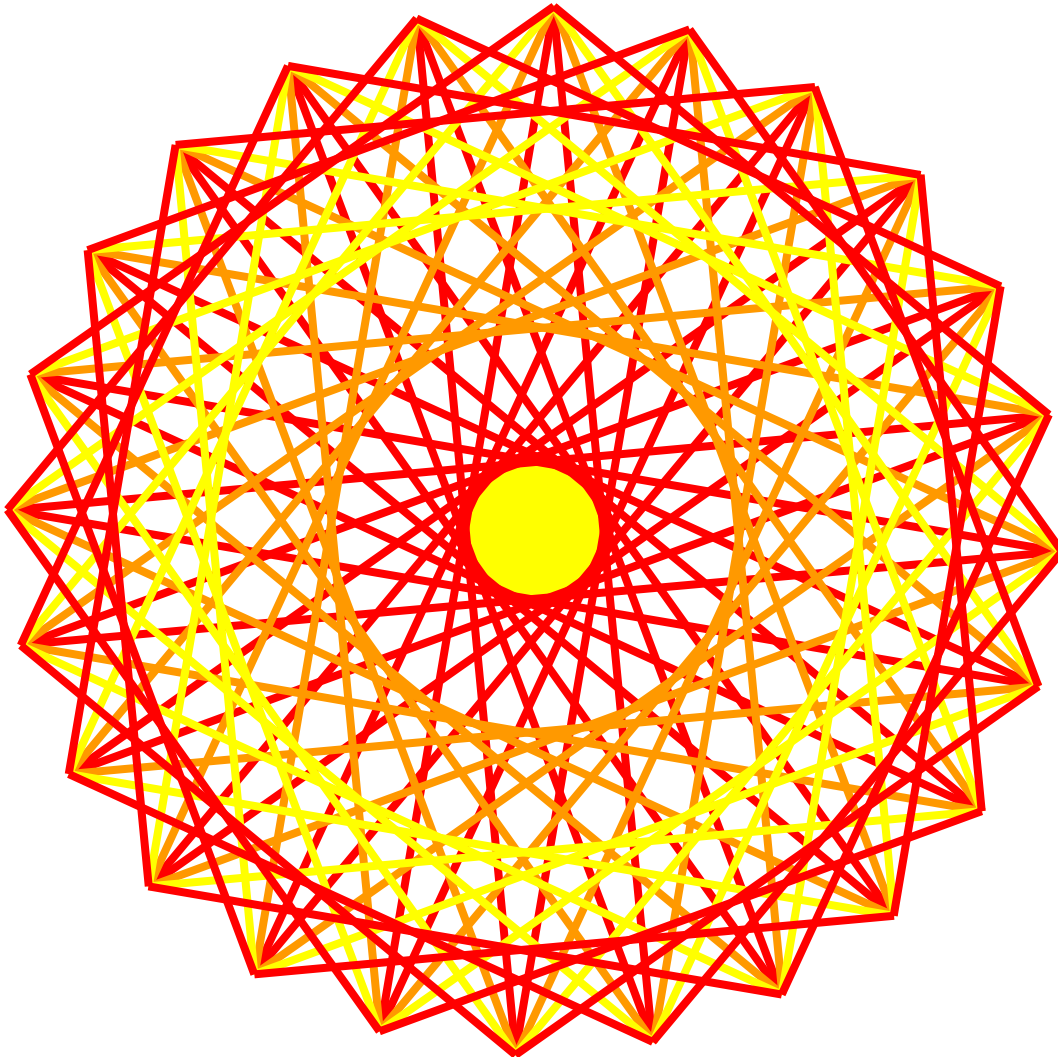




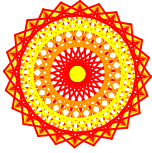
Thirteenth Conference for African American Researchers in the Mathematical Sciences
Northeastern University and the University of Massachusetts Boston, June 19-22, 2007



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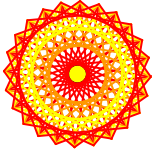
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Ilesanmi Adeboye
University of Southern California
“Volumes of Hyperbolic Orbifolds”
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A hyperbolic n -orbifold is a quotient of hyperbolic n -space by a discrete group Γ of isometries of \mathbb{H}^n . Various authors have previously established explicit lower bounds on the volume of hyperbolic orbifolds of dimension three and of hyperbolic manifolds of any dimension. I will summarize the history of results in hyperbolic volume. I will show examples of hyperbolic manifolds and orbifolds. Finally, I will give a visual proof of Hurwitz's theorem on Riemann surfaces, which was the two-dimensional motivation for my thesis work.



Caleb Ashley
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“A Sight-Seeing Map for Tour de Geometries”
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If a sight-seeing expedition is taken as a tour within a tour, then this poster best represents my excursion into the treasure chest of mathematical ideas and worlds via a wonderful little book “Geometry: Euclid and Beyond,” by Robin Hartshorne. Upon endeavoring to make this tour in three short panels, I can not possibly say how much this book has touched me. My aim will be, as the author says, “to establish a connection between the abstract geometry based on axioms and the methods of modern algebra.” Indeed, geometry has been abstractly defined by Felix Klein, as a set with a group action on it. (Quite truthfully, my frame of reference is based on my striving to pass an algebra qual at the end of the summer!) But for all of those who do not have this particular worry and know this story already, I hope to be able to import enough Euclid as to make even more compelling the spirit of his “Elements” and of this spirits’ resonance in the Tour de Force of Descartes, Galois, and Hilbert. A piece of each of these is included in the poster; in particular, Galois Theory, the precious gem which provides proofs of the impossibility of certain classical ruler and compass constructions. Finally, this map includes some minor results (mostly hand waving and pointing) on a new geometry that has been dubbed “Tropical” geometry. The results here are due to a Colloquium given in by Prof. D. Sundararaman, of Howard University, Spring semester, 2007.



John Belcher

Boston University

“Automorphisms of Algebraic Curves”

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Algebraic curves are a key area of research in algebraic geometry. The study of algebraic curves can be reduced to the study of irreducible algebraic curves, which, up to birational equivalence are categorically equivalent to algebraic function fields.

The study of invariants and symmetries of mathematical objects is at the core of mathematical activity. Automorphisms of algebraic curves arise in various contexts. One particularly rich area of investigation is projections of plane curves to lines. If such a projection results in a Galois extension, this produces an automorphism group. We state and prove results for quartic curves.



Byron E. Bell

Chicago State University

***“A Mathematical Regression of U.S. Gross Private
Domestic Investment 1959–2001”***

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I plan to study U.S. Gross Private Domestic Investment (GPDI) from the year 1959 to the year 2001 and carry out a statistical regression analysis. This will consist of showing a relationship between a dependent variable Gross Private Domestic Investment (GPDI) and the independent variable(s) that could affect prices on the stock exchange. The independent variable(s) will be the Dow Jones Industry of 30 Stocks (DJ), Standard and Poor's Index of 500 Stocks (SP500), New York Stock Exchange Index (NYSE), Consumer Price Index (CPI-U) and Three Month Treasury Bill's Rate (TB3).



Yakira Braden

University of Wisconsin-Madison

**“Eigenstructure Assignment in
Power System Control Design”**

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Synchronous generators connected to an AC network form a single dynamical system, with strong coupling across considerable geographical distances. This natural coupling between synchronous machines offers an opportunity for predatory control to take place. Predatory control occurs when a group of generators destabilizes competing machines in the network while minimizing the impact of the unstable mode within the group exercising control. For a group of m machines, linear feedback control exercised from their frequency and angle measurements can be constructed such that one mode of an otherwise stable, linearized system is unstable. Within the control group, $m-1$ machines are guaranteed to have no participation in the unstable mode. Simultaneous eigenvalue/eigenvector placement using state feedback is used to implement predatory control.



Dennis A. Dean II

Harvard University

***“Applying Permutation Tests to
Magnetoencephalography and
Electroencephalography Source Localization”***

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Source localization of magnetoencephalography and electroencephalography data is a non-invasive method of assessing underlying brain activity which can provide insight into functional mechanisms of neurobehavioral performance and electrical activity in humans. Magnetoencephalography (MEG) and electroencephalography (EEG) data are respectively signal recordings the magnetic field and scalp current surrounding the human skull. In our experimental paradigm 306 MEG signal are recorded from 102 location and 64 EEG signals are recorded from 64 locations. The process of source localization uses an inverse operator derived from magnetic resonance imaging (MRI) recordings of the human skull. Since the number brain partitions considered are much greater then the number of signals, source localization is an under-constrained inverse problem and requires additional assumptions to arrive at a single solution. In this work we consider the minimum normative estimate which assumes that the cortical activation is normal to and originates from the cortical surface.

Of considerable interest in the field of brain mapping is developing statistical methods for determining significant brain activations as compared to baseline brain recordings. One possible approach is to use of permutation methods. Permutation methods are a non-parametric approach that has been shown to converge to exact solutions with very few assumptions. Although the theoretical advantages are clear, the computational and memory requirements of permutation methods limits there application to only the most expensive workstations. In this work we review the application of permutation methods to source localization and discuss computational consideration when implementing on the current generation of multi-core work stations. This is joint work with Emery Brown of the Massachusetts Institute of Technology.



Anthony Dixon
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*“Mathematical Modeling of
Cerebral Blood Flow Dynamics”*
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During postural change from sitting to standing, blood pools in the lower extremities of the body. This effect leads to a decrease in blood pressure in the upper body and the brain and an increase in blood pressure in the legs. In subjects who suffer from orthostatic intolerance, postural change is not well understood, and this work aims to validate a mathematical model that can help describe this regulatory mechanism in more detail. Using a three element Windkessel model that was previously utilized by Dr. Olufsen, our primary goal is to model the cerebral blood flow during a postural change. Since blood pressure data was already collected, it was sufficient to treat this problem as an inverse problem. The parameters of the model were estimated using the inverse least squares method. Once the parameters were estimated the model was validated against the observed data. The model was able to accurately depict the dynamics of cerebral blood flow.



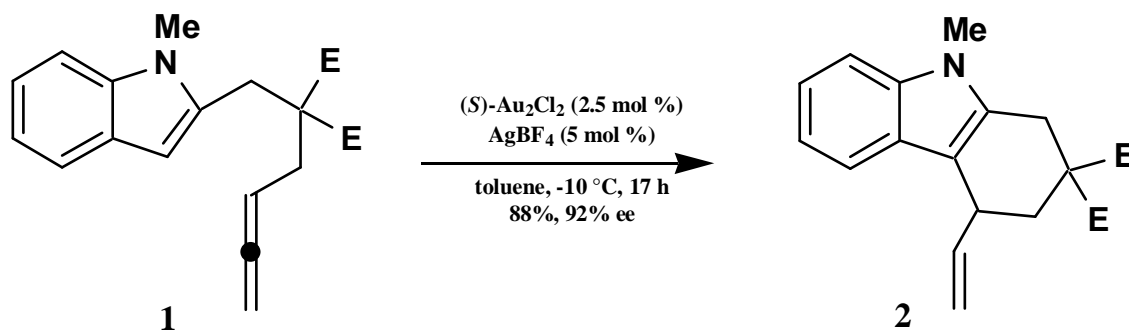
Alethea N. Duncan

Duke University

“Gold(I)-Catalyzed Intramolecular Enantioselective
Hydroarylation of Allenes with Indoles”

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Treatment of 2-allenyl indole **1** with a catalytic mixture of (*S*)-Au₂Cl₂ [*S* = 3,5-tBu-4-MeOBIPHEP] and AgBF₄ in toluene at 0° C for 24 h led to the isolation of tetrahydrocarbazole **2** in 88% yield with 92% ee. The protocol was effective for the cyclizations of terminally unsubstituted allenes as well as symmetrically and asymmetrically disubstituted allenes. This is joint work with Cong Liu, and Ross A. Widenhoefer.





Shaun Gittens

Auburn University

***“Training Neural Networks to Generate Sequences
While Operating in Sequential Environments”***

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Effective supervised learning techniques for multi-layered neural networks have been developed and continually improved for decades. When desired behavior in the output space of the neural network learner is available and utilized, very effective training procedures exist to train a neural network with initially randomized weights. However, further investigation is required for training neural networks where learning is based on desired outcomes which occur as a result of interaction in an unknown environment mapping rather than on known desired immediate actions. Furthermore, it is understood even less how to similarly train recurrent neural networks which operate in sequential environments that accept and map time-varying sequences of neural network action into corresponding sequences of transformed behavior. The methods described here demonstrate how to augment and train recurrent neural networks that operate in sequential environments without the luxury of frequent updates on their current states. Most notably, these recurrent networks are designed to rely heavily on maintaining their own “memory” of prior behavior in deciding on subsequent action. To highlight its effectiveness, a study is demonstrated in which a small-scaled simulation aimed at approximating speech acquisition in the human brain is designed and constructed using this procedure.



Raymar Hampshire

Merrill Lynch

“Introduction to the Mathematics of Bond Trading”

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At Merrill Lynch, we work with many individuals who seek a conservative but flexible approach to investing. They want a steady stream of income that gives them the opportunity to sell at a favorable fair market value. Bonds are the financial instruments that accomplish this. Using the computational and descriptive methods of ordinary differential equations, we are able to determine the present value of a bond at any time during the duration of maturity. Moreover, we can use these equations to determine when it is advantageous to sell or hold the bond at any given time.



Olamide A. Harrison

Virginia State University

*“On Complexity: An Investigation Into
Traffic Flow Using Cellular Automata”*

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We introduce a cellular automaton model which we use to investigate traffic flow on a ‘ring’. The model displays traffic jams, the effect of traffic density on ‘flow’, and flow instability of high speed traffic. We create a fundamental plot of flow versus car density, defining flow simply as total velocity on the CA lattice. We find an increase in total velocity with increasing road density up to about 0.4 cars per site where the total velocity begins to decrease. We also investigate the effect of randomization of acceleration and deceleration reflecting driver autonomy, and the effect of having a system where all vehicles begin with full speed. We find that this system is less stable than the system where vehicles organize themselves to a critical state.



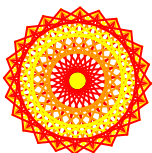
Wainwright Joseph

University of Arizona

*“The Isaacs-Navarro Conjecture and
Combinatorial Properties of Young Diagrams”*

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The Isaacs-Navarro conjecture was first published in 2002 by I.M Isaacs and Gabriel Navarro as a refinement of the famous McKay conjecture. The conjecture addresses the question of computing certain global invariants of a finite group G locally? [1]. The Isaacs-Navarro conjecture states that for an arbitrary finite group G and for $N = N_G(P)$, where $P \in \text{Syl}_p(G)$. Then for each integer k not divisible by p , $M_k(G) = M_k(N)$. Where $M_k(G)$ denotes the total number of irreducible characters of G having degree congruent modulo p to $\pm k$ and $M_k(N)$ denotes the total number of irreducible characters of the Normalizer of the Sylow- p subgroup having degree congruent modulo p to $\pm k$ [2]. The poster will explicitly show that the Isaacs-Navarro conjecture holds for the Symmetric group on four symbols $S(4)$ and the alternating group $A(5)$ and $A(6)$ for the fixed prime $p = 2$. Also the poster will highlight a combinatorial approach that uses the prime partitions and Beta Numbers. This approach holds promise of proving the Isaacs-Navarro conjecture for several classes of finite groups. Recently the Isaacs-Navarro conjecture was proved for the Symmetric groups (P. Fong) and has been extended to the Alternating groups (R. Nath). This poster will also examine several other related combinatorial properties of Young diagrams which are currently under investigation.



Lakeita M. Larkins

University of Michigan

“Analysis of the Hodgkin-Huxley Model: Threshold Voltage for the Release of an Action Potential and Stability of the System”

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We recreated the Hodgkin-Huxley model using the computer program, Matlab, where we wrote a suite of functions that input voltage values. These functions solved for values of conductance, current, and the m , n , and h subunits (representing the sodium/potassium channels). We simulated these functions in the form of diagrams using Matlab, for the different values of voltage we have previously chosen. Finally, using our values for the ionic currents at a set voltage, we analyzed the total membrane current. When channels open, the movement of the ions causes a change of voltage with respect to time. The rate at which the channels open, the ions flow, the voltage changes with respect to time, etc. are all dependent on the initial clamped voltage. Based on this information, we determined whether an action potential has been released as well as the threshold voltage required for its release. We also provided stability analysis of a reduced system of equations that we calculated from the original model in order to pay attention to certain dynamics.



Charles R. Rogers

University of Texas at El Paso

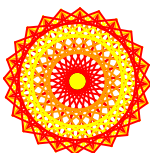
“New Jersey’s Pervasive Ghost: An Assessment of Lethal Ambient Air Mercury Transport”

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Across the United States, mercury air pollution from coal-fired power plants and other sources contaminates our lakes, rivers, and oceans. Toxic mercury emissions deposit from the air into water bodies and then concentrate in fish. Eating mercury-contaminated fish damages the brains and nervous systems of children and can harm cardiovascular and immune systems in adults. The New Jersey Department of Environmental Protection (NJDEP) established mercury air monitoring sites in Elizabeth and New Brunswick, NJ to better understand this problem. The complex and extensive mercury data sets were collected using the Tekran Continuous Mercury Analyzer. Elemental, particulate, and reactive gas mercury were measured at each city during 2004 and 2005. Because of a peculiarity in the way the instrument operates, the mercury levels were measured beginning at random start times after midnight, so that no two measurements were collected during the same time period. Accordingly, we created a method for dealing with the random start times so that the data could be compared. The objective of this assessment was to focus on mercury pollution transport to answer a number of questions such as:

- (1) Is mercury air pollution regional in nature?
- (2) Do sources affect air monitoring sites in both Elizabeth and New Brunswick simultaneously or are they out of phase by an hour or more?

These and other questions were answered by determining the hourly correlations between the sites, the individual correlation of each form of mercury by time difference, and the correlation between sites for primary wind directions. The assessment and statistical protocol developed for this project will assist the NJDEP with determining criteria for assessing mercury levels that affect the quality of air that humans breathe. This is joint work with Fawn E. Hornsby and Sarah A. Thornton of North Carolina State University



Walter E. Simmons III

Morgan State University

*“An Analysis of the
Berlekamp-Massey Algorithm for the Decoding of
Bose-Chaudhuri-Hocquengham (BCH) Codes”*

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Communication theory is the study of transferring information from one source to another. It is used in everyday life through the use of the telephone, high frequency radio, and satellite communications. There are many smaller aspects of communication theory, one of which is called coding theory. Coding theory tackles the serious problem of detecting and correcting high speed data transmission errors caused by noise on a channel. At the core of coding theory, mathematics is prominent. Abstract algebra is the foundation of mathematical coding theory through the area of field theory. Error-correction codes are used to correct errors when messages are transmitted through a noisy communication channel. The *Berlekamp-Massey algorithm* is an efficient procedure for finding the shortest linear recurrence of a finite field that will generate a sequence of nonnegative integers consisting of code words. It is primarily used to invert matrices with constant diagonals. The main focus of this paper is to analyze the Berlekamp-Massey algorithm for decoding of *Bose-Chaudhuri-Hocquengham* (BCH) codes and to investigate its connection to a special subclass of infinite lower-triangular matrices called Riordan matrices. The preliminary conclusion is that the Berlekamp-Massey algorithm can be generalized using Riordan matrices. Thus, this generalization provides a more efficient method of decoding BCH codes.



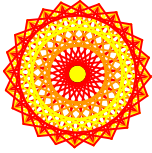
Stephanie Somersille

University of California at Berkeley

“Tug-of-War and the Infinity Laplacian”

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Game theoretic techniques have now been used to solve an old PDE problem. We describe a seemingly simple tug-of-war game and some of its far reaching implications. In particular we show that every bounded Lipschitz function F on a subset of a length space admits a unique absolutely minimal Lipschitz extension to the entire length space. In \mathbb{R}^n , u is infinity harmonic, that is, a viscosity solution to the infinity Laplacian of u equals 0. Game theory has also been used to solve the p -Laplacian problem for finite p . However it is the infinity Laplacian case that PDE experts had previously found to be intractable.



Jesse Hosea Turner

Rice University

*“Adaptive Multi-scale Stochastic Simulations for
Chemical Reaction Systems”*

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Modeling the time evolution of a biochemical system in a cellular environment poses a challenge for quantitative biologists. Three major approaches model the time dependent behavior of biochemical systems: ordinary differential equations (ODEs), stochastic differential equations (SDEs), and Gillespie's stochastic simulation algorithm. Unfortunately, many chemical reaction systems exhibit characteristics not well captured individually by any of these methods. Therefore, a hybrid model incorporating aspects from all three must be employed. The aim is to construct one that is close in accuracy to Gillespie's algorithm, but comparable in computational speed to a differential equations approach. Applications to biological reaction systems would then be more tractable.



Timothy A. Thornton
University of California, Berkeley
*“Case-Control Association Testing with Related
Individuals: A More Powerful
Quasi-Likelihood Score Test”*
thornton@stat.Berkeley.EDU

Case-control studies have been extremely valuable in evaluating associations between candidate genes and complex diseases. Traditional case-control studies use unrelated subjects and compare allele or genotype frequencies of the cases and the controls at genetic markers. When affected related individuals are used in association studies, the power to detect an association is increased since affecteds with affected relatives have a higher expected frequency of the alleles that increase susceptibility for a genetic trait than do affected individuals that do not have affected relatives. We propose a new MQLS test that improves power over previously proposed tests by taking advantage of the fact that affected individuals that have affected relatives are more likely to have the predisposing variants than individuals that do not have affected relatives. One of the motivations for using the MQLS test is that for any arbitrary set of outbred individuals, the MQLS statistic has maximal non-centrality parameter in a general class of linear statistics, for all 2 allele disease models, as the effect size tends to zero. Simulations are performed to compare the type I error and power of the new test with those of competitors. We apply the methods to analyze data on an alcoholism related phenotype in a sample of moderate-size outbred Caucasian pedigrees from GAW 14 COGA data provided by the Collaborative Study on the Genetics of Alcoholism (U10AA008401). This study was supported by National Institutes of Health grant HG001645.