2005

2005 Program and Abstracts

University of Dayton. Department of Mathematics

Undergraduate Mathematics Day at the University of Dayton

November 5, 2005

PROGRAM

8:30 - 9:45	Check-in and folder pick-up Refreshments	Science Center Auditorium Lobby
9:45 - 10:00	Welcome: Paul Benson Associate Dean for Integrated Learning and Curriculum College of Arts and Sciences, University of Dayton	O'Leary Auditorium, Miriam Hall
10:00 - 11:00	Invited Address: Kristen Lampe Carroll College Shuffle Up and Deal: Should We Have Jokers Wild?	O'Leary Auditorium, Miriam Hall
11:10 - 12:05	Contributed Paper Sessions (Part I)	Science Center 114, 128, 150, 217, 323
12:15 - 1:45	Lunch	East Ballroom, Kennedy Union (2nd floor)
1:45 - 2:50	The Sixth Annual Kenneth C. Schraut Memorial Lecture: Patrick Flinn National Security Agency Gröbner bases: A Natural Extension of Gaussian Reduction and the Euclidean Algorithm	O'Leary Auditorium, Miriam Hall
3:00 - 3:30	Break with Refreshments	Science Center Auditorium Lobby
3:30 - 5:05	Contributed Paper Sessions (Part II)	Science Center 114, 128, 150, 217, 323

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Schedule for Contributed Paper Sessions, Part I:

	Science Center 150	Science Center 128	Science Center 114 Auditorium	Science Center 323 Schraut Lecture Hall	Science Center 217
11:10 - 11:25	Ellen Peterson Wittenberg University Robustness and Transients Applied to	Masako Yatsuki University of Dayton A Numerical Method To Compute Optimal	Anneliese Spaeth Xavier University The Moore Method: A Student Perspective	Alexander Giffen University of Dayton An Exploration of the Lights Out Solitaire Game	Brian Geier University of Dayton Psychophysiological Dynamics Associated with

	Harvesting of the Peregrine Falcon Population	Thresholds for Security Trading		on Paths, Cycles, and Caterpillar Graphs	Image Complexity
11:30 - 11:45	Sara Rowell Xavier University Using Sets of Winning Coalitions to Generate Feasible Banzhaf Power Distributions	Joshua Sullivan University of Pittsburgh Numerical Simulation of the Body's Defense to Infection	Michelle Kight University of Dayton Characteristics of Higher Education Mathematical Tutorial Support Programs for the Sciences	Christopher Brown Kenyon College A Theorem for Algebraic Graph Theory	Joanne Sklodowski University of Dayton A Statistical Investigation of Obese and Diabetic Mice Through Islet Observation
11:50 - 12:05	Matt Kocoloski University of Dayton Modeling Traffic Flow Through a Toll Plaza	James Pierce Illinois Institute of Technology A Linear Time Algorithm for Finding a p-Center of a Tree	Carrie Herman Centerville High School Fast Math	Michael McGowan John Carroll University Ideal-divisor Graphs of Commutative Rings	Yumi Muramatsu, Catherine Smith Northern Kentucky University Undergraduate Experience at a Statistical Consulting Center

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Schedule for Contributed Paper Sessions, Part II:

	Science Center 150	Science Center 128	Science Center 114 Auditorium	Science Center 323 Schraut Lecture Hall	Science Center 217
3:30 - 3:45	John Grande Miami University Cryptography: Why Large Primes are Important	Angeliki Ermogenous Illinois Institute of Technology Brownian Motion and Applications in the Financial World	Nathan Eloe Melanie Luken Chaminade Julienne High School It's Not Acidic, so it Must be BASEic	David Nassar Denison University The Quantum Distance Between Matrix Spaces	Monique Owens Central State University Statistical Analysis of Substance Abuse in the United States
3:50 - 4:05	Benjamin Johnson Kenyon College Orbit Representatives in Multitwisted Codes	Emma Stull University of Dayton A Foreign Exchange Rate and a Linear Model: The Value of the U.S. Dollar per Eurodollar	Ron Taylor Berry College Optimization of Cubic Functions without Calculus	Justin Gieseler Ohio Northern University Distribution of Points on Elliptic Curve Projections	John Whitaker Shawnee State University A Funny Thing Happened on The Way to Infinity
4:10 - 4:25	Tarika Mansukhani Denison University Optimal Frames for Erasures	Ashley Askew Clayton State University Methods of Solution for Second Order Linear Equations on Time Scales	Harsha Bulathsinghalge Sinclair Community College Holey Sphere: Getting to the Core of the Spherical Volumes	Speaker cancelled	Patrick Johnson University of Dayton The Axiom of Choice and its Consequences
4:30 - 4:45	Scott Reynolds University of Dayton Grammatical Evolution Learning Techniques for Robots	Alissa Crans The Ohio State University Opportunities for Women Undergraduates in Mathematics	Kristi Patton Ohio Northern University Continued Fractions	Bill Higgins Wittenberg University Adventures with Rubik's Spaceship	Octavio Mesner John Carroll University Well-Ordering Theorem
4:50 - 5:05	Alek Zywot Centerville High School Order out of Chaos, why		Carrie Carden, Jessie Penley Berry College		

	Chaos is not Chaotic		Bisections and Reflections: A Geometric Investigation		

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Abstracts:

Listed in alphabetical order by author (if a paper has multiple authors, the presenters are marked with *).

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Ashley Askew, Clayton State University
Methods of Solution for Second Order Linear Equations on Time Scales
A time scale, T, is a nonempty closed subset of the real numbers $\boldsymbol{R}$. In this talk, we will present several methods of solution for second order linear equations on a time scale. An advantage of these methods is that we can obtain solutions on a system comprising of continuous and/or discrete elements. Using some examples, we will derive solutions for a general time scale; after restricting the time scale to be $\boldsymbol{R}$, we will show that these solutions are equivalent to those obtained using differential equations methods.

Nuh Aydin, Benjamin Johnson*, Kenyon College
Orbit Representatives in Multitwisted Codes
In coding theory, we are interested in a quantity called the Hamming weight because the error detecting and correcting capacity of a code is determined by the smallest Hamming weight among its code words. In this talk, I will discuss a new class of codes that we have constructed algebraically, called multitwisted codes. Multitwisted codes are interesting for two reasons: First, the well-known cyclic, constacyclic, quasi-cyclic, and quasi-twisted codes are actually special cases of multitwisted codes. Second, using algebraic tools, we can partition MT codes into subsets such that each subset contains code words of equal weight, and then examine one codeword from each subset. This allows us to determine the weight enumerator of an MT code without examining all of its code words and serves as a crucial piece in our currently-under-development computer program to search for good QT codes.

Christopher Brown, Kenyon College
A Theorem for Algebraic Graph Theory
How can we compute the symmetries of a finite graph? We present a theorem which computes the symmetry group of a finite graph while avoiding the need for a matrix reformulation of the problem. We then describe the problem of symmetric graph construction and how this theorem can be used to verify solutions to the construction problem. We will demonstrate two different graphs solving the $\boldsymbol{Z_3}$ symmetry problem, one constructed by the speaker and another by a student in his Abstract Algebra course.

Harsha Bulathsinghalge, Sinclair Community College
Holey Sphere: Getting to the Core of the Spherical Volumes
We are going to drill a cylindrical hole through the center of a solid sphere with radius of greater than $a/2$ units so that the height of the hole is exactly a units. We will show that the volume of the remaining solid is independent of the radius of the original sphere.

Mihai Caragiu, Justin Gieseler*, Ronald A. Johns, Ohio Northern University
Distribution of Points on Elliptic Curve Projections
Let f be a polynomial of degree 3 with coefficients in a (large) finite prime field GF(p). If L(x,p) is the quadratic character modulo p, we will study the distribution properties of the sequence {L($f(t)$,p): t = 0,...,p-1}. The cumulative sums of this sequence can be seen as successive positions of a "particle" performing a (quasi-)random walk, while the sum of all the terms of the sequence is closely related to the number of points on the elliptic curve $y^2 = f(x)$. In our study we will use both exponential sums methods and computer algebra systems such as Maple and Matlab.

Carrie Carden*, Jessie Penley*, Berry College
Bisections And Reflections: A Geometric Investigation
In this paper we explore a geometric problem involving reflections over the angle bisectors of a triangle. Starting with a point on a side of an arbitrary triangle bisect one of the angles on either side of the point and reflect the point across this line. Continuing in this manner, being sure to travel the same direction that we started around the triangle, we arrive at some interesting conclusions. In particular we will show that any point will return to its original position in at most six reflections. Furthermore, there is a special point on each side of every triangle which has a return time of exactly three reflections. This point has a special geometric significance. In addition to these conjectures, we present some other interesting geometric observations.

Patrick Coate, Jeremy Lynch, Matt Kocoloski*, University of Dayton
Modeling Traffic Flow Through a Toll Plaza
A team of University of Dayton students participated in the 2005 Mathematical Contest in Modeling. The problem selected by our team was to consider the optimal number of tollbooths that should be deployed along highways, such as the Garden State Parkway and Interstate 95. In this problem, we defined “optimal” as the greatest flow of cars through the toll plaza. We wanted to maximize flow in order to process as many cars as possible through the tollbooth lanes, thus decreasing the wait time and annoyance of the drivers. In this talk, we will describe the model we developed and the solution obtained.

Alissa Crans, The Ohio State University
Opportunities for Women Undergraduates in Mathematics
These days, numerous opportunities for undergraduate math majors exist: REUs, internships, NSA programs, special conferences, and Pi Mu Epsilon events. Some, however, are specifically for WOMEN! We will familiarize ourselves with three well-known programs for women: the Summer Mathematics Program at Carleton College, the George Washington Program, and the EDGE (Enhancing Diversity in Graduate Education) Program. Our discussion will focus on the prerequisites and application process for attending these programs, the differences and similarities between these experiences and the more traditional REUs, and the short and long-term benefits of participating in such programs.

Allison B. Cuttler, Audrey L. De Guire, Sara Rowell*, Xavier University
Using Sets of Winning Coalitions to Generate Feasible Banzhaf Power Distributions
In his paper, John Tolle enumerates the possible Banzhaf power distributions in a 4-player weighted voting system. Expanding on Tolle's ideas, we construct sets of winning coalitions in the n-player system by organizing them into a rooted tree, utilizing the partially ordered lattices of weighted coalitions. By counting the nodes of the tree, we enumerate all possible sets of winning coalitions and all possible Banzhaf power distributions. We characterize these distributions by identifying the possible denominators and the necessary conditions on the numerators.

Jessica Dietrich, Carrie Herman*, Megan Kelly, Centerville High School
Fast Math
Math and NASCAR??? Who'd a' thunk it? In a high school Algebra 2 class, two projects bring mathematics alive by integrating rote calculations into real-world situations. Students are asked to choose a driver and look up his/her finishes from the previous season. From there the students will assess their driver based on statistics: mean, median, mode, outliers, histograms, scatter plots with lines of best fit, etc. The second project has the students using trigonometry to figure out how much material (land, dirt, asphalt, concrete, etc.) they will need to build their own racetrack. After they design the track itself, they need to decide how many people it will seat and create accommodations accordingly. Ohio State Standards will be addressed.

Nathan Eloe*, Melanie Luken*, Kevin McCormick, Chris Scupski, Jenna Yaney, Chaminade Julienne High School
It's Not Acidic, so it Must be BASEic
Sir Isaac Newton once observed that the first 5 rows of Pascal's Triangle could be concatenated to yield the powers of 11. Arnold et al uncovered an algorithm that supports the claim that the powers of 11 can be determined from subsequent rows and surmised that the pattern may hold for other bases than base ten. We have rewritten Pascal's Triangle in other bases and will demonstrate that this pattern does indeed hold true.

Angeliki Ermogenous, Illinois Institute of Technology
Brownian Motion and Applications in the Financial World
The oddness and complexity of Brownian motion reveal a deep subject in the field of mathematics that has not yet been fully understood or explained. The purpose of this talk is to introduce Brownian motion and its properties, and to explain how it is applied in an everyday but totally unpredictable environment like the stock market.

Brian Geier, University of Dayton
Psychophysiological Dynamics Associated with Image Complexity
Visual search ability is governed by previous exposure to stimulus or knowledge of a given scene. Pupil dilation is a method that is employed to study the discrimination between two different independent variables. In this study, we examine the effectiveness of pupil dilation in the context of the Stroop Color Naming task, which is a task comprised of an incongruent and congruent condition. We constructed an experiment in which one participant was used. We employed the Stroop Color Naming task in order to demonstrate the reliability and efficiency of using pupil dilation as a function of cognitive change in relation to the change in stimulus represented, whether it is of congruent or incongruent nature. We employed a one-way complex (2X3) analysis of variance to analyze the relationship between the two variables or conditions, which were congruent and incongruent, and between the days data was collected. The analysis of the data is currently underway. We hope the analysis will reveal an interaction between the condition of congruency and a physiological response, pupil change.

Alexander Giffen*, Darren Parker, University of Dayton
An Exploration of the Lights Out Solitaire Game on Paths, Cycles, and Caterpillar Graphs
Let G be a graph with a vertex set V and edge set E. We label each vertex with a number between 0 and n-1, in an n-coloring of G. Lights Out is a solitaire game in which the player's goal is to change the value of every vertex to zero. To change the values associated with a vertex, the player selects a vertex v. When v is selected, the value of v and of all vertices adjacent to v increase by one. If a vertex with a value of n-1 is selected, its number changes to zero. The game is won when all vertices have a value of zero. If, given a graph G, any initial coloring can result in the win condition, the graph is called *always winnable*, and the graph is known as an *AW-graph*. Our research is aimed at examining which graphs are AW. We prove results for AW-paths and AW-cycles for n colors and construct algorithms for winning the game in such graphs. We also make progress on caterpillar graphs, particularly when n is prime. Finally, our research explores the relationship between Lights Out problems and generalizations of parity domination problems on similar graphs.

John Grande, Miami University: Cryptography
Why Large Primes are Important
My presentation will explore the RSA encryption and decryption method. It will include a brief history about the development of the method, but my focus will be on the actual method itself. Demonstrating how to fully encrypt a message, I will give examples of where such encryption keys can be found and what they can look like. Summarizing the topic, I will explain why large prime numbers are very important in this case.

Bill Higgins, Wittenberg University
Adventures with Rubik's Spaceship
The Rubik's UFO Puzzle is an alien cousin of Rubik's Cube. Twelve pieces are arranged in two "hexagons" forming the top and bottom of the spaceship and may be scrambled by using twists and rotations. Adventures in solving this puzzle (a Christmas gift given to our son), and modeling the

puzzle on a TI-89 calculator will be described. Some properties of the permutation group behind Rubik's UFO puzzle will also be explored.

Patrick Johnson, University of Dayton
The Axiom of Choice and its Consequences
The Axiom of Choice is the tenth axiom of Zermelo-Fraenkel set theory. It has been very controversial amongst mathematicians, dividing them into different schools of thought. The assumption that the Axiom of Choice is true gives rise to many well known theorems. The assumption that it is false gives rise to a whole group of theorems also. The third option of assuming neither its truth nor falsity gives rise to yet a different branch of Zermelo-Fraenkel set theory. Which assumption do you prefer?

Michelle Kight, University of Dayton
Characteristics of Higher Education Mathematical Tutorial Support Programs for the Sciences
The goal of this study is to compare and summarize the practices used in mathematical tutorial support programs at four neighboring institutions. In addition to traditional tutoring, their programs included the use of technology, long-distance learning, enrichment workshops, and developmental classes. One institution featured a specialized program for minority students. In addition, we compare these programs to analogous programs at the University of Dayton.

Tarika Mansukhani, Denison University
Optimal Frames for Erasures
This topic was studied with an application in coding theory. It discusses the optimal frames that can be designed if there are erasures in the original information. The talk also makes use of linear algebra to some extent.

Michael McGowan, John Carroll University
Ideal-divisor Graphs of Commutative Rings
Given a commutative ring R, one can construct the zero-divisor graph of R by letting vertices correspond to non-trivial zero-divisors and by placing an edge between two vertices whose product is 0. This concept can be generalized to "ideal-divisor" graphs, and many interesting properties can be discovered, especially when examining the graphs of direct products of various rings.

Octavio Mesner, John Carroll University
Well-Ordering Theorem
A set X with order relation $<$ is said to be well-ordered if every nonempty subset of X has a smallest element. It is easily seen that the natural numbers are well-ordered. But, consider the real numbers. The set (3, 5] has no smallest element where $\boldsymbol{R}$ has the usual order. Is it possible to order $\boldsymbol{R}$ in such way that $\boldsymbol{R}$ is well-ordered? In 1904, Zermelo proved that any set can be well ordered! This startled the mathematical world; moreover, many were skeptical of his axiom of choice. This presentation shows that the axiom of choice, Zorn's lemma, and the well-ordering theorem are equivalent.

Yumi Muramatsu*, Catherine Smith*, Northern Kentucky University
Undergraduate Experience at a Statistical Consulting Center
The Burkardt Consulting Center (BCC) is an educational, service, and outreach unit in Northern Kentucky University's Department of Mathematics. The faculty and students who work at BCC provide advice, project and data management, mathematical modeling, and statistical analysis for the university and surrounding community. The students working at the BCC gain valuable out-of-classroom experience. Along with developing their statistical and mathematical skills, students are able to develop their communication skills, get experience working with real data, and learn about a variety of different areas through the projects brought to the Burkardt Consulting Center. We will further discuss our experiences as first-year student consultants in the Burkardt Consulting Center.

David Nassar, Denison University
The Quantum Distance Between Matrix Spaces
Matrix spaces can be used to represent physical situations as demonstrated by Heisenberg. For my summer research project, I calculated the quantum distance between two matrix spaces to gain insight on the interaction between the two physical situations they represented. This talk is suitable for those who have taken an elementary linear algebra course.

Monique Owens, Central State University
Statistical Analysis of Substance Abuse in the United States
Where do major drug problems occur in this country among the states? How are social and economic factors related to substance abuse in the states? We approach the answer to these questions with multivariate statistics. By using factor analysis, we distinguish the underlying factors of a collection of variables related to substance abuse. With discriminant analysis, we design a rule for classifying states as either having a major or minor drug problem. The results might surprise you!

Kristi Patton, Ohio Northern University
Continued Fractions
This talk will look at continued fractions, a few short proofs, and some applications to high school mathematics.

Ellen Peterson, Wittenberg University
Robustness and Transients Applied to Harvesting of the Peregrine Falcon Population
Plants and animals recently removed from the endangered species list are still vulnerable to decline in their population. However, there is a demand for harvesting some animals for food, game, and other reasons. In order to fulfill this demand while maintaining positive population growth, we examined the maximum possible percentage of harvest for one case study, peregrine falcons. US Fish and Wildlife Services have recently begun to allow minimal harvesting of peregrine falcons as they are no longer on the endangered species list. We create a population projection matrix model that takes into account the often imprecise population data using the robustness and transient analysis tools of Hodgson et al.

James Pierce, Illinois Institute of Technology
A linear time algorithm for finding a p-center of a tree
The general facilities location problem is an optimization problem which involves finding a set of central facilities which "best" serves the customers. "Best" can be described in various ways depending on our notion of distance as well as other constraints. We present a fast algorithm for solving a version of this general facilities location problem.

Scott Reynolds, University of Dayton
Grammatical Evolution Learning Techniques for Robots
We describe an approach to use Grammatical Evolution to evolve complete programs to be run on an OOPic robot controller board. Grammatical Evolution is a way to generate and evolve programs based on a Backus-Naur grammar and using variable length linear genomes. The genomes dictate how the BNF grammar is mapped to a program. Grammatical Evolution (GE) maps a binary genotype into a phenotype which is a computer program. Using this technique we can generate and evolve programs for the OOPic robot controller board that can solve complex problems like border navigation.

Joanne Sklodowski*, University of Dayton, Donnie Stapleton and Brian Yandell, University of Wisconsin
A Statistical Investigation of Obese and Diabetic Mice Through Islet Observation
Several studies suggest that obesity increases a person's risk for diabetes, however it is unclear what the cause of diabetes is. This study observes the islets (insulin-producing cells) in two obese strains of mice, B6 and BTBR, the BTBR strain having Type II diabetes also. We took several different measurements in order to determine whether there are differences in the characteristics of the islets between strains. We know that there are sick islets found in the diabetic strain, but is it a significant amount according to the values computed? According to a 2-sample t-test, we found a significant difference in the area of islets between strains. Further research must be done in order to determine why this is so. Other results had several limitations due to the lack of mice available for the study.

Anneliese Spaeth, Xavier University
The Moore Method: A Student Perspective
The Moore Method is a student-driven teaching method, begun and developed by R.L. Moore at the University of Texas. In this method, students are encouraged to develop the mathematics of the course without the use of outside resources. Traditionally, students do not work with one another except in the classroom setting, when students present ideas and proofs to one another as an alternative to traditional lecture. Xavier University's Real Analysis course has been taught using a slight adaptation of this method. The immense benefits of the Moore Method, as well as some difficulties which accompany this teaching style, will be presented from a student perspective.

Emma Stull, University of Dayton
A Foreign Exchange Rate and a Linear Model: The Value of the U.S. Dollar per Eurodollar
While some people are concerned with foreign exchange rates only when traveling, others make a living by purchasing and selling foreign currencies. However, foreign exchange rates say a lot about the state of a country's economy. For example, a weak or strong U.S. dollar says something about our competition in foreign markets, inflation, tourism and foreign investment.
Now, looking at the value of the U.S. dollar per Eurodollar, what determines this exchange rate? Normally, the exchange rate is found when the supply of Eurodollars in exchange for U.S. dollars is equal to the demand for Eurodollars which is derived from the demand for the foreign goods, services and financial assets (stocks, bonds, real estate). But can it be explained or predicted by other variables? In fact—it can be explained using other economic variables. Using regressions and statistical analysis, a linear model was built to predict the value of the U.S. dollar per Eurodollar.

Joshua Sullivan, University of Pittsburgh
Numerical Simulation of the Body's Defense to Infection
When the body is attacked by a bacterial infection, it initiates a series of events designed to eradicate the infection while causing minimal damage to the body. Our model is to investigate the defenses of the organ walls to the spread of infection. To do this we have chosen to model a volume of the body that includes the organ wall, as well as the lumen outside of it and the blood and tissue within it. We have also taken into account the varied responses of the body, and our model includes many interacting agents that are part of the infection and defense processes, as well as agents that attempt to prevent the infection from breaching the organ wall. The model is written in MATLAB, and has many visualization options to better see the progression of the infection. It is hoped that this model will help us to understand the failure of the body's defenses in such situations as NEC, and with this understanding a method of prevention will hopefully be devised.

Ron Taylor, Berry College
Optimization of Cubic Functions without Calculus
We show that it is possible to find the relative extreme values of a cubic polynomial function without calculus. Instead, we use algebraic techniques including transformations of functions and finding roots of polynomials.

John Whitaker, Shawnee State University:
A Funny Thing Happened on the Way to Infinity
This talk will concentrate on the known result that Lebesgue measure does not exist in infinite dimensional space. This fact will be illustrated through a simple example involving unit balls. A brief introduction to separable Hilbert spaces will be given.

Masako Yatsuki, University of Dayton
A Numerical Method to Compute Optimal Thresholds for Security Trading
If one employs a regime-switching normal diffusion model to construct optimal thresholds for security trading, one generates a system of second order ordinary differential equations with boundary conditions. The scalar case can be analytically solved. The system cannot be analytically solved. Recently, it was shown that the system has a unique solution. In this paper, we employ the box method and numerically solve the system. The analytic solutions of the scalar case are employed.

Alek Zywot, Centerville High School

Order out of Chaos; Why Chaos is not Chaotic

Fractals are shapes that are self-similar. Enlarging a small part of the fractal will look exactly like the whole. Fractals do not exist in 3 dimensions, but in fractal dimensions. Fractals are a way to see infinity. There are two different types of fractals: natural and mathematical. In essence, fractals are strange attractors. An attractor is a shape that attracts all points to it. A strange attractor is the fate of a chaotic system. Strange attractors are infinitely long, and reside in phase space. Phase space is a multidimensional space that displays systems and their change over time.

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