ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Undergraduate Mathematics Conference

Student Speaker Abstracts
(listed according to times)

Friday 3:30 - 3:50 p.m., G219, Crapo Hall

Bobby Arn, Millikin University

Title: ***Combating Noise in Imaging Systems***

Abstract: Noise is a problem that occurs in all types of digital imaging system, whether it be normal daytime snapshots or high resolution medical scans. In recent years imaging sensor technology has improved greatly in respect to reducing the amount of noise present. For the average camera user, noise is no longer a problem, however, for many scientific applications these advancements are not enough. We explore the use and mathematics of two (inexpensive) techniques to reduce the effects of noise in the context of astrophotography: stacking multiple images and thermal reduction.

Friday 3:30 - 3:50 p.m., G221, Crapo Hall

Katherine Varga, Kent State University

Title: ***Greater Than Sudoku and Partially Ordered Sets***

Abstract: Greater Than Sudoku, a variation of the Sudoku game you all know and love, provides inequalities rather than number clues. In this talk we will explore the mathematics of partially ordered sets in order to learn more about the inequality arrangements within the blocks of a Greater Than Sudoku puzzle.

Friday 3:30 - 3:50 p.m., G222, Crapo Hall

Ryan Bowman and Kris Wease, Vincennes University

Title: ***Examining the Relationship Between Teachers' Images of Mathematics and Their Mathematics History Knowledge***

Abstract: This study reveals what K-12 teachers nationwide (N > 4,600) believe about mathematics, what they know about mathematics history, and the significant correlational relationships between level of mathematics history knowledge and beliefs about mathematics. Teachers believe that mathematics is fun, thought-provoking, and intricately connected to the real world. They disagree with statements like "everything important in mathematics is already known" and "mathematics is a disjointed collection of facts, rules, and skills." Teachers with high history scores were more likely to strongly agree that mathematics is fun, thought-provoking, creative, ever-changing, and makes a unique contribution to human knowledge. Teachers with high history scores were more likely to disagree that mathematics is a disjointed collection of facts, rules and skills, and that everything important in math is already known. This large-scale correlational study shows that there is indeed a relationship between teachers' knowledge of mathematics history and their images of mathematics, as claimed by many theorists, and that further research is needed to test a causal relationship.

Friday 4:00 - 4:20 p.m., G219, Crapo Hall

Kyla Lutz, Rose-Hulman Institute of Technology

Title: *Protein Structure Alignment*

Abstract: We address the problem of aligning the 3D structures of two proteins. Our pairwise comparisons are based on a new optimization model that is succinctly expressed in terms of linear transformations and highlights the problem's intrinsic geometry. The optimization problem is approximately solved with a new polynomial time algorithm. The worst case analysis of the algorithm shows that the solution is bounded by a constant depending on the data of the problem.

Friday 4:00 - 4:20 p.m., G221, Crapo Hall

Michael Lopez, Kent State University

Title: ***A brief examination of the Dedekind Number***

Abstract: The Dedekind number M(n) is the number of monotone Boolean functions with n arguments. There is currently no closed-form expression for M(n), but interesting research on the topic has produced upper and lower limits for this number. In this presentation we will see how one can elegantly derive these limits using combinatorics and graph theory.

Friday 4:00 - 4:20 p.m., G222, Crapo Hall

Amanda McGlone, Saint Mary-of-the-Woods College

Title: ***Mathematical Induction***

Abstract: Are you a teacher? Are you a student who finds themselves questioning mathematical concepts? Do you ever wonder if students' questions may be questions you also have? Come remind yourself about math induction and see how to answer some common misconceptions. We will also use a generalized form of induction to show the difference when working with sets other than the natural numbers.

Friday 4:40 - 5:00 p.m., G219, Crapo Hall

John Wang, Illinois Mathematics

Title: ***A Model of Semi-Rational Behavior in Asset Markets***

Abstract: Empirical research has shown that asset market participants usually do not exhibit fully rational behavior. A large amount of research has shown that investors tend to overreact to price changes, creating short-run price momentum and long-run price reversal. This paper takes these empirical findings into account by creating a model with two types of investors: momentum and value investors. Simulations of this model are run and price behavior is analyzed. I then compare how well the model holds up against the empirical findings and other models of investor behavior. Finally, I use my results to suggest possible strategies for trading in asset markets.

Friday 4:40 - 5:00 p.m., G221, Crapo Hall

Arnold Yim, Rose-Hulman Institute of Technology

Title: ***Algebraic Tori***

Abstract: The purpose of this talk is to define a particular type of algebraic tori. The type of tori we will be investigating are of particular interest because of its potential use in public key cryptography. However, before we can use them in cryptography, we must determine whether they are rational. We will look at what it takes for a torus to be rational, and look at some small examples of rational tori.

Friday 4:40 - 5:00 p.m., G222, Crapo Hall

Abby McKee, Saint Mary-of-the-Woods College

Title: ***Vector Spaces and Their Impostors***

Abstract: Is it possible you have been led astray by economical, but mathematically costly, quantifiers when identifying vector spaces? Is it possible that a structure can look like a vector space, act like a vector space, but not actually be a vector space? Come help unmask the impostor!

Saturday 10:10 - 10:30 a.m., G219, Crapo Hall

Philip Hu, Yale University

Title: ***Matching Preclusion and Conditional Matching Preclusion for Bipartite Networks***

Abstract: The matching preclusion number of a graph is the minimum number of edges whose deletion results in a graph that has neither perfect matchings nor almost-perfect matchings. For many interconnection networks, the optimal sets are precisely those induced by a single vertex. Recently, the conditional matching preclusion number of a graph was introduced to look for obstruction sets beyond those induced by a single vertex. It is defined to be the minimum number of edges whose deletion results in a graph with no isolated vertices that has neither perfect matchings nor almost-perfect matchings. In this paper, we prove general results regarding the matching preclusion number and the conditional matching preclusion number as well as the classification of their respective optimal sets for bipartite graphs. We then use these general results to study the problems for a number of popular interconnection networks including the hypercubes, star graphs, Cayley graphs generated by transposition trees and the hyper-stars.

Saturday 10:10 - 10:30 a.m., G221, Crapo Hall

Ben Mackey, Kent State University

Title: ***Nearly Normal Tridiagonal Matrices***

Abstract: The behavior of normal matrices is very well studied. In particular, normal matrices can be completely characterized by their singular value decompositions. In this talk, we define a matrix to be nearly normal if its commutant with its Hermitian adjoint has rank 2. In the case of tridiagonal matrices, we explore the eigenvalues and eigenvectors of these matrices and prove a result concerning their singular value decompositions analogous to what we know about normal matrices.

Saturday 10:10 - 10:30 a.m., G222, Crapo Hall

Andrew Fork, Siena Heights University

Title: ***How generic is 2^n? A computational approach***

Abstract: Powers of two are often used to measure computer memory. 2^n is the number of ways the bits<http://en.wikipedia.org/wiki/Bit> in a binary integer of length n can be arranged. So is this by coincidence? I conjecture that no matter what number is specified as long as the number is a positive whole number, I can discover an exponent where 2 to that exponent will have a solution that begins with the same number specified. I will be using computer programming languages of "Visual Basic", "C++" and the mathematical programming language of "Maple" to examine the conjecture.

Saturday 10:40 - 11:00 a.m., G219, Crapo Hall

Eric Angelton and Tyler Foxworthy, IUPUI

Title: ***Evaluation of a novel approach to the solution of the nonlinear Riccati equation***

Abstract: The Riccati equation is a rich sample problem for the evaluation of new numerical methods for nonlinear equations because it has an easily derived exact solution. The aim of our research was to develop an algorithm to quickly solve the Riccati equation by dividing the solution into multiple subintervals and determining the optimimum solution-method for each subinterval. These methods include a fast Taylor-series derived solution and a novel exponential scheme based on an n-stage interpolant. Error characteristics in addition to the number of computational operations required for a particular interval provide a suitable heuristic through which a decision can be made governing which method to use.

Saturday 10:40 - 11:00 a.m., G221, Crapo Hall

Matt Grimm, Kent State University

Title: ***Undirected Graphs of Hermitian Matrices that Admit Only Two Distinct Eigenvalues***

Abstract: We consider the problem of determining those n-vertex graphs that admit a Hermitian matrix with only two distinct eigenvalues, k and n - k. After giving some general algebraic characterizations of such dual multiplicity graphs, two major graph theoretical necessary conditions are given. The dual multiplicity graphs on fewer than 6 vertices are also determined.

Saturday 10:40 - 11:00 a.m., G222, Crapo Hall

Joel Parrish, Siena Heights University

Title: ***Multi-touch methods***

Abstract: Multi-touch is a technology which allows for multiple user inputs, and more importantly multi-user interaction with a computer interface. Begun in the early 1970's, Multi-touch is currently the subject of much research. At Siena Heights University a small group of science, math, and computer students have undertaken some experiments in Multi-touch. We will present the current status of our work; including hits, misses, future research, and a presentation of a multi-touch system we currently have working.

Saturday 11:20 - 11:40 a.m., G219, Crapo Hall

Robin Rice, Saint Mary-of-the-Woods College

Title: In Defense of the Pentagon

Abstract: Who were the mathematicians who discovered the pentagon construction and defended its proof? Did you ever wonder how to inscribe a regular pentagon in a circle? In this talk you will learn some ways to construct a regular pentagon inscribed in a circle.

Saturday 11:20 - 11:40 a.m., G221, Crapo Hall

Bill Karr, IUPUI

Title: ***Eigenvalue Density Distribution of Random Non-Hermitian Matrices with Purely Real Spectra***

Abstract: Random matrix theory is a well established field of mathematics with wide applications in subjects from number theory to nuclear and statistical physics. In particular, Wigner's semicircle law - which predicts the eigenvalue density of large Hermitian matrices whose entries are drawn randomly from an arbitrary probability distribution with zero mean and a well-defined variance - is the most celebrated and robust result. In this particular case, the matrix is Hermitian with respect to the standard inner product on CM^N, M^\dagger = M^{*T} where M^\dagger is the adjoint of the matrix M, and T represents the transpose. We explore the eigenvalue density of large random matrices that are Hermitian with respect to a general inner product (,) on $C^{\cdot}$ defined by a positive-definite function f, (u, v) = $\sum_{i=1}$^{N} f(i) u_i* v_i. The eigenvalues are, as expected, purely real. The eigenvalue density, however, does acutely depend on the function f. We present numerical results and heuristic arguments for the eigenvalue density, and point out outstanding questions.

Saturday 11:20 - 11:40 a.m., G222, Crapo Hall

Krista Schaefer, Valparaiso University

Title: ***When does quarantine make things worse?***

Abstract: We will analyze an epidemic model that resembles an infection transmitted through both direct contact and an intermediate host. We show that, if the intermediate host cannot be controlled, restricting the infected individuals by quarantine may worsen the spread of the disease or even cause an endemic situation. Specifically, the epidemic reproductive number is computed in the absence and presence of the quarantined population. We show that, if the infection rate among quarantined individuals and susceptible intermediate hosts is high enough, a stable endemic equilibrium will occur while, at the same time, the absence of quarantine measures may still lead to a disease free situation. This theoretical model is inspired from the Bubonic Plague epidemic of the 17th century.

Saturday 11:50 a.m. - 12:10 p.m., G219, Crapo Hall

Scott Rexford, St. Kishwaukee College

Title: ***A Simple Decagon Construction***

Abstract: The purpose of this talk is to present a construction of a decagon in Euclidian two space with a compass and unmarked straight-edge. This presentation will consist of constructing a decagon in accordance with Euclid's axioms and proving its proportions by Euclid's proposition. The proof also involves a lemma which uses analytic geometry and more modern mathematical techniques. The presentation will finish with a brief discussion of its usefulness in expansions to geometry and art.

Saturday 11:50 a.m. - 12:10 p.m., G221, Crapo Hall

Darrin Weber, Millikin University

Title: ***Cut-Sets in Zero-Divisor Graphs of Finite Commutative Rings***

Abstract: We examine minimal sets of vertices which, when removed from a zero-divisor graph, separate the graph into disconnected subgraphs. We classify these sets for all finite commutative rings with identity.

Saturday 11:50 a.m. - 12:10 p.m., G222, Crapo Hall

Mark Burek, Valparaiso University

Title: ***Modeling Segregation of Neighborhoods with Three Types of Individuals***

Abstract: In a segregation game, the investigator is studying patterns of movement amongst two types of individuals in a community. Individuals are content when they are next to other individuals like themselves. Two types of equilibrium states exist in this game which leave the community either segregated or integrated together. Previous research has demonstrated that segregated equilibrium states are the only stochastically stable states, but has limited its focus to two types of individuals. Our work extends the segregation game to three types of individuals. We show that given random perturbations of groups in a community, the only stochastically stable states are the segregated equilibrium states. This is joint work with Spencer Roach and Michael Borchert.