We are delighted to host the Southwestern Undergraduate Mathematics Research Conference this year. It is our pleasure to extend a warm El Paso welcome to you all! We hope you will enjoy the presentations and be motivated to pursue a career in STEM research.

Time	**Speaker**		
Friday			
5:00 - 6:00 pm	Registration		
6:00 - 7:00	Dinner		
7:00 - 7:10	Welcome - Provost Richard Jarvis		
7:15 - 8:15	Prof. Art Benjamin		
8:15 - 9:30	Student Social / Moderators Meeting / Faculty Meeting		
Saturday			
8:00 - 8:30 am	Breakfast		
8:30 - 8:50	A. Doerfler	J. Belka	J. Cain
8:55 - 9:15	N. Coston	L. Garnaat	K. Davis/R. McPeck
9:20 - 9:40	Z. Plueger	F. Prieto	J. Alonso
9:45 - 10:05	B. Pleasanton	B. Sena	D. Canales
10:05 - 10:30	Break		
10:30 - 11:30	Prof. Rodrigo Bañuelos		
11:35 - 11:55	S. Howe	M. Bencomo	C. Katerba
12:00 - 12:20 pm	T. Le	R. Casillas	J. Yatsko
12:30 - 1:30	Lunch		
1:30 - 1:50	K. Johnston	J. Prellberg	D. Grambihler
1:55 - 2:15	J. Gamez	S. Ramsey	Z. Kuiland
2:20 - 3:20	Prof. Richard Ehrenborg		
3:20 - 3:45	Break		
3:50 - 4:10	K. Baker	J. Neufer	I. Douglas
4:15 - 4:35	E. Cervantes		J. Xu
4:40 - 5:00	K. Millan		J. Truman
5:00	Closing		
6:30 - 7:30	Dinner		
7:30 - 9:30	Prof. Larry Lesser and “open-mike”		
Sunday			
8:00 - 8:30 am	Breakfast		
8:30 - 8:50	L. Guzman	D. Springer	G. King
8:55 - 9:15	A. de la Cruz/J. Guerrero	A. Muñiz/R. Duran	K. Bryant
9:20 - 9:40	M. Robledo	P. Krecker	M. Sanchez
9:40 - 10:00	Break		
10:00 - 11:00	Leo Saldivar		
11:00 - 12:30 pm	travel to Lunch/Closing		

Friday, March 5, 2010

7:15–8:15 **Arthur T. Benjamin**, Harvey Mudd College

Combinatorial Trigonometry (and a method to DIE for)

Many trigonometric identities, including the Pythagorean theorem, have combinatorial proofs. Furthermore, some combinatorial problems have trigonometric solutions. All of these problems can be reduced to alternating sums, and are attacked by a technique we call D.I.E. (Description, Involution, Exception). This technique offers new insights to identities involving binomial coefficients, Fibonacci numbers, derangements, zig-zag permutations, and Chebyshev polynomials.

Biography:

Arthur Benjamin earned his B.S. in Applied Mathematics from Carnegie Mellon and his Ph.D. in Mathematical Sciences from Johns Hopkins. Since 1989, he has taught at Harvey Mudd College, where he is Professor of Mathematics and past Chair. In 2000, he received the Haimo Award for Distinguished Teaching by the Mathematical Association of America, and served as the MAA's Polya Lecturer from 2006 to 2008. His research interests include combinatorics and number theory, with a special fondness for Fibonacci numbers. Many of these ideas appear in his book (co-authored with Jennifer Quinn), "Proofs That Really Count: The Art of Combinatorial Proof", published by MAA. In 2006, that book received the Beckenbach Book Prize by the MAA. Professors Benjamin and Quinn were the editors of Math Horizons magazine from 2004 through 2008. Art is also a magician who performs his mixture of math and magic to audiences all over the world, including the Magic Castle in Hollywood. He has demonstrated and explained his calculating talents in his book "Secrets of Mental Math" and on numerous television and radio programs, including The Today Show, CNN, The Colbert Report, and National Public Radio. He has been featured in Scientific American, Omni, Discover, People, Esquire, New York Times, Los Angeles Times, and Reader's Digest. In 2005, Reader's Digest called him "America's Best Math Whiz."

Saturday, March 6, 2010

10:30–11:30 **Rodrigo Bañuelos**, Purdue University

The isoperimetric inequality, a historical point of view

We will describe the isoperimetric inequality taking a historical point of view that goes back over 3,000 years and pointing out its connections to, and influence on, various areas of modern mathematics. We will illustrate George Pólya's statement "the isoperimetric theorem, deeply rooted in our experience and intuition, so easy to conjecture but not so easy to prove, is an inexhaustible source of inspiration" with some examples from Brownian motion and the bass note of drums. Some isoperimetric problems which are easy to conjecture but remain unsolved will be mentioned.

Biography:

Rodrigo Bañuelos was born in rural La Masita, Zacatecas, Mexico, to a Mexican-American father and a Mexican mother. He did not attend school until the age of 16 when he moved to the United States. Bañuelos earned his Ph.D. in Mathematics from the University of California, Los Angeles in 1984. He spent two years as a Bantrell Research Postdoctoral Fellow at the California Institute of Technology and one year as a National Science Foundation Postdoctoral Fellow at the University of Illinois at Urbana before moving to Purdue University in 1987 as an Assistant Professor. He was promoted to Associate Professor in 1989 and to Full Professor in 1992. He has served as Head of the Department of Mathematics since 2007. Bañuelos' research is at the interface of probability, harmonic analysis, partial differential equations and spectral theory. Bañuelos was a National Science Foundation Presidential Young Investigator from 1989 to 1994. He was elected Fellow of the Institute of Mathematical Statistics in 2003. He received the Blackwell-Tapia National Prize in Mathematics in 2004 for his mathematical contributions and for his efforts to address the problem of the under-representation of minorities in mathematics. From 1998 to 2002, he served on the Scientific Advisory Council of the Mathematical Science Research Institute at Berkeley. He was a member of the United States National Committee on Mathematics from 1998 to 2001 and served on the Board of Trustees of the Institute for Pure and Applied Mathematics at UCLA from 2005-2009. He has served on several AMS committees and on several editorial boards of mathematical journals, including the Annals of Probability, the Transactions and Memoirs of the American Mathematical Society and Revista Matemática Iberoamericana. He has delivered 100's of invited addresses at national and international meetings, including meetings in 21 different countries, in 6 different continents.

2:20–3:20 **Richard Ehrenborg**, University of Kentucky
The Mathematics of Juggling

We consider simple juggling patterns where the juggler catches and throws one ball at a time. A result by Buhler, Eisenbud, Graham and Wright determines the number of juggling patterns of period d having at most n balls. We then present the q-analogue where we count the number of such patterns with respect to the number of crossings occurring and we give the "book proof" of this extension. This is joint work with M. Readdy.

Biography:
Richard Ehrenborg received his bachelor degree from University of Stockholm, and his doctorate from MIT. He has then held a post-doc position at the University of Quebec at Montreal, H.C. Wang Assistant Professorship at Cornell University and been a member at the Institute for Advanced Study in Princeton. He is currently a Professor at the University of Kentucky. More importantly, during late nights in graduate school at MIT he learned to juggle.

7:30–8:30 **Larry Lesser**, University of Texas at El Paso
Greater Lesser Hits: A Mathemμsical Journey

UTEP Associate Professor and published songwriter Dr. Larry Lesser shares his passions for math and music with a live, full-length concert including some of his Greater Lesser Hits (like "Hotel Infinity", "American Pi", and "The Gambler") with a strong mathematical theme accompanied by visuals, demos, and educational patter. The concert will be followed by an "open-mike" session in which students (or faculty mentors) are invited to take turns sharing their favorite mathematical jingles, raps, songs, poems, jokes, dance moves, etc.

Biography:
A UTEP Associate Professor since 2004, Larry Lesser has taught math, statistics and math education courses in Georgia, Colorado, and Texas. His time in Texas also includes work as a state agency statistician and as a full-time high school math teacher. Lesser's extracurricular math involvements (Mu Alpha Theta, ARML, Putnam) helped inspire him to go on to get a BA in mathematics, MS in statistics, and a Ph.D. in mathematics education. His scholarship includes 50 peer-reviewed papers/books in statistics/mathematics education (including the co-authored 2009 edition of the COMAP math-for-liberal-arts textbook For All Practical Purposes and a major research paper on English language learners in statistics), 50+ national/international talks (the next one is this summer in Slovenia!), and has led to service on several national/international research or editorial boards. His scholarship has been cited in 20+ journals and his teaching innovations have attracted stories/interviews in international mass media including CNN Headline News, Australia's largest newspaper, and Jamaica newstalk radio. To support his mission in increasing mathematics awareness and motivation, Lesser has merged two of his great loves - math and music. His math songs have led to opening session presentations for major conference audiences spanning mathematicians (e.g., the opening banquet of the 2008 summer meeting of the MAA), statisticians (e.g., the 2009 USCOTS kickoff mixer), and math teachers (e.g., an SRO audience of 800+ at the 2009 NCTM conference in Nashville). He wrote the first juried comprehensive articles on using songs in math/statistics class and dozens of his math lyrics appear in national journals and on his website.

Sunday, March 7, 2010

10:00–11:00 **Leo Saldivar**, University of Texas at El Paso
Bioinformatics and the Golden Era of Biology

Our ability to read DNA has created a tidal wave of biological data. The information we are gleaming from mining this data is changing every aspect of our lives. The way we practice medicine and law, the foods we eat, it is redefining economies, creating new fuel sources, debunking long held religious dogmas, creating new life forms as well as frighting new bio-weapons. I will be exploring some of the many exciting/dangerous outcomes of the DNA revolution and how bioinformatics is making this happen.

Biography:
Leo Saldivar is a staff bioinformatician at the University of Texas at El Paso. He has also worked as a bioinformatician at the U.S. Department of Agriculture and the National Cancer Institute. He holds a M.S. in Bioinformatics and a B.S. in Mathematics.

Session A. Room: 301
Saturday, March 6, 2010

8:30–8:50 **Anita Doerfler**, Northern Arizona University
Greek Ladders: An Often Overlooked Method in Diophantine Approximation

Greek Ladders are an ancient method for approximating irrational numbers. As a visual array of recurrence relations, Greek Ladders are simple, yet precise. With connections to Newton's Method, they are a viable area of interest. There are yet many open questions concerning Greek Ladders, some of which are currently under investigation.

8:55–9:15 **Natalie Coston**, Northern Arizona University
Greek Ladders, Part II

Greek Ladders, an ancient and often overlooked technique in Diophantine Approximation, are easy to compute and provide accurate estimation of irrational numbers. Some recent results show that, by taking a deeper look into classic Greek Ladders, we can not only expand into higher-dimension Greek ladders but we can also make connections between Greek Ladder approximations and those derived from the Continued Fraction Algorithm and Newton's Method.

9:20–9:40 **Zach Plueger**, Northern Arizona University
Greek Ladders of Width 4 or More

As the width of Greek Ladders increase, trends appear in the limits of fractions created by the rungs of the ladder. For ladders of width 3 and greater, we have identified these trends using computational evidence.

9:45–10:05 **William Pleasanton**, United States Air Force Academy
Greek Ladders of Polynomials

We will extend the investigation of Greek ladders to polynomials. We will examine convergence behavior of such ladders as well as connections to other fields of mathematics such as numerical analysis. We will conclude with some current and open questions on this topic.

11:35–11:55 **Sean Howe**, University of Arizona
Symmetrization and Isoperimetric Problems in Manifolds with Density

We will begin by discussing the classical isoperimetric problem in the Euclidean plane and the proof via Steiner symmetrization that circles are isoperimetric. We will then introduce the relatively new field of isoperimetric problems in manifolds with density and discuss some interesting results in this area, including those from our upcoming paper (Diaz, Harman, Howe, Thompson - "Isoperimetric problems in sectors with density"). Here we will focus on the intuition of the problem and on visualizations of isoperimetric regions. We will conclude with the statements of some theorems from our upcoming paper on symmetrization in manifolds with density (Morgan, Howe, Harman - "Symmetrization in warped products and fiber bundles with density") and an example of how these can be used to simplify the study of the isoperimetric problem in $\mathbb{R}^n$ with a radial density.

12:00–12:20 **Tuan Le**, Fairmont High School
On the extremal problem of Polya

The notion of transfinite diameter of planar sets was introduced by M. Fekete around 1920s. This concept plays an important role in the classical complex analysis and is related to other well-known concepts such as the logarithmic capacity and Chebyshev polynomials. The transfinite diameter of a compact set is the limit of n-diameters. For each $n \geq 3$, the n-diameter $d_n(E)$ of E is given by

$$d_n(E) = max\left\{\prod_{1\leq i<j\leq n} /z_i - z_j/^{\frac{2}{n(n-1)}}\right\}$$

The following is the extremal problem of G. Polya: among all n-tuples $E = \{z_1, z_2, \cdots, z_n\}$ with $|z_i| \leq 1$, find one with the largest n-diameter. The solution of this problem, attributed to Polya, is the following

$$d_n(E) \leq n^{\frac{1}{n-1}}$$

and the equality holds for n-tuples of equally spaced points on the boundary of D. While investigating the transfinite diameter of sets of constant width,Prof. Zair Ibragimov was led to the following weaker version of Polyas problem: among all n-tuples $E = \{z_1, z_2, \cdots, z_n\}$ with $|z_i - z_j| \leq 2$, find one with the largest n-diameter, which is essentially the same as find the optimal convex configuration of these n points in the complex plane. In this paper, I will present my solution of Ibragimovs problem for the case $n = 5$, which uses a so-called isoperimetric inequality and an "almost completed" approach for $n = 7$. I will also discuss why other cases can not be proved using the same method as for $n = 5$.

1:30–1:50 **Kassandra Johnston**, University of New Mexico
Subgraph Summability

The Subgraph Summability number, $\sigma(G)$, of a connected graph G is the largest integer defined by labeling the vertices of G so that the label sums of connected induced subgraphs cover the set of positive integers $\{1, 2, ..., \sigma(G)\}$. This is a generalization of problems in number theory and design theory. Here we present subgraph summability numbers of certain graph classes including double stars, crowns, brooms, and $K_{2,S} + e$.

1:55–2:15 **Jose Gamez**, University of Texas at El Paso
Graffiti.pc

Graffiti.pc is a conjecture-making (database) program, whose design was influenced by the well-known conjecture making program, Graffiti. The program generates a system of inequalities (conjectures) between graph invariants. Furthermore, the program assumes that each conjecture is true. The researcher's job is to verify if the conjecture is true or false by either finding a counter-example to show that the conjecture was false, or give a proof to show that the conjecture was true. The three main graph invariants that I studied as an undergraduate using Graffiti.pc were the independence number, independent domination number and the residue of a graph. The talk will attend to how the program played an important role on my undergraduate research in finding new bounds for graph invariants.

3:50–4:10 **Kari Baker**, Arizona State University
Pi

Various methods have been used to calculate the value of π throughout history. This presentation will discuss some of these methods. The methods discussed will range from about 2000 BC to present day.

4:15–4:35 **Eduardo Cervantes**, University of Texas at El Paso
Sacred Geometry

Sacred geometry is for those who do not believe there is a higher order. There exist geometric evidence that align everything as if it were part of an orchestra where everything works with harmony like in a concert. This knowledge has remained hidden for thousands of years, despite having been studied by Plato, Pythagoras, and Da Vinci, among others. There are rumors of major scientific discoveries that have been silenced by vested interests. Do you want to know the hidden mysteries of mathematics? Some of the topics that will be covered are: Implosion, the Three of Life, Phi (and the golden ratio), the Flower of Life, numerology, etc.

4:40–5:00 **Kristell Millan**, Arizona State University
Calculus Applications in the Realm of Dance

Although calculus is seen by many as a highly theoretical math form, the reality is that calculus can be applied to many different aspects of life. This paper discusses one of these such applications, an application of basic calculus principles in the realm of dance, particularly ballet. Through a combination of the derivative and integral concepts of calculus and some basic knowledge of the physics involved with projectile motion I was able to derive good approximations for the motion of a ballerina's grand jete. In doing so, I was able to discover some of the mathematical properties underlying the beauty and grace of one of my favorite dance moves.

Sunday, March 7, 2010

8:30–8:50 **Lynette Guzman**, University of Arizona
The Prefreshman Engineering Program (PREP): Creating Opportunities for Underrepresented Minorities in STEM fields

Inequality in educational opportunities is a common problem among schools across the nation. This issue affects some students in certain socioeconomic classes more than others, and these students must carry this burden throughout their academic careers. Many academic enrichment programs strive to narrow the gap of inequalities in education by creating opportunities for low-income, underprivileged students. In particular, the San Antonio Prefreshman Engineering Program (PREP) enhances students' skills in math and science to promote careers in the science, technology, engineering, and mathematics (STEM) fields. Established in 1979 by Dr. Manuel Berriozábal, San Antonio PREP encourages high achieving middle and high school students to participate in strengthening their backgrounds for future careers in STEM fields. PREP takes place in various participating universities for seven-weeks during the summer. With a mathematics intensive curriculum, students take classes such as logic, engineering, and problem solving. This program has expanded throughout the state of Texas, known as Tex PREP, and continues to grow even more through PREP-USA with the goal of targeting underrepresented minority groups in preparation of building scientific and engineering career paths.

8:55–9:15 **Amber de la Cruz & Jaquelyn Guerrero**, Valle Verde Early College High School
Chicanas En Acción

In the field of mathematics many people have discriminated females, but in reality the potential that a mathematician can have comes from the heart, and not from the gender. In this presentation we will talk about how effort, passion, and commitment can lead into a successful career of a woman mathematician regardless of her gender.

9:20–9:40 **Mariela Robledo**, Arizona State University
Mathematician and Artist Within

Many people categorize themselves as either being good at mathematics or being a great artist. It seems to be a pattern among the masses, to be artistic or be logical, but there are also the select few that are talented in both. There is no better way to explain the influence that art and mathematics have amongst each other than with G.H. Hardy's words: "A mathematician, like a painter or poet, is a maker of patterns." M.C. Escher is a great example of how artistic talent and mathematical concepts combined can create the most stunning works of art. His collections of tessellation paintings are the artistic proof of how mathematics is everywhere, even in art.

Session B. Room: 302
Saturday, March 6, 2010

8:30–8:50 **Jacob Belka**, United States Air Force Academy
Optimizing GPS using mathematical programming

In the last two decades both civilian and military functions have grown to greatly depend on GPS. From navigating in a car or airplane, to programming coordinates into smart missiles, GPS has become a huge part of our lives. At a minimum, GPS consists of 24 satellites, four in each of six equally spaced orbital planes. A GPS receiver must have at least four satellites in line-of-sight to obtain a reading, and the relative positions of those satellites determine the accuracy of the reading. The question comes: if we can add a spare satellite, which orbital plane do we pick and where in that plane should we place it for optimal performance? What if we can add two or more? Our approach uses mathematical programming and numerical methods, a technique that does not appear to have been previously applied to GPS. We are comparing our new results with those found by the Air Force Space Command and contractors.

8:55–9:15 **Lynn Garnaat**, University of Arizona
Stochastic Particle-Based Model of Cell Rearrangements

The development of tissues is due to the movement of individual cells acting collectively. To study the rearrangement of cells in tissues, we developed a suite of two and three dimensional grid-free stochastic models using Matlab. We modeled cells as clusters of randomly moving particles and used a Lennard-Jones force to represent the attraction and repulsion between cellular particles. The method is seen to take computational time which varies linearly with the number of particles. We developed methods which model cell growth and division, adhesion, and polarization. By altering the strength of adhesive interaction between groups of cells, we were able to simulate the difference in surface tension between cells of different tissue types and could clearly see the cells sorting as they do in vitro. We adapted our model to include polarized cells so that we may simulate the formation of the gut tube in frog embryos.

9:20–9:40 **Frank Prieto**, University of Texas at El Paso
Relationships in the Fibonacci Series to Movements and Retracement Ratios in Stock Market Trends

In this presentation, I would like to demonstrate that behavior in the stock market reflects patterns that are based on relationships in the Fibonacci Sequence. Specifically, I would like to focus on how retracement ratios and trends have Fibonacci characteristics, and how these characteristics can be useful for making predictions and Forcasts in the market.

9:45–10:05 **Bobby Sena**, University of New Mexico
Probabilistic modeling of action potential generation by neurons

The function of many cells and organs in the body is absolutely dependent on their ability to generate an electrical signal termed an action potential. The action potential represents a temporal sequence of changes in the electrical potential across a local domain of a cellś plasma membrane, and results from a carefully coordinated sequence of changes in membrane conductance for sodium and potassium ions. We present a model of the dynamical behavior of the gated ion channels that are responsible for the changes in membrane conductance. Our model is based on the electrical properties of parallel RC circuits, but improves on most current models because it incorporates the time- and membrane-potential dependent probabilities that the gated ion channels are in one of three states: closed, open, or inactive. The dynamics of our model correspond closely to empirical results for individual nerve cells. More importantly, our model accounts for the so-called membrane threshold, which is the membrane potential at which the sequence of changes in conductance commences.

11:35–11:55 **Mario Bencomo**, University of Texas at El Paso
Application of Least Squares in Dose Calibrator Linearity Assessment

The U.S. Nuclear Regulatory Commission (NRC) Consolidated Guidance About Materials Licenses states that a licensee that prepares its own dosages is required to possess and calibrate all instruments used for measuring patient dosages in accordance with prescribed guidelines. The instrument of choice for gamma-ray emitters is the ionization chamber dose calibrator, with which radioactivity can be measured over several orders of magnitudes with precision and remarkable stability. One of the required quality control assessments is linearity of response. The NRC provides a guideline of data acquisition and analysis but however does not offer a methodology for data fitting. The method of least squares (LS) was employed in this research as a fitting technique in which the sum of the squared residuals (SSR) is minimized with respect to the model parameters, in this case a non-linear minimization problem since the model is exponential. A total of 12 LS cases, prompted by literature and practice, were analyzed: non-linear LS, linear LS (by linearization of the data points), weighted linear LS (as an approximation to the non-linear LS) while considering for each the 2-parameter model, and 1-parameter models in which either the highest activity or a more "central" data point is fixed, or in which the half-life is fixed. Non-linear optimization techniques were considered in the non-linear LS. The non-linear 2-parameter LS case provided the smallest minimized value for the SSR (at least an order of magnitude in improvement when compared to the linear cases) while the weighted linear 2 parameter LS case provided results within the same magnitude as that of the non-linear case serving as a good approximate.

12:00–12:20 **Ruben Casillas**, University of Texas at El Paso
Parallel Web Computing

Mathematical modeling require solution of computational intensive tasks. In this paper a special version of distributed computing, which use the internet and HTTP request will be presented. Presented approach will be applied to the Monte Carlo simulations of selected engineering problems with the random parameters.

1:30–1:50 **Jessica Prellberg**, Arizona State University
Water Flow in Unsaturated Soils, an SVFlux/FlexPDE experience

We are studying the flow of water in unsaturated soils, under various weather conditions and soil properties. We discuss here our experience with the commercial package SVFlux/FlexPDE in obtaining numerical simulations for this problem. Our goal is to evaluate the potential difficulties and numerical stability issues, as well as identify possible remedies.

1:55–2:15 **Samantha Ramsey**, Arizona State University
Water Flow In Unsaturated Soil - A MatLab Experience

We study the flow of water in unsaturated soils, under various weather conditions and soil properties. We implemented a model problem in Matlab using a method of lines and compared different (stiff) ODE solvers. We compared the result with those obtained from the commercial software SVFlux/FlexPDE.

3:50–4:10 **Jared Neufer**, Arizona State University
Interacting Particle Systems and the Majority Rule Model

Interacting particle systems, a type of stochastic processes, have many applications from biology, to physics, to social dynamics. This presentation examines the majority rule model, (a model with applications mostly to social dynamics) which unlike most interacting particle systems, changes multiple sites with each event. Using the dual process, this presentation provides a proof that the majority rule model clusters in 1 dimension, then introducing new techniques, examines the model in 2 dimensions, comparing its behavior to the voter model, a similar, simpler model.

Sunday, March 7, 2010

8:30–8:50 **Daryl Springer**, University of Arizona
Elliptic Curve Cryptography in Embeddable Computer Networks

In this paper I will examine why security is needed in embeddable sensor networks in RFID tags and mention some particular cryptographic algorithms and protocols that are being attempted on such machines. In addition I will look at the special case of using Elliptic Curve Cryptography (ECC) as opposed to the RSA scheme. Finally I will describe some work I did over the summer at an REU in Portland, OR on ECC and explain some of my team's results from that project as it relates to heightened security in embeddable computer systems.

8:55–9:15 **Abigail Muñiz & Raven Duran**, Valle Verde Early College High School
Mathematical Algorithms for Caesar's Code

Julius Caesar was a great historical figure whose military strategies led his empire to acquire vast body of land. When sending important military messages he used an encoding and decoding system that is now called Caesar's Code. This code involves shifting the alphabet so that one letter represents another. The project involves finding if Caesar's Code can be accurately expressed mathematically with the formulas $E_n(x) = (x+n) \pmod{26}$ and $D_n(x) = (x-n) \pmod{26}$. To do this, it is necessary to decode and encrypt messages with Caesar's Code. Then the same messages are decrypted and encrypted with the mentioned algorithms. In the future this experiment can be further explored to see if there are other mathematical devices to express Caesar's Code. Such a device could be using a matrix.

9:20–9:40 **Patrick Krecker**, Arizona State University
An Overview of Cryptographic Key Exchange Algorithms

Key exchange is a critically important feature of modern cryptographic exchanges. The Diffie-Hellman algorithm, while extremely important and pervasive, does not trivially extend to many modern uses in computer networking and the World Wide Web (WWW). SPEKE, B-SPEKE and J-PAKE all introduce features like mutual authentication that are useful in modern network applications and these features are commonly used in practice.

Session C. Room: 303
Saturday, March 6, 2010

8:30–8:50 **Jonathan Cain**, University of Arizona
Numerically Inverting the Laplace Transform

The Post Formula is an inherently ill-posed procedure for numerically inverting the Laplace transform. To account for this we developed arbitrarily high precision programs for Fa'a di Brun's formula, which calculates the high order derivatives of composition functions arising from our application to wave propagation through dispersive media. Furthermore, Post's formula converges at a logarithmic rate, which we accommodate through the use of high precision sequence accelerators: Wynn's ρ Acceleration. Ultimately, we arrive at the conclusion that Mathematica is the most suitable programming package because of its symbolic and high-precision capabilities.

8:55–9:15 **Kirsten Davis & Ryan McPeck**, Northern Arizona University
Newton's Method for Radial & Non-radial Solutions of PDE

Ryan McPeck and Kirsten Davis are presenting a project they did for the NASA Space Grant Internship program at NAU. We worked with PDEs on different domains, most notably the disk. The GNGA method developed by our mentor, Dr. Neuberger, and Dr. Swift was our primary method for finding numerical solutions and drawing bifurcation graphs of solution sets.

9:20–9:40 **Jorge Alonso**, University of Texas at El Paso
System of Equations with Random Set Parameters

The Finite Element Method leads to the solution of parameter dependent system of equations. In many cases parameters of the system are uncertain. If we have many set valued measurements, then it is possible to apply the random set theory. In this paper a special version of Monte Carlo will be presented. Using presented approach it is possible to calculate upper and lower probability.

9:45–10:05 **Diego Canales**, University of Texas at El Paso
Applications of Parallel Computing to the Solution of Equations with the Random Parameters

Many discretization methods (the Finite Element Method, Finite Difference Method, Boundary Element Method etc.) leads to the solution of parameter dependent system of equations. If parameters of the system can be described by the random variables, then the solution is also the random variable. Solution can be characterized by the multidimensional probability density functions. In order to get probabilistic results the Monte Carlo method will be applied.

11:35–11:55 **Charles Katerba**, Northern Arizona University
Hamadard Matrices, their Constructions, and Generalizations

I will present an overview of Hadamard matrices, including classic construction techniques and open questions concerning Hadamard matrices and their generalizations.

12:00–12:20 **John Yatsko**, Northern Arizona University
The Circulant Hadamard Conjecture

This presentation will begin where the previous Hadamard Matrix talk ended. I will cover our team's investigation of the Circulant Hadamard Conjecture.

1:30–1:50 **Daniel Grambihler**, Mesa Community College
Forced Induction

A general method of deriving closed form solutions for summations of polynomials.

1:55–2:15 **Zachary Kuiland**, Arizona State University
Disneyland and Probability

Using material taught in Arizona State University's Finite Mathematics class, this presentation illustrates how introductory probability theory can be applied to make the most of a day at the Disneyland Resort in Anaheim, California. Data from the website "The Disneyland Linkage" revealed that Disneyland is generally the least crowded in autumn. This fact helped construct the first two problems in the presentation: how many possible ways to make four trips during off-peak tourist season and the probability of going exactly once a month. Disneyland does not release official data as to what attractions are visited the most, so a third-party poll of the most popular attractions was used to develop tree diagrams. The tree diagrams all have two layers to them. The first layer denotes the probability of visiting a certain attraction in a section or group of sections in the park, and the second layer (for humorous effect) illustrates the probability of becoming sick at a certain attraction. In summary, the presentation combines mathematical principles with the experiences of a frequent park visitor to show how to most enjoy a day at the Magic Kingdom.

3:50–4:10 **Ian Douglas**, Northern Arizona University
New Results in Combinatorial Games: Edge Polyomino Weak (1,2)-Achievement Games

This talk will focus on a branch of game theory which studies abstractions of Tic-Tac-Toe, called polyomino achievement games. A variation of polyomino achievement games is studied, in which the cells the players mark are the edges of the three tilings of the plane by regular polygons. Planar game boards whose faces have a bijective correspondence to the edges of the tilings by regular polygons are presented, and all but one of the edge animals on each tiling are characterized as either a winner or loser.

4:15–4:35 **Jason Xu**, University of Arizona
Odd Wins

The game of Odd Wins is a variation on the popular combinatorial game of Nim. A standard game of Odd Wins is played by two players on a pile with odd number of objects. Players must remove a number of up to k objects per turn, and the winner is the player who has removed an odd total when there are no remaining objects. Because this objective is not linked to being the last player to move, the traditional analysis used for Nim and many other combinatorial games cannot be applied. The presentation will discuss winning strategies to the original game of odd wins, as well as results found in other variants of the game. The research was conducted at Linfield College in an REU Summer 2009, with professor Dr. Hans Nordstrom and undergraduate research partner Erica Shannon.

4:40–5:00 **Jeffrey Truman**, University of Arizona
Detection of Nuclear Threats: Defending Multiple Ports

Ever since September 11, 2001, the U.S. government has been highly concerned with preventing further terrorist attacks. One threat is that terrorists may try to smuggle weapons into the U.S., particularly through our ports. The goal is to detect and to deter terrorist threats, but there is a trade-off between threat detection and the cost of false alarms. There are also tradeoffs involved in allocating resources among multiple ports. Drawing on previous work which establishes a linear relation between resources and detection, at low budgets, and on game theory generally, the problem can be reduced to a zero-sum finite game, solvable by classical techniques as a linear programming problem. For strained budget levels, this helps to determine the optimal resource allocation for defensive purposes. We are also able to extend the solution to model the cost to the adversary of mounting attacks on specific ports. For very high budget levels, the problem becomes non-linear, but does remain separable. Model results are presented, and their implications discussed.

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Sunday, March 7, 2010

8:30–8:50 **Gavin King**, Arizona State University
The Existence of Arbitrary Length Sequences of Abundant Numbers

A natural number n is abundant if the sum of its proper divisors is greater than n. Abundant numbers are relatively rare, and so it seems unlikely that two consecutive numbers, being coprime and thus sharing no divisors, could both be abundant. This paper uses elementary number theoretic methods to find not only pairs, but arbitrarily long strings of consecutive abundant numbers. This also includes some computationally derived results on consecutive abundant numbers.

8:55–9:15 **Kathryn Bryant**, Northern Arizona University
Recent Developments in Numerical Semigroups and Perfect Bricks

A brief introduction to numerical semigroups and perfect bricks is followed by the presentation of new results of recent research on the same topic.

9:20–9:40 **Mychael Sanchez**, New Mexico State University
Hom Complexes and the Lefschetz Fixed Point Theorem

Given graphs G and H, The Hom Complex $\mathrm{Hom}(G, H)$ is a simplicial complex formed by the graph homomorphisms from G into H. The Hom Complex allows one to prove results about graph colourings and chromatic number. We are investigating the topology on the Hom Complex by applying the Lefshetz Fixed Point Theorem. By studying automorphisms of G and H, we obtain conditions under which $\mathrm{Hom}(G, H)$ is not contractible.

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