The Sixteenth Annual Nebraska Conference for Undergraduate Women in Mathematics

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POSTER ABSTRACTS

Posters by Undergraduate Students

Elaina Aceves, California State University, Fresno
Jennifer Elder, California State University, Fresno
[A-1] An Invariant for Spatial Graphs

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.

Rubi Almanza, University of California, Merced
[B-1] Gradient Based Optimization for Structural Variation Discovery

Structural variants (SVs) such as deletions, duplications, insertions and inversions are thought to be important contributors to phenotypic variation. Recently, the declining cost of DNA sequencing has enabled the sequencing of thousands of individual genomes. These data sets represent an important resource for cataloguing human genetic diversity; however, most methods for predicting SVs are not designed to simultaneously analyze many individuals because of the complexity of the solution space. We present a novel approach for predicting SVs in the genomes of multiple individuals. We utilize gradient-based optimization to determine the SVs present in each individual. Importantly, our approach represents a significant improvement for structural variants detection methods as it is capable of representing the relatedness of individuals in a study, something not been considered before, to constrain the set of possible solutions and increase the prediction accuracy.

Candace Baker, University of Central Oklahoma
[A-2] A Within-Host Mathematical Model of HIV Infection During Combination Therapies

Mathematical models provide us with a quantitative description of the immune system and its interactions with viruses and other pathogens. We model HIV infection dynamics within a host to study the effects of drug treatments, specifically those that alter the ability of the virus to infect susceptible cells and to produce infectious viruses. The two drugs considered in the model are Reverse Transcriptase inhibitors and Protease inhibitors which block the ability of HIV to successfully infect a cell, and cause the production of non-infectious viral particles, respectively. Our current model has four equations describing the behavior of target T-cells (T) that are susceptible to infection, infected T-cells (I), infectious virus (Vi), non-infectious virus (Vni). Changes in the efficacies of these drugs can cause large fluctuations in host cell and virus dynamics. We will expand the model to examine the effects of novel drug combinations and more detailed T-cell population structure on host and virus dynamics.

Mollie Breen, Duke University
[B-2] Women's Math Mentoring

This program pairs female first-years who declared an interest in math with upper-class women who are pursuing a major or minor in math. Through investing in a mentor-mentee relationship, both women have the chance to learn more about what it means to study math. Participants can be involved in a variety of activities hosted by the program, too. These activities include dinners, movie nights, and even Saturday afternoon hikes. With these events, students have the opportunity to develop a candid relationship in which they feel open to discuss questions about math courses, math study habits, as well as student life from the perspective of an upper-class math major. Overall, the aim of the program is to provide role models, opportunities to explore, and a supportive network that will enable women to break through informal barriers that might otherwise keep them from becoming mathematicians. In my poster session, I will discuss participants' individual experiences as well as what they have learned about math.

Alexandria Burnley, University of Illinois at Urbana-Champaign
[A-3] The Lattice of Set Partitions and Transition Matrices of Symmetric Functions

In 1991, O. Eğecioğlu and J. Remmel studied the transition matrices between several bases for the commuting symmetric functions. In our poster we describe an alternative way to obtain these transition matrices using symmetric functions in non-commuting variables and the lattice of set partitions. In particular, we study the functions $\mathrm{N}_\lambda(\mu)$, the number of set partitions of type μ that are coarser than a set partition of type λ, and $\mathrm{n}_\lambda(\mu)$, the number of set partitions of type μ that are finer than a set partition of type λ. In addition, if $\hat{0}$ is the minimal set partition, we also study $J_\lambda(\mu)$ which is defined as the number of set partitions σ of type μ such that $\pi \wedge \sigma = \hat{0}$ for a given set partition π of type λ. Finally we show how these functions relate to the transition matrices.

Sydney Butler, Utah Valley University
Kristen Smith, Utah Valley University
Emily Stucki, Utah Valley University
[B-3] Encouraging High School Girls to Study Math

Math Girls Rock!, Utah Valley University's outreach program, promotes the pursuit of higher education in mathematics of high school girls. Each year, three female math/math-ed college students work as assistants in this program, working with and mentoring local high school girls to encourage them to further their education beyond high school. As this year's assistants, we work with program directors on planning and preparing math projects to spark the interest of the high school girls we mentor. In this presentation, we will focus on how we encourage the girls to pursue an education in math by interacting with them in an enjoyable atmosphere and leading discussions about women and careers in math. Additionally, we will show how we use the hands-on projects to promote students' interest in math, encourage them to take more math classes, and show them that math is fun, interesting and important. Also, the effect of these activities on the students' attitude toward math will be presented.

Orsola Capovilla-Searle, Bryn Mawr College
Ashley Weber, University of Michigan
[A-4] The Spectrum of Knots

Traditionally, knots have been tabulated according to their crossing number, which is the least number of crossings in any projection of the knot. Recently, these traditional crossings have been extended to n-crossings, where n strands of the knot intersect in the projection. Hence by minimizing the number of n-crossings, we can define a sequence of crossing numbers for every knot that we call the crossing spectrum. We will discuss the computation of these numbers for various knots. Furthermore we investigate how the n-crossing number behaves under composition.

Ryann Cartor, Bellarmine University
[B-4] Estimating The Size of A Polynomial

Given a homogeneous polynomial of degree k with n variables of the form, $p(x_1, x_2, \cdots, x_n) = a_1 x_1^k + \cdots + a_n x_n^k + b_1 x_1^{(k-1)} x_2 + \cdots$, there exists some constant c_k such that $\sum_{j=1}^{n} |a_j| \leq c_k ||p||$, where $||p|| = max|p(x_1, x_2, \cdots, x_n)|$ when $x_i \in [0, 1]$. Finding the bounds for c_k allows us to better estimate the size of the polynomial. Estimating these maxima proves particularly useful for polynomials that have degree $k > 3$ or a large number of variables, as finding the maximum using calculus for these equations becomes increasingly difficult.

Megan Chambers, Youngstown State University
[B-5] A Mathematical Analysis of Celtic Knots

Celtic knots are a very diverse and historically relevant group of knots. In this talk, we will discuss properties of Celtic knots and methods to create basic Celtic knots. A proof using concepts from algebra and basic number theory will also be presented.

Tsungai Chibanga, Michigan State University
[A-5] Some Remarks on Diophantine Triples

Let a, b, c be positive integers. We say the triple (a, b, c) is a d-Diophantine triple if ab+d, bc+d and ac+d are all perfect squares. The most widely studied Diophantine triples are when $d = 1$. One such example is $(1, 3, 8)$. In this talk, we present a method to generate infinite sequences of 1-Diophantine triples. Recurrence relations, closed forms as well as some remarks about generating d-Diophantine triples for $(d > 1)$ will also be presented.

Mercedes Coleman, Lamar University
[A-6] The Diameter and Girth of Group Graphs

For a group G with generating set $S = s1, s2, ..., s_{(k)}$, the G-graph of G, denoted (G, S), is the graph whose vertices are distinct cosets of in G. Two distinct vertices are joined by an edge when the set intersection of the cosets is nonempty. In this paper, we studied the diameter and girth of $\Gamma(G, S)$ where $\Gamma(G, S) = K_{(m,n)}$, $\Gamma(G, S) = K_{(2,n)}$, and $\Gamma(G, S2) = C_{(n)}$.

Kenna Collums, University of Mississippi
[B-6] The Matrix Method of Linear Dichroism

This talk will be about linear dichroism, and in particular about the matrix method behind this spectroscopic technique. Linear dichroism uses the difference in the absorption of light that is parallel, and the absorption of light that is perpendicular, to an orientation axis. From this process, the structure and function of molecules can be studied. The matrix method diagonalizes a Hamiltonian matrix with a unitary matrix. This Hamiltonian matrix is constructed from the transition energies, which are the diagonal elements, and coupling energies, which are off-diagonal elements.

Sarah Coulson, University of Oklahoma
Elizabeth Matys, Gettysburg College
Karina Peña, Rio Hondo College
[B-7] Signature Authentication Using Wavelet and Fourier Analysis

We explore three different methods to authenticate a signature given a data bank of genuine signatures. After quantifying the signatures, we use raw data, wavelet, and Fourier analysis to authenticate them. We compare the reliability of these three methods and conjecture the reasons behind the strengths and weaknesses of each.

Ariana Deltoro, University of San Francisco
[A-7] Dynamic Asynchronous Communication and Partitioning Using Robotic Agents

In applications such as environmental monitoring and search and rescue operations, a team of robots is asked to perform a task over a large space. Distributed environment-partitioning algorithms consist of control and communication laws for individual robots such that the team divides a space into regions in order to optimize the quality of service provided. In this work we look at two existing partitioning and coverage control; one-to-base-station and pairwise partitioning. These algorithms are novel in that the communication is distributed, and in the fact that coverage cost is improved after every discrete time step. In our work we accomplish two main tasks. First, we simulate the algorithms and confirm their effectiveness under "ideal" conditions. Second, we implement the protocol on physical hardware to validate robustness of theoretical framework in real-world application. Successful implementations showed that in-fact the algorithms performed robustly on real hardware with no modification needed.

Sonja Dery, Winona State University
[A-8] A Mathematical Model of the Physical and Social Aspects of Smoking

The controversy of smoking has become widely popular. This presentation examines a mathematical model predicting the effect of the CYP2A6 enzyme that metabolizes nicotine in the blood and how inhibition of CYP2A6 can potentially decrease smoking habits in adults. Further, it is hypothesized the decreased amount of nicotine in the body is directly proportional to the amount of cigarettes that are consumed daily, eventually smoking little to no cigarettes a day. The research examines a case in which a young male adult with a relatively active lifestyle and poor diet, smoking 1/2 to 1 pack of cigarettes a day. By applying the hypothesis to our study, the effectiveness of the medication can be predicted and analyzed. Meanwhile, another case involving a two person zero sum game was applied to smoker A and nonsmoker B who are good friends as well as roommates. The situation applied is predicting the outcomes for each of the choices both players have control of.

Qi Dong, Duke University
[A-9] Individual Treatment Assignment as a Decision Problem

Previous studies put great weight on drawing causal inferences and assigning treatment based on the average treatment effect. This paper explores an alternative strategy. We focus on individual level treatment assignment and frame it as a decision problem using Bayesian modeling. Under the assumption that there is no unmeasured confounding factor in the data, we adopt the Rubin Causal Model framework and build a Bayesian model based on past data to predict any incoming individual's potential outcomes with and without treatment applied. Based on that comparison, we assign treatment to the individual with the objective of maximizing the individual's probability of obtaining a desirable result. The paper examines the advantage and implication of this framework by applying it to the RHC dataset collected from 5 medical centers in the U.S. We show that our framework can be used as a meaningful and reliable tool that enables decision makers to assign treatment effectively and efficiently.

Jennifer Elder, California State University, Fresno
see **Elaina Aceves**

Eva Forrester, Pacific University
[B-8] Mixed Integer Programming in Real time

Linear, integer and mixed-integer programming are optimization programs where all solutions are forced to be integers. Their algorithms are most prevalent in the area of Operations Research and Management Science. They are techniques used to find minimum-cost, maximum-efficiency, shortest-path and other variations of the kind. My poster will explore the different programming techniques prevalent in industry and how their optimality is best produced using linear algebra and other techniques. We will delve into advanced linear programming, in search of the most optimal solution with smallest degree of error.

Jingxing Gan, Duke University
[A-10] Mathematical Ideas on Impressionist Music

Although the ancient Chinese, Egyptians and Mesopotamians are known to have studied the mathematical principles of sound, music remains the most transcendental form of art. Throughout the history, musicians or music critics have tried to classify music in words. Contemporary music theorists are no longer satisfied with such generalized classification but more interested in the details of compositional patterns of composers of different music eras. The aim of my project is to mathematically analyze impressionist music. I look specifically into chord progressions in the tetrachordal space, $T^4/S4$, define new group actions, and investigate the influence of the use of chromatic scale in impressionist music.

Maxine Gonzalez, Universidad Metropolitana
[A-11] Analysis of The IFN Epsilon Regulation in HPV Induced Carcinogenesis

Interferons are a family of functionally related cytokines that play a key role in a broad range of cellular responses, including anti-tumor, mediating antigrowth responses, and modulation of immune responses. During the infection of the HPV several dysfunctions occur in which the progression from viral to a malignant status is promoted. Dysfunctions that occur involve a selective and strong downregulation of the members of the interferon type I family such as IFN_ε and IFN_K. A series of tests were conducted (alignments, similarity percentage CpG Islands, transcription binding factors) to the gene sequences of each interferon studied. IFN_β does not downregulate once the cells are infected; then by analyzing the transcription binding factors of epsilon and kappa a better understanding of the similarities could be achieved. While a preliminary analysis was done, many possible estrogens TF were detected and a further filtering process will be followed up to calculate which are present in the gene sequences.

Jessica Hairston, University of Montevallo
[B-9] Item Response Theory: Using Item Information to Reduce Test Length

Fisher Information, $I(\theta)$, arises in the context of maximum likelihood estimation and is defined as $I(\theta) = E\left[\left(\frac{\partial \log f(X;\theta)}{\partial \theta}\right)^2\right]$, for a random variable X with a probability density function $f(X;\theta)$ and where θ is an unknown parameter to be estimated. In Item Response Theory, IRT, θ represents an examinee's ability estimate. I will show that the square root of $I(\theta)$ is inversely proportional to the standard error of measurement. Thus, information is a measure of a test's reliability. In addition, $I(\theta)$ indicates how much each item contributes to the test. The IRT analysis of a fifty item college algebra final exam will be used to identify and remove items that contribute little to test reliability. I will conduct IRT analysis of the shortened exam with regard to ability estimates. A reduction in the number of items required for an accurate assessment has beneficial implications for both the University and the student.

Ara Han, University of Central Oklahoma
[A-12] Modeling of The Relationship Between uPA and PAI-1, and Tumor Cell Growth

The plasminogen activators, tissue-type plasminogen activator(tPA) and urokinase(uPA), are expressed in tumor cells. uPA is most common with its receptor(uPAR) and is mostly involved in cellular functions. Also, PAI-1 which is one of the plasminogen activator inhibitors of fibrinolysis, the degradation of blood clots, plays a major role in tumor cell growth as well as in cancer. In other words, increased uPA and PAI-1 were associated with a worse prognosis. We build a mathematical model of the relationship between uPA and PAI-1, and tumor cell growth. The model equations are solved in Matlab, and clinically relevant results are discussed.

Emily Hannon, University of Colorado, Boulder
[B-10] Mathematical Modeling in Psychiatry

Until recently, nonlinear dynamic tools have been largely ignored when investigating empirical data that quantifies the behavior of biological systems. In particular, these methods have had a slow advance in psychiatry. Paradoxically, they would be most useful in this field since psychiatry critically needs quantitative, neurophysiology-based (rather than symptom-based) clinical assessments. Progress in both imaging and the theory of dynamical systems has increased the feasibility of applying nonlinear methods to neural signals. We are using fMRI data from two individuals to apply several nonlinear dynamic tools: system reconstruction methods (Principal Component Analysis and time-delay embedding techniques); and computation of dynamic invariants both in the phase space (entropy) and in the frequency domain (power spectral scale invariance). We show that mathematical modeling can be used to explain the behavioral differences between our two subjects, one responsive to stress, and the other stress-resilient.

Cecilia Harden, Benedictine College
[A-13] Tangent Circles

A problem from MAA monthly problem number 11727. Given Circle C with origin O, and then two more circles C_1 and C_2 given that C_1 and C_2 are externally tangent to each other and internally tangent to C. With a straight edge and a compass get a third circle C_3 that is externally tangent to C_1 and C_2 and internally tangent to C. I will be explaining this through the inversion of circles. I will also show the application of this through the packing test problems and how it works with gears.

Kelsey Kalmbach, Colorado School of Mines
[B-11] The Effect of Disasters on Social Networks

This project deals with modeling the effects of a disaster, such as a blackout, on intra-network communication pathways. Social networks deal with the interactions between communicative beings, signified by nodes, via communication pathways, signified by edges. This model focuses on the removal of nodes via a disaster and the regrowth of those nodes, monitoring the change in path length between any two nodes after the disaster occurs. The model is based off of the Barabási - Albert model for social network growth, with extensions to account for the disaster and regrowth. After running multiple trials with varying parameters, it was found that increasing the removal chance of the disaster increases the average shortest path length, although increasing the radius of the disaster had a greater impact on the average shortest path length. The correlation between regrowth chance and regrowth time is similar to exponential decay, with regrowth time approaching one interval as the regrowth chance increases.

Rachael Kline, St. John Fisher College
[A-14] Asymptotic Spectral Properties of the Schrodinger

We give background information on the motivations and techniques for answering the open question related to the Thue-Morse sequence posed by Damanik, Embree, and Gorodetski in their 2012 survey of spectral properties of Schrödinger operators arising in the study of quasicrystals. We then report results obtained from our analysis of these spectral properties.

Keri Kodama, Seattle University
[B-12] The Stability of Traveling-Wave Solutions to the Whitham Equation

Two equations that can be used to model the evolution of surface waves on shallow water are the Korteweg-de-Vries (KdV) equation and the Whitham equation. Bottman and Deconinck (2009) proved that all traveling-wave solutions of KdV are stable. However, KdV fails to account for many dispersive effects of the full water wave problem. The Whitham equation is a generalization of KdV that accounts for most of the dispersive effects in the full water wave problem. Ehrnstrom and Kalisch (2009) established that Whitham admits periodic traveling-wave solutions of a wider variety than KdV. We numerically examine the stability of this broad class of solutions using the Fourier-Floquet-Hill method. We establish that these solutions are stable below a certain amplitude and unstable with respect to modulational instabilities above that amplitude.

Xin Liu, Washington University in St. Louis
[A-15] A fitted Finite Volume Method for Unit-Linked Policy

In this presentation, fitted finite volume method is developed to solve a nonlinear degenerate Black-Scholes equation applied in the valuation of unit-linked policy with surrender option, based on the fitting idea in S. Wang [IMA J. Numer. Anal., 24 (2004), 699-720]. Unlike the conventional pricing method mentioned in H.J. Shang's Actuarial Science which is using the free boundary method to calibrate the valuation PDE, what we will develop is a power penalty method which can numerically resolve the linear complimentary problem in the variational inequality arising from the valuation of unit-linked policy with surrender option. With the degenerate boundary and non-smoothnal condition, we will show that it is essential to refine the mesh to remain the convergence and super-convergence order.

Angie Loong, University of Nebraska-Lincoln
Katie Pawlowski, University of Nebraska-Lincoln
Helen Pitts, University of Nebraska-Lincoln
Jacquelyn Voss, University of Nebraska-Lincoln
Shalima Zalsha, University of Nebraska-Lincoln
[B-13] Sustainability of Groundwater Resources in Nebraska

As the world population grows, many wonder how long our water supply can last if we continue our current method of usage. Here in the Midwest, most of the groundwater usage goes into irrigation. We created a mathematical model using recharge and water usage for irrigation to see how two local reservoirs are currently behaving and responding to drought. It was found in the Crete Princeton Adams reservoir that water levels were declining at an increasing rate, most likely due to over-irrigation, drought conditions and the planting of water inefficient crops. Respectively, in the Upper Big Blue Natural Resources District, a mathematical model was created to help predict change in water level in terms of precipitation, temperature, and water usage.

Nicole Lopez, University of St. Thomas
[A-16] Statistical Analysis of Vehicle Components

In the automotive industry it is important to know whether the failure of some car part may be related to the failure of others. This project studies warranty claims data for five engine components obtained from a major car manufacturer with the purpose of modeling the joint distributions of the failure of two parts. The lifetimes of each of the components are modeled using Weibull distributions both when the component failed in conjunction with another part failing as well as individually across all claims data. The one-dimensional distributions of components are combined to construct a bivariate copula model for the joint distribution that enables us to estimate the probabilities of two components failing before a given time. Ultimately, the influence of the failure of one part on the operation of another related part can be described, predicted and addressed.

Elizabeth Matys, Gettysburg College
see **Sarah Coulson**

McKenna Mettling, Regis University
[B-14] Quarterback Passer Rating System: Accuracy Beyond Measure?

Statistics have been used for many years in sports in order to provide players with an idea of how well they did during a game; however, baseball was the first sport to take the statistics and use them in a way to get a better sense of what they needed to do in order to win. There have been many statistics systems developed in order for fans to better understand the game as well as allow for fans to participate in the game through events like fantasy football. Consequently, the National Football League (NFL) continues to work on developing different models that fans and even the coaches can use to better understand the game and the capability of the players. I understand the growing desire to better determine the ability of the players. Hence, I have chosen to look at the current system in place for rating quarterbacks so that I can determine its accuracy as well as to test a new system that I hope to develop that will hopefully rate the quarterback as a whole rather than just as a passer.

Melania Meyer, College of Saint Benedict
[B-15] Parallelizing Sparse Matrix-Vector Multiplication

For this project, we worked with a conjugate gradient mini-app called HPCCG. This program uses the conjugate gradient method to compute an approximate solution to $Ax = b$ where A is a sparse matrix and b is a known vector. Because A is a sparse matrix, by keeping track of only the indices of the matrix with non-zero values, this program reduces the number of operations required to compute our unknown vector x. HPCCG uses operations that are associative, so we were able to find different ways to parallelize the program to decrease its run time.

Jessica Oehrlein, Franklin W. Olin College of Engineering
[A-17] $L(d, 1)$-labelings of Edge-Path-Replacements by Factorization of Graphs

For an integer $d \geq 2$, an $L(d, 1)$-labeling of a graph G is a function f from the vertex set to the non-negative integers such that if vertices x and y are adjacent, $|f(x) - f(y)| \geq d$, and if x and y are at distance two, then $|f(x) - f(y)| \geq 1$. The λ_d-number is the minimum span over all $L(d, 1)$-labelings of G. For an integer $k \geq 2$, an edge-path-replacement of G, $G(P_k)$, is the graph obtained by replacing each edge of G with a path on k vertices. We show that the edges of G can be colored using $\lceil \Delta(G)/2 \rceil$ colors so that each monochromatic subgraph has maximum degree at most 2 and use this fact to provide general upper bounds of $\lambda_d(G(P_k))$ for $k \geq 4$. As a corollary, we settle a conjecture by Lü concerning $\lambda_2(G(P_4))$ and show that the class of graphs $G(P_k)$ with $k \geq 4$ satisfies a conjecture by Havet and Yu on $(d, 1)$-total labeling of graphs.

Ashley Orr, Youngstown State University
Valeria Pereira, Loyola Marymount University
[A-18] What's the Word? Methods for Spoken Word Recognition

Our poster will present three different methods used for spoken word recognition; Haar Wavelet analysis, Discrete Fourier Transform, and Signal Analysis. We will reference five varying algorithms, each with a different method and basis for comparison. By comparing the data collected from executing our algorithms, we will share observations regarding which method correctly completes the spoken word recognition the most often and present conjectures on why this is occurring.

Katie Pawlowski, University of Nebraska-Lincoln
see **Angie Loong**

Karina Peña, Rio Hondo College
see **Sarah Coulson**

Valeria Pereira, Loyola Marymount University
see **Ashley Orr**

Helen Pitts, University of Nebraska-Lincoln
see **Angie Loong**

Akaanchya Pradhan, Western Oregon University
[A-19] The Game of Graph Nim

Nim is a well-known impartial combinatorial game. Various versions of playing Nim on graphs have been investigated. We introduce a new version of graph Nim, give some preliminary results, and discuss open problems.

Tiffany Reyes, Whittier College
Katy Weber, State University of New York at Geneseo
[A-20] Haarmony: Chord Recognition Using Wavelets and Other Methods

Our research examined whether a computer can effectively distinguish between different musical chords. We employed different techniques from signal processing in order to determine which method recognized the correct guitar chord most often, including Fourier analysis (using the discrete Fourier transform), wavelet analysis (using the level one Haar Wavelet decomposition), and raw data comparison. We give basic overviews of the theory behind each of these methods, explain how we collected our data and implemented our algorithm, and report on the accuracy of each method. In addition, we discuss and provide evidence for why we think each method worked as it did.

Sophia Rivera, Mercer University
[B-16] Understanding Intracontinental Trade in Europe Using Rankings

The objective of this research is to further understand the power of intracontinental trade in European. We are performing the Colley, Massey, and Keener Method on the import and export data from eleven different countries in the Europe. We define an export win for country A if country A exports more to country B than country B exports to country A. These pair-wise comparisons will be used to calculate export wins and losses. An export loss is similarly defined, but country A sends fewer exports to country B than country B sends to A. Using these three different methods to create a ranking we will better understand the status of each economy compared to the others within Europe, we hope to find which methods are more promising in understanding the current trade interactions between selected countries.

Yesenia Rivera, Universidad Metropolitana
[A-21] Observing the relativistic jet from a super-massive black hole with the event horizon telescope

Very Long Baseline Interferometry (VLBI) is a technique to obtain images of compact radio with the combination of widely distributed telescopes around Earth. The Event Horizon Telescope (EHT) is an international project coordinated by the MIT Haystack Observatory to carry out VLBI at $\leq$ 1.3mm with an extremely high resolution of $\sim$ 20as. 3C 279 is an extremely luminous quasar in the Virgo constellation. The EHT observed 3C 279 with sufficient resolution to look at the structures of this source on scales of several light years. 1.3mm EHT observations of 3C 279 from March 21, 2012 were reduced and compared to prior EHT results obtained in 2011 (Lu et al. 2013) to study structural variations of the jet. The obtained data were explained with a 2 component model. The comparison with 2011 data indicates a superluminal motion of 2 c (light speed) and a superluminal expansion of $\sim$ 3 c. This is the first work to verify structure variations of the jet in 3C 279 with annual EHT observations of this source.

Wendy Rummerfield, University of Redlands
[B-17] Computational Flame Dynamics of Micro-Channels

For the last decade, the study of micro-combustion has increased tremendously due to its applications in aerospace and industrial technology as a more efficient form of power and heat source. Unfortunately, complications arise with these small channels creating much instability with the flame including repetitive extinction reignition patterns which are currently not understood. Our aim is to model these flames computationally and adjust specific variables such as the mixture ratio of fuel to oxidizer, heat loss through the channel walls, and channel width in the hopes of better understanding the parameters needed to create a stable flame. My research has involved expanding our understanding of non-symmetric flames and experimenting with new methods to obtain more accurate results from our computer code.

Michelle Schoon, Concordia University Irvine
[B-18] Applications of Linear Algebra to Image Processing

The majority of the research in facial recognition by computers involves comparing single images. To increase accuracy we can compare sets of images. We will look at one such method that uses the singular value decomposition of the data matrix for the set of images.

Alison Schuetz, Hood College
[A-22] Polygon Partitions and Reversions of Series

The Catalan numbers C_k were first studied by Euler, in the context of enumerating triangulations of polygons P_{k+2}. One generalization of the Catalan numbers, the Fuss-Catalan numbers $C_k^{(d)}$, counts enumerations of $(d+1)$-gon dissections of polygons $P_{k(d-1)+2}$. We present here a further generalization $C_k^{(d_1,d_2,\ldots,d_r)}$, arising in the enumerations of mixed polygonal dissections into $(d+1)$gons, where $d \in \{d_1, d_2, ..., d_r\}$. These mixed dissections arose in context of studying series arising from iterated polynomials, and we compute recursive (and closed) formulas for $C^{(d_1,d_2,\ldots,d_r)}$ by examining the reversions of certain power series.

April Senner, Western Oregon University
[A-23] Exploring Spatio-Temporal Trends in Reactions to Disaster Situations on Twitter

Current disaster responding suffers from lack of valuable information in early response after disasters; however, the situation could be improved by the emergence of geo-tagged user-generated content from social media sites such as Twitter. By finding disaster-related tweets for a set of disasters, we explore the opportunity to use this real-time information to detect trends in people's reactions over time and distance in past disasters so that responders will be better-informed in future disasters. The main contributions of this work include: (i) a classifier for each of eight disaster types (e.g. earthquakes, hurricanes, tornadoes) to accurately filter non-disaster related tweets from truly related ones; (ii) a statistical study to quantify the data and visualize it in various ways; and (iii) a focused comparison and analysis between two specific hurricane events.

Carly Shinners, University of Wisconsin-La Crosse
Katherine Zoroufy, University of Wisconsin-La Crosse
[A-24] Christine Ladd-Franklin: The First American Woman to "Earn" a PhD in Mathematics

Christine Ladd-Franklin became the first American woman to earn a PhD in mathematics after completing the requirements at Johns Hopkins University. Despite the fact that Johns Hopkins published her graduate thesis, "On the Algebra of Logic", they did not award degrees to women at that time and thus she did not receive the degree for another 44 years. In addition to her work in mathematics, Ladd-Franklin published a psychology theory on sensation in the book Colour and Colour Theories. Along with Ladd-Franklin's academic success, she lectured for little to no pay at universities such as Harvard and Columbia and she was the first woman to lecture in the arts and sciences at Johns Hopkins University. Christine Ladd-Franklin's bold and courageous attitude along with her passion for learning and helping other women makes her a crucial leader for professional women and someone mathematicians can be proud of.

Larissa Sime, University of Central Oklahoma
[B-19] A Mathematical Model of Fibrinolysis to Identify Effective Stroke Treatment

Fibrinolysis, the proteolitic break down of fibrin fibers that stabilize blood clots, is driven by tissue-type plasminogen activator (tPA). A macroscale mathematical model of the factors that influence the lysis rates in the clots have shown that tPA could significantly increase or decrease the rate of fibrinolysis as we vary the concentration administered near clots; it has been observed clinically that too rapid fibrinolysis result in excessive bleeding and too slow fibrinolysis results in stroke. Interestingly , with the model we identify an optimal tPA dissociation constant, and start exploring different treatment options related to stroke and excessive bleeding.

Kristen Smith, Utah Valley University
see **Sydney Butler**

Caitlin Snyder, Xavier University
[A-25] Spatial Analysis: Mapping

My primary focus will be on mapping political maps through R, a computer program that creates a visual representation of statistical data. I will be discussing my collaboration with students in the "PPP" (Philosophy, Politics & the Public) program to address the question of how political candidates decide where to strategically allocate their resources for campaigning. Many factors go into answering this question. I will demonstrate how to visually map and utilize important data like voter turnout and previous election results. After creating a visual map of the data, I will exhibit how this visual representation is easily manipulated to show the political candidate where their campaigning would be most beneficial to them.

Emily Stucki, Utah Valley University
see **Sydney Butler**

Alexa Syryczuk, University of Wisconsin-Eau Claire
[A-26] Constructing 4-Dimensional Tops

The polar duality transformation takes a polytope with integer lattice points to its polar dual. If the polar dual is also a lattice polytope then we refer to the polytopes as reflexive polytopes. Reflexive polytopes have been classified in 3 dimensions and 4 dimensions, with $4,319$ and $473,800,776$ classes respectively. We extend the idea of splitting a reflexive polytope into two pieces to define a top. Bouchard and Skarke have classified the 3 dimensional tops corresponding to each class of reflexive 2-dimensional base polytopes, and related them to Dynkin diagrams. We use this to construct new, "exceptional" examples of 4-Dimensional tops.

Teika Thompson, Stillman College
[A-27] Raman Measurements of Nitrates and Other Chemicals

Raman Spectroscopy is a detection method that can identify chemicals within a matter of seconds by using its characteristic Raman spectrum. Previous studies have shown that by using a proper excitation laser, detector, and dedicated Raman analyzer it is possible to detect and identify chemicals and hazardous materials. In this work, Raman measurements of concealed and exposed Ammonium Nitrates, Sodium Nitrates, Perchloric Acid and other chemicals were carried out using Enwave Optronics EZRaman system with 785 nm excitation wavelength from a diode laser source.

Jacquelyn Voss, University of Nebraska-Lincoln
see **Angie Loong**

Ashley Weber, University of Michigan
see **Orsola Capovilla-Searle**

Katy Weber, State University of New York at Geneseo
see **Tiffany Reyes**

Miaozhi Yu, University of Illinois at Urbana-Champaign
[B-20] Do There Exist Mon-Smooth Extremals?

Using a set of differential equations, we explore a variety of solutions in order to find the shortest, non-straight and non-curved path between two points.Namely,we are looking for a path which is non-smooth, such as a corner of a square which consists of two lines meeting at a point.The equations are:

$$\begin{aligned} x'(t) &= v(t), \\ y'(t) &= u(t), \\ v'(t) &= F(x,y)u(t), \\ u'(t) &= -F(x,y)v(t). \end{aligned}$$

By construction we have a non-smooth solution called the baseline trajectory of length two. By drawing a line of length one from the origin to the starting point and another line of length one from the origin to the ending point, we have the baseline for comparison. If we can produce a solution to the given set of equations with a length greater than two, then the optimal path would be the baseline trajectory itself. We plan to do this through an exploration of varying values of epsilon. As a result we will find one example of a non-smooth optimal path between two points.

Shalima Zalsha, University of Nebraska-Lincoln
see **Angie Loong**

Katherine Zoroufy, University of Wisconsin-La Crosse
see **Carly Shinners**

The Sixteenth Annual Nebraska Conference for Undergraduate Women in Mathematics

January 31 - February 2, 2014

POSTER ABSTRACTS ADDENDUM

Ana Perez-Gea, Instituto Tecnológico Autónomo de México

[B-21] Fast Generation and Tracking of GPS Visibility and Dilution of Precision Regions Using Level Sets

Two major performance measures of GPS systems are visibility and Dilution of Precision (DOP). Visibility is defined by regions that share a direct line of sight with sufficiently many satellites in orbit, while DOP is a metric correlated with GPS user error. Our hypothesis is that implementing Level Set Methods to measure visibility and DOP will prove to be more time efficient and equally as accurate as the systems that are currently used by analysts. Working jointly with The Aerospace Corporation, two separate strategies were investigated and implemented: a Static Approach and a Dynamic Approach. Furthermore, efforts to implement and test different numerical optimization schemes, in relation to the problem framework and Matlab software, were pursued. Initial results of these techniques have shown to be promising with regards to analysis and calculation of GPS Satellite Visibility Zones and DOP metrics.

Maya Rotmensch, Harvard University

[A-28] Mapping Domain Names to Categories

In order to produce a meaningful link between an internet domain name and a category (a classification of areas of interest hierarchically constructed by companies such as Oversee.net which specialize in monetized domain parking), both need to be described and compared in the same semantic space. Through the introduction of descriptive keywords, this link can be created with the use of Explicit Semantic Analysis. In this work, we implement such a procedure. Additionally, we present methods of creating new keywords to describe domain names. The main challenge we try to address is the scarcity of input information, since domains usually do not have any meaningful content, and many of the domain names useful for this purpose are unintentional misspellings of some other domain name. We test our methods, discuss our results and propose directions for future research.