distance function presented is the area difference distance measurement, and we have produced a formal proof which demonstrates the validity of this measurement. In order to accurately measure distance using this function, Procrustes method is applied by aligning the arbitrary contour to a fixed contour. This optimal alignment requires minimizing the distance function in terms of rotating, scaling, and translating the arbitrary contour. The succeeding proof validates that these values, which optimize the distance between two contours, can be found with sets of data points representing each contour. Through the use of Matlab, synthetic data is applied to test the effectiveness of area difference distance measurement. The application of this metric function to medical imaging will be our future work.

Emily Eisner, Dartmouth College
The Turn Algebra of Signed Permutations

In this talk I will define the descent algebra of the symmetric group which was introduced by Loday in 1989. This algebra is defined using the number of descents of a permutation. If we sum the permutations with the same number of descents, we get a subalgebra of the group algebra of the symmetric group. In 1995, Doyle and Rockmore introduced the turning algebra that is defined using the number of turns in a permutation. A turn in a permutation, w, is a position i such that $w_{i-1} < w_i > w_{i+1}$ or $w_{i-1} > w_i < w_{i+1}$. In this talk I will discuss how we can generalizations of these algebras to the group of signed permutations. The talk will be elementary. I will not assume any prior knowledge.

Kaitlyn Gayvert, State University of New York at Geneseo
Sara Gearhart, State University of New York at Geneseo
Wavelet Packet Transforms and the FBI Fingerprint Image Compression Standard

The FBI began collecting records of fingerprints almost a century ago. Now with more than 250 million fingerprints on record and growing at rate of about 8,000 new fingerprints per day, there is a great need to store them in a digital database. Lossy compression is necessary, yet too much information cannot be lost if the fingerprints need to be admissible in court. To address this issue, the FBI decided on the use of a biorthogonal wavelet decomposition with scalar quantization (WSQ) for the compression of the fingerprints. This standard uses the symmetric and biorthogonal CDF97 filter, produced by Cohen, Daubechies and Feauveau. We will investigate the WSQ algorithm that is used by the FBI, and the resulting image quality and compression rate. We also will look at the reasoning behind their basis of choice and compare it to the result of the best basis algorithm.

Sara Gearhart, State University of New York at Geneseo
see **Kaitlyn Gayvert**

Montana Goodman, Southern Illinois University Carbondale
Fundamentals of Computational Neuroscience

After a biological explanation of the basic mechanisms of a neuron, I will discuss how computational neuroscientists build mathematical models for the behavior of neurons. By focusing on a single neuronal cell, I will examine how chemical and electrical potentials affect the propagation of an action potential - the force behind every synaptic fire. I will show the relevance of applying mathematical concepts to other fields of research and how an understanding of communication between neurons can lead to theoretical investigations of consciousness itself.

Amanda Goodrick, Slippery Rock University
Tilings of a square with the central square removed

This talk is motivated by the following problem posed by Donald E. Knuth in the April 2011 edition of Mathematics Magazine: Let n be an integer greater than or equal to 2. Remove the central $(n-2) \times (n-2)$ squares from an $(n+2) \times (n+2)$ array of squares. In how many ways can the remaining squares be covered with $4n$ dominoes? Here we solve Knuth's problem, as well as the analogous problem of finding the number of straight tromino tilings of the region obtained by removing the central $(n-3) \times (n-3)$square from an $(n+3) \times (n+3)$ square.

Kara Grier, Alverno College
Generalizing and Justifying: Pre-Service K-8 Teachers' Strategies and Representations

Use of multiple representations can positively influence students mathematical learning and problem solving performance. In this study, we investigate how seventeen K-8 pre-service teachers worked through eleven pattern finding problems, yielding 184 written solutions. We looked at their processes of generalizing and justifying – specifically at their use of various problem solving strategies, representations and their uses of structural and numerical information. Multiple ways of thinking about mathematical concepts provide evidence of deeper understanding and will allow a teacher to better meet the needs of diverse learners. Inductive Reasoning (i.e. reasoning from specific cases to the general) is an important way of mathematical thinking and is the basis of this study.

August Guang, Harvey Mudd College
Application of a Hillclimber Algorithm to Parallelize Graph-Based Genome Assembly

Shotgun whole genome sequencing is a technique that has been developed to address the costs associated with sequencing an entire genome base by base. This technique outputs short fragments of DNA, which subsequently require assembly algorithms. ABySS (Assembly By Short Sequences) is a popular choice for assembly due to its highly parallel nature. We improve upon the runtime of ABySS using a hill climbing algorithm designed to minimize communication costs between processors. It executes in less than a minute and cuts down on communication between processors by 6 to 10%, which in our preliminary trials has cut the run time of ABySS in half when running on four processors.

Emily Hill, Metropolitan State College of Denver
Sudoku Hypercube Construction and Bounds

Much is known about latin squares and sets of mutually orthogonal latin squares. Sudoku squares are a specialized, more restrictive type of latin square. In this talk, we will provide a definition of Sudoku cubes, and a method for constructing them. Additionally, we will prove that the maximum number of Sudoku cubes of order n^3 that can be constructed by this method is given by $(n^3-n)(n^3-n^2)$, a novel result. Finally, we will generalize our results to higher dimensions.

Stephanie Ihrig, Slippery Rock University
Two-Faced Monty Hall: A Variation of Host Behavior

Consider a game show in which a contestant is to choose one of three doors. Behind two doors are goats and behind the third is a car. Whatever the contestant chooses he or she wins. Before revealing what is behind the chosen door, the host then opens a non-selected door and reveals a goat. The player must decide whether he or she would rather keep the original door or switch to the remaining one. This is the infamous "Monty Hall Problem." In this talk we will analyze this original scenario, along with several variations (changing the host's behavior, multiple plays, and assigning varying probabilities to switch or stay). In each game, we determine the odds of winning the car based on the behavior of the contestant.

Emily Jennings, Georgia Institute of Technology
The delta-squared process and Fourier series of functions with multiple jumps

The delta-squared process is used to accelerate the convergence of a series. This talk discusses the effects of the delta-squared transform on the partial sums of Fourier series for functions with a finite number of jump discontinuities. Without strict constraints on the placement and lengths of the jump discontinuities, the transformed series for this class of functions fails to converge uniformly to the original function.

Ran Ji, Wellesley College
Linear Forms Over Finite Abelian Groups

A 3-term arithmetic progression (AP) can be formalized as a non-trivial solution to the equation $x_1+x_2-2x_3=0$, where a solution is *trivial* if $x_i=x_j$ for $i\neq j$. Finding the largest subset of a finite abelian group G containing no 3-term AP is equivalent to evaluating, for $\vec{r}=(1,1,-2)$,

$$D(G)=\max\{|A| : A\subseteq G, A \text{ contains no nontrivial solution to } \vec{r}\cdot\vec{x}=0\}.$$

Let G be a finite abelian group, $s\geq 3$, and $\vec{r}=(1,\ldots,1,-s)$. Our aim is to find the maximal cardinality of a set $A\subseteq G$ containing no non-trivial solution to $\vec{r}\cdot\vec{x}=0$ with $x_i\in A\,(1\leq i\leq s+1)$. Let

$$d(m)=\sup_{c(H)\geq m}\frac{D(H)}{|H|},$$

where $c(H)$ is the rank of H. We prove that for any $n\in\mathbb{N}$, $d(n)\leq\frac{C}{n^{s-2}}$, where

$$C=\max\left\{\left(\frac{2s-4}{e\log 2}\right)^{s-2}\sqrt{s^2+s}, 2(2^{s-1}-2)^{s-2}\right\}.$$

Alexis Johnson, Grand Valley State University
Word Length in Alternate Presentations of Thompson's Group F

Thompsons groups F and T were introduced by Richard Thompson in the 1960's in connecton with questions in logic. They have since found applications in many areas of mathematics including algebra, logic and topology and their metric properties with respect to the standard generating sets, X_n have been studied heavily. In this presentation, we introduce a new family of generating sets, which we denote as Z_n, establish a formula for the word metric with respect to Z_1 and prove that F has dead ends of depth at least 1 with respect to Z_1.

Lisa Kaylor, Westminster College
Straightline Hanoi

We investigate a variation of the Tower of Hanoi Puzzle called Straightline Hanoi in which disks may only be moved to or from the first peg. For n disks and for varying numbers of pegs we devise an algorithm for playing the game which we conjecture gives the minimal number of moves needed to solve it. We will present formulas for the number of moves needed to complete the puzzle when using our algorithm.

Pauline Khoo, Hollins University
Predicting Economic Turning Point

This study examines Penang, Malaysian's second smallest state with the third largest economy of the country. The focus of the study is to predict the turning point of the economy using the Neftci Probability Method. Using sequential analysis, the economic cycle is predicted to allow decision-making for economic policies.

Heather Kitada, Lewis & Clark College
Commutative Ideals of Upper Triangular Matrices Bijected to Well-Known Catalan Objects

In this talk, we will demonstrate a counting argument for the number of ideals in the ring of upper triangular matrices by right justified Ferrers diagrams. It is known that the n-th Catalan number is the number of ideals in the ring of $(n-1) \times (n-1)$ upper triangular matrices. In addition, we will focus on the subset of ideals that are commutative. It turns out that there are 2^{n-2} commutative ideals in the ring of $(n-1) \times (n-1)$ upper triangular matrices. We will show through a partition of Young's lattice how one can count these commutative ideals using binomial coefficients, which are manifested in Pascal's triangle. Furthermore, we hope to illuminate how commutative ideals translate to other Catalan objects, including Dyck paths, binary trees and ordered plane trees by creating binary operations on the objects and illustrating analogous cover relations.

Kelsey Larson, College of Saint Benedict
Art Meets Algebra: Exploring Colored Graphs of Groups

The concept of distance in the reals generalizes to all groups using edge colored complete graphs. We investigate the group of color permuting bijections of the graph of a group. The automorphisms of a group can provide key insights into the group of these color permuting bijections.

Danika Lindsay, California State University Channel Islands
Stem Detection of Strawberries Utilizing the Medial Axis Transform

We propose a geometric approach to automated strawberry stem detection using the skeleton of the convex hull of a berry to define a bounding rectangle containing the berry stem. Robotic food harvesting offers a solution both to day laborers' toxic working environments due to pesticides and also to the increasing conversion of California farmland to real estate developments. This project addresses the problem of stem detection in automated strawberry harvesting for a berry-picking robot currently under construction in the CSU Channel Islands computer science department. Recognizing the red portion of a ripe strawberry to find the location of the fruit is straight forward, but recognizing the stem location in a mass of plant foliage is quite challenging. Our project uses a tool called the medial axis to capture the global geometry of the berry shape and thereby predict the location of the stem.

Kathryn Lockwood, Fairfield University
Geometry and Flow Effects on the Performance of Vertical Residential Geothermal Heating Systems

Residential geothermal heating technology has been developed over the past few decades as an alternative to fossil-fuel based heating. However, the high initialization cost of these systems has proven to be a signicant barrier to their acceptance. In order to reduce these initial costs, a better understanding of how the different pipe geometries and their orientations within a grout-lled borehole is needed.

Allison Loesl, Northern Arizona University
see **Ashley Bezio**

Danielle Mallare, Canisius College
New Techniques for Computing Generalized Roundness

Computing the exact generalized roundness of a metric space depends on one being able to solve complicated families of non linear inequalities. The notion arose in relation to the study of uniformly continuous maps between metric spaces that have uniformly continuous inverses. Even in the case of a finite metric space of small cardinality, exact computation of the generalized roundness of the space can easily remain elusive. Recently some new techniques for enabling this type of computation have been isolated. The purpose of this talk will be to discuss some of these developments, particularly as they pertain to computing the generalized roundness of finite and countable metric trees, but also to graph metrics in general.

Rebecca Miller, University of Central Oklahoma
The Effects of Varying Conditions on a Fibonacci-Type Polynomial Sequence

Consider the following Fibonacci-type polynomial sequence given by the recurrence $G_0(x) = -a, G_1(x) = x - a, G_n(x) = x^k G_{n-1}(x) + G_{n-2}(x)$ where $n \geq 2$ and $a > 0$. Let $g_{a,n}$ represent the maximum real root of $G_n(x)$. In this presentation, we will display asymptotic results for $g_{a,n}$ numerically, as well as, analytically for the case $k = 2$. We will also explore $g_{a,n}$ for positive integers k where $k > 2$.

Rebecca Mitchell, Colorado College
The Restricted 3-Body Problem: A Mission to L4

The investigation sought to find a cost efficient route for a spacecraft to travel using Lagrangian equilibrium points in the sun-earth system. By expressing the restricted three body problem as a system of ordinary differential equations and linearizations we were able to understand the behavior of points geometrically. Using these methods and a program which approximates solutions in systems of differential equations, we found an orbit which uses the unstable nature of L1 to slingshot towards L4.

MurphyKate Montee, University of Notre Dame
Recursion in the BRWT Polynomial of Ribbon Graph Families

Given a nested tower of ribbon graphs successively built from a given ribbon graph pattern, we extend the transfer method of N Biggs and Noy-Ribo for the computation of the Tutte polynomial to the computation of the Bollobas-Riordan-Whitney-Tutte polynomial of ribbon graphs. Based on work begun by Jordan Keller, the concept of an amalgamation state is extended from the connected partitions of the set of amalgamating vertices to include cyclic partitions of sectors of the amalgamating vertices. The key result is the proof that changes in certain ribbon graph statistics depend only on the amalgamation state of an edge subset. The characteristic polynomial of the state transition matrix of the transfer method yields a recursion between the polynomials of the ribbon graphs in a tower. Applications to knot theory are given to find recursions among the Jones polynomials of links whose diagrams form a tower BRWT polynomial of the ribbon graph obtained from the all-A smoothing of a knot to the Jones polynomial.

Karen Murata, California State University Stanislaus
see **Jessica DeSilva**

Kizza Nandyose, Hood College
Optimization of Multi-Criteria Decision Analysis Methods

We develop a fuzzy measure and a software module that can assist a (non-expert) Decision Maker (DM)/Analyst in building an aggregation function that closely models his/her expectations regarding aggregation behavior. We focus on the optimization of the construction of MCDA aggregation functions, in particular OWA and Choquet integral, subject to a set of high-level constraints given by the DM. Given vectors of criteria, the aim is to use optimization to define appropriate parameters for the OWA function and the Choquet integral, (weighting vectors for OWA, and importance and interaction indices for the Choquet integral), such that the aggregation of any of these vectors closely reflects the DM's desired behavior. We take into account relative importances among criteria, e.g. criterion x is twice as important as criterion y, interactions among criteria(synergies and redundancies), and vague statements like 'most of the criteria must be satisfied' or 'at least k criteria (out of n) must be high'.

Michelina Pallone, Boston College
Generic Polynomials for Triangular Groups over Finite Fields

Let G be a group and K a field. A polynomial $f \in K(t_1, \ldots, t_n; X)$ is G-generic over K if the Galois group of $f(X)$ over $K(t_1, \ldots, t_n)$ is G and for any extension L of $K' \subset K$ with $L \supset K'$ and Galois group G we have that L is the splitting field of of a specialization of $f(X)$. We will look at two methods of computing generic polynomials for groups of upper triangular matrices over fields containing . The first method utlizes Frobenius modules. It will always produce a generic polynomial. However it uses many parameters. The second method modifies recursive polynomials found by Kemper to find nice generic polynomials (Kemper). It works for groups of matrices between the full upper triangular group and the full unipotent group.

Lisa Piccirillo, Boston College
Reduced Colored Khovanov Homology of Alternating Knots

Khovanov homology associates to a knot a bigraded chain complex whose homology is a knot invariant. Moreover, Khovanov homology categorifies the classical Jones polynomial in that the graded Euler characteristic of the Khovanov homology of a knot yields the Jones polynomial of the knot. It was proved by Manolescu and Ozsvath that the Khovanov homology of alternating knots is homologically 'thin', hence determined by the Jones polynomial and the signature. In *Categorifications of the Colored Jones Polynomial*, Khovanov describes a generalization of his construction categorifying the reduced colored Jones polynomial. A natural question to consider is whether Khovanov's reduced colored Khovanov homology is also homologically thin on alternating knots. We give a number of counterexamples to this question, obtained computationally using a Mathematica program we developed, building upon Dror Bar-Natan's FastKh algorithm contained in the open source KnotTheory package.

Regina Pollack, Canisius College
Connections between Mathematics and Music: The Auditory Aesthetics of the Baroque Era

The Baroque era signifies a new beginning of music theory and a transition from early musical compositions to an era of strong musical pattern and technique. It is known that the most basic musical substances such as beat, rhythm, and pitch, all have an obviously mathematical and scientific foundation. Although these theoretical aspects of music are important to analyze in such a mathematical style, it is especially interesting to consider the aesthetic portion of music in a mathematical sense. Within newer branches of mathematics such as Information Theory, one can analyze the predictability of musical tones and pattern and attempt to discover a musical composition's aesthetic potential. The baroque era introduced musical theory that has been a continuous source of inspiration for musical composers and its connection to mathematics is extremely significant to the development of later works.

Whitney Radil, College of St. Benedict
Periods of Periodic Orbits for Maps on Graphs Homotopic to a Constant Map

The talk provides information about two theorems concerning the set of periods of periodic orbits for maps of graphs that are homotopic to the constant map and such that the vertices form a periodic orbit. The first result is that if v is not a divisor of 2^k then there must be a periodic point with period 2^k. The second is that if $v = (2^k)s$ for odd $s > 1$, then for all $r > s$ there exists a periodic point of minimum period $(2^k)r$. These results are then compared to the Sharkovsky ordering of the positive integers.

Mary Russell, Canisius College
see **Kassandra Averill**

Alees Seehausen, Metropolitan State College of Denver
see **Susannah Coates**

Bertilla Sieben, Northern Arizona University
Princes and Dragons

In Dragon Territory, any two countries are connected by a dragon flight in one direction. A country where a prince is searching for a bride is called a royal country, and for the princes' convenience, any other country can be reached from a royal country by a maximum of two dragon flights. In this talk, we will examine the number of royal countries that can exist for different values of n where n is the total number of countries in Dragon Territory.

Lauren Stemler, St. Lawrence University
Finding the Representation Number for Wheel Graphs and Complete Graphs Minus Disjoint Wheels

According to Erdős and Evans a graph G has a representation modulo $N > 1$ if all its vertices can be assigned distinct labels from the set $\{0, 1, 2, \ldots, N-1\}$ such that two vertices in G are adjacent if and only if the difference of their labels is relatively prime to N. Among all possible representation numbers of a graph G, we focus on the smallest N that satisfies these conditions for a graph G, defined as the representation number of G. Another closely related concept that is of great interest is a representation of G with least number of prime factors. The smallest number of prime factors in a representation of G is referred as the Prague dimension of G. I will discuss the representation number and the Prague dimension of a wheel graph, a complete graph minus a wheel, multiple disjoint wheels of the same size, and multiple disjoint wheels of different sizes. This project was funded in part by NSF grant number 1062128.

Hong-Lien Tran, Kennesaw State University
Domination and Independence on the Triangular Honeycomb Chessboard

Puzzles on the chessboard have long been studied by mathematicians. We do not restrict ourselves to the standard 8×8 chessboard. Generalizations are quickly made to the square board of sides other than $n = 8$, $m \times n$ rectangular boards and other variant surfaces. Chessboard problems are most frequently set in the context of Graph Theory. Two classic problems in Graph Theory that appear again and again are those of dominating sets of minimum cardinality and independent sets of maximum cardinality. For chessboards the question of a minimum dominating set transforms into how to threaten or occupy every square on the board with the fewest pieces. Maximum independent sets become the problem of how to place the most non-attacking pieces. Our project explores these two combinatorial problems on the variant triangular honeycomb chessboard for the rook, bishop, knight and king.

Camila Tulyaganova, St. Mary's University
Modeling Resource Competition with Allelopathy and Metabolic Load

A new model for two-species chemostat with allelopathy will be presented. The model incorporates an assumption that toxin-production carries a 'metabolic load,' inflicting a poison-production penalty on the growth of the environment-poisoning species. Examining the local asymptotic behavior the parameter ranges were found for the four stable states: extinction of both species, survival of poison-producer, survival of poison-susceptible, coexistence. Simulations will be presented with parameters coming from P. Parvum.

Katherine Turner, Texas A&M University
Finding Zero Sets of Tetranomials

The real roots of a polynomial can be described combinatorially when its coefficients lie in a large region defined by an A-discriminant amoeba. We examine tetranomials in one variable from this point of view and show how to achieve faster real root counting algorithms.

Kayla VonHagel, Kennesaw State University
Access Control Logic

Access control is concerned with the policies and mechanisms that permit or deny the use of a resource or capability in a military operation. There exists no standardized method to reason about or represent access control, so mathematicians can utilize Access Control Logic to reason and prove the soundness of access control designs and specifications. The Information Assurance Internship of 2011 allowed inters to explore the elements of Access Control Logic and Mission Assurance in order to design, develop and verify cutting edge systems for the United States Air Force. The application of Access Control Logic consists of rigorous proofs pertaining to confidentiality, integrity, availability, authentication and attribution. Each solution created by the interns gave the Air Force Research Laboratory valuable insight on the state of the military within cyber operations and is currently being used a framework for new solutions.

Anna Weigandt, Illinois State University
see **Kassandra Averill**

Kamara Wright, University of Nebraska-Lincoln
Emergency Response in the City of Lincoln: Analysis of the Allocation of Responding Police Officers.

The city of Lincoln allocates over 50% of their budget towards public safety, making it one of the highest priorities for the city. One of the main recipients of this money is the Lincoln Police Department which currently has roughly 415 employees, 320 of which are police officers and the rest who are support staff. These employees are divided among three police stations, two of which are located in northern Lincoln, and the third of which is located in downtown Lincoln. The department's responding officers are divided into five sections that cover the entire city. The primary goal of this project is to analyze how efficiently these teams can respond to calls by looking at their response times and allocation of police officers throughout the city. We will evaluate our responding officer to population ratio to determine if the department is under- or overstaffed. Then, we will look at creating optimal responding boundaries for the stations and teams based on response times from each station. Finally, we will calculate an optimal location for a future police station and observe the affects it could have on response time and the allocation of police officers.

Samantha Youmans, Canisius College
Non Linear Geometry of Ultrametric Spaces

An ultrametric space is a metric space that satisfies a strong triangle inequality. In practice, this means that any three distinct points in an ultrametric space form an isosceles triangle in which the length of the base does not exceed the length of the legs. Ultrametric spaces arise in a variety of fields including number theory, physics, theoretical biology, and so on. It is possible to visualize ultrametric spaces in terms of certain trees. The purpose of this talk will be to examine this process and to describe some entirely new non linear characterizations of ultrametric spaces.

Rui Zhao, Northeastern University
Commuting Nilpotent Matrices

Assume an $n \times n$ matrix B is in Jordan canonical form with Jordan type (Jordan Block Partition) of P, there is a unique partition of $Q(P)$ that is the Jordan partition of the generic element of the nilpotent commutator of B. There have been several results on the partition of $Q(P)$ but not been completely understood yet. For my talk, I will introduce Oblak's formula about a part $Q(P)$. By showing how we can exhaust all P's with given Q, I am going to show some duality implication of that formula.