2003

2003 Program and Abstracts

University of Dayton. Department of Mathematics

Undergraduate Mathematics Day
at the University of Dayton

November 1, 2003

PROGRAM

8:30 - 9:45	Registration and refreshments	Science Center 328
9:45 - 10:00	Welcome: Panagiotis A. Tsonis Bro. Mann Chair of the Sciences	Chudd Auditorium
10:00 - 11:00	Invited Address: Chikako Mese Connecticut College *Curvature*	Chudd Auditorium
11:10 - 12:05	Contributed Paper Sessions (Part I)	Science Center
12:10-1:30	Lunch	West Ballroom, Kennedy Union (2nd floor)
1:35 - 2:05	Unveiling of Dr. Schraut's Portrait	Science Center 323
2:10 - 3:10	The Fourth Annual Schraut Memorial Lecture: Robert Lewand Goucher College *How not to get lost while on a random walk*	Chudd Auditorium
3:10 - 3:30	Refreshments	Science Center 328
3:35 - 4:50	Contributed Paper Sessions (Part II)	Science Center

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Schedule for Contributed Paper Sessions, Part I:

Part I: 11:10 - 12:05	SC 216	SC 224	SC 320

11:10 - 11:25	Robert Arnold Christopher Brockman Chaminade-Julienne Catholic High School Newton's unfinished business: uncovering the hidden powers of 11 in Pascal's triangle	Kevin Berridge Andy Schworer University of Dayton Knowbot: Mobile agent programming	Mark Walters Miami University Arc length and surface area - are we on the same page?
11:30 - 11:45	Kevin Hurley Maine South High School Interesting multiples of nine	Patrick Berarducci University of Dayton An Introduction to quantum computing	Ron Taylor Berry College The equal length stick number of the 8-19 knot
11:50 - 12:05	Lisa Rome College of Mount St. Joseph Mathematical puzzles and the magical number nine	Jennifer Seitzer University of Dayton Using simple graph theory to identify truth	Mathew Marsico Berry College The limit of inscribed infinigons

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Schedule for Contributed Paper Sessions, Part II:

Part II: 3:30 - 4:50	SC 224	SC 320	SC 216
3:35 - 3:50	Jason Kauffman University of Dayton Unbreakable cryptography using a pseudorandom number generator	Rebecca Swanson Dakota Wesleyan University Michael Willis Pennsylvania State University Hilbert's third problem	Andy Schworer University of Dayton The use of the Newton-Raphson algorithm in calculating maximum likelihood estimates
3:55 - 4:10	Walter Chen Cornell University	Micah Fuerst Wright State University An introduction to	Mai Fadag University of Dayton

	Constructions of low-density parity-check codes using Ramanujan graphs	circulant weighted matrices and some non-existence solutions	Notes on basic properties of the diamond derivative on time scales and their applications
4:15 - 4:30	Raj Doshi Miami University The subgraph summability number of a graph	David Jordan Pennsylvania State University Rhiannon Schayer Northwestern University Rational points on the Cantor middle thirds set	Paul Baginski Elena Fuchs UC Berkeley Calculating coefficients of the modular equation
4:35 - 4:50	Gayatri Gunda University of Dayton Pebbling on directed graphs	Benjamin Johnson University of Dayton Modeling stellar atmospheres	Christopher Ryan University of Dayton Linear alignment in binary images

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Abstracts:

(If a papers has multiple authors, the presenters are marked with *)

K.T. Arasu, Grady Burkett and Micah Fuerst*, Wright State University: An introduction to circulant weighted matrices and some non-existence solutions

Circulant Weighing Matrices are square matrices with entries from {0,1,-1} such that every row is a cyclic shift of the previous row with the following property:
If W is an n x n circulant weighing matrix of weight k (denoted CW(n,k)), then we have $WWT = kI_n$, where I_n is the identity matrix of size n. Using algebraic techniques including group rings, we prove the non-existence of one such candidate matrix and present an open problem.

Robert Arnold*, Tom Attenweiler, Christopher Brockman*, Bethany Lesko, Tina Martinek, Colleen McCormick, Jessica McQuiston, Jessica Parker and Amy Rohmiller, Chaminade-Julienne Catholic High School: Newton's unfinished business: uncovering the hidden powers of 11 in Pascal's triangle

Sir Isaac Newton once observed that the first five rows of Pascal's Triangle, when concatenated, yield the corresponding powers of eleven. He claimed without proof that subsequent rows also generate powers of eleven. Was he correct? While not all rows can simply be concatenated, the powers of eleven can still be derived from each. We have uncovered an algorithm that supports Newton's claim and will prove its validity for all rows of the Triangle.

Paul Baginski* and Elena Fuchs*, UC Berkeley: Calculating coefficients of the modular equation
We determine a linear time algorithm for calculating the modular equation $\Phi_N(X, J)$ for $N = p_1 p_2$, where p_1 and p_2 are distinct primes.

Patrick Berarducci, University of Dayton: An Introduction to quantum computing
Quantum computing is the use of quantum mechanics, as opposed to conventional electronics, for the core technology of computers. Quantum computers will allow parallel computing, enabling computers to perform large calculations in one step (ex - factoring numbers).

Kevin Berridge*, Ben Lee and Andy Schworer*, University of Dayton: Knowbot: Mobile agent programming
In this work we examine the definition, technology, and applications of knowbot technology. Knowbots are artificially intelligent computer programs. However, they are a special type of program called a mobile agent that has the ability to move or clone itself to other computers within a network. Thus, knowbots can be used for many sorts of applications having to do with large amounts of data being moved, very efficiently. Potentially a knowbot could move closer to a resource that it needs to interact with in order to utilize the network bandwidth efficiently. In our work, we are studying knowbots, and setting up an experimental testbed of knowbots on a small, isolated, computer network. Our future project plans include the use of a swarm of knowbot programs, running Dijkstra's shortest path algorithm, to intelligently map a network.

Alexandra Cameruci, Kevin Hurley*, Maine South High School: Interesting multiples of nine.
We have unraveled two neat and powerful algorithms for calculating certain multiples of nine. These discussions might make for an interesting introduction for a number theory course, or a supplemental project in a Calculus or Advanced Algebra class. The mathematics involved is within a student's grasp, and the results are quite startling.

Walter Chen, Cornell University: Constructions of low-density parity-check codes using Ramanujan graphs
Low-density parity-check (LDPC) codes have recently become a popular interdisciplinary area of research. Widely unknown after their invention by Gallager in 1965, the existence of efficient encoding and decoding algorithms coupled with performance that operates near theoretical limits has led to the rediscovery of LDPC codes. I will give a brief history and present the theoretical basis for LDPC codes. The focus of the talk will be on present work in the construction of these codes using Ramanujan graphs.

Raj Doshi, Miami University: The subgraph summability number of a graph
The subgraph summability number is a vertex labeling problem on simple graphs that involves the sums of vertex labels for all connected, induced subgraphs. We look at the definition of the subgraph summability number and explore some known results. Then, we examine some new results pertaining to the subgraph summability number for paths and "squid" graphs.

Mai Fadag, University of Dayton: Notes on basic properties of the diamond derivative on time scales and their applications
Recently, there have been considerable activities to develop the theory of dynamic equations on time scales, as this theory unifies the theories of differential and finite difference equations. The new methods developed are not only significant in the theoretical study of differential and difference equations, but also potentially to numerical analysis. The primary purpose of my talk is to show certain important properties of the diamond differentiation on time scales. Discussions about its potential applications for solving differential equations will also be addressed.

Gayatri Gunda* and Aparna Higgins, University of Dayton: Pebbling on directed graphs
The pebbling number f(G) of a connected graph is the least number of pebbles such that any distribution of f(G) pebbles on G allows one pebble to be moved to any specified, but arbitrary vertex, where a move involves the removal of two pebbles from one vertex and the addition of one pebble to an adjacent vertex. We discuss the pebbling numbers of certain configurations of directed Wheels (W_n) and directed Complete graphs (K_{2n+1}) where n>=2.

Peter Hovey, Andy Schworer*, University of Dayton: The use of the Newton-Raphson algorithm in calculating maximum likelihood estimates
In this work we explore the difficulties and the means by which maximum likelihood estimates can be calculated for multiple sets of data. The Newton-Raphson algorithm can be used to do these calculations. However, this algorithm has certain limitations that will be discussed. An alternative algorithm, Fisher scoring, which is less dependent of specific data values is a good replacement. The Fisher scoring method yields results from data sets that would not converge when using the Newton-Raphson algorithm. An analysis and discussion of both algorithms will be presented. Their real world application on analysis of jet engine part inspection data will also be discussed.

Benjamin Johnson, University of Dayton: modeling stellar atmospheres

The intent of this project was to create a three-dimensional model of a stellar atmosphere in order to test a physical phenomenon known as microturbulence. The project involved the creation of a three-dimensional model using mathematical equations for the conservation of Energy, Momentum, and Mass as well as an equation that modeled the radiation in the atmosphere. The stellar model was created using the FORTRAN computer language and involved complicated mathematical testing.

David Jordan*, Pennsylvania State University, and Rhiannon Schayer*, Northwestern University: Rational points on the Cantor middle thirds set
The Cantor Middle Thirds Set is a familiar object in dynamical systems, but the properties of its rational points have not been investigated. Our work on the Cantor rationals focuses on two main results. First, we exploit number theoretic methods to develop strict bounds on the asymptotic behavior of the Cantor rationals. Then, we apply an algebraic approach to prove that the period length for the ternary expansion of a rational number divides the count of all Cantor rationals with the same denominator .

David Jordan and Michael Willis*, Pennsylvania State University, and Rebecca Swanson*, Dakota Wesleyan University: Hilbert's third problem
If we are given two polyhedra with the same volume, is it possible to cut one into pieces by planes and assemble the other? Here we explain the answer to this question as well as its two-dimensional analog. This paper is based on a colloquium lecture given by Professor Fuchs at Penn State University on September 11, 2003.

Jason Kauffman, University of Dayton: Unbreakable cryptography using a pseudorandom number generator
Currently used cryptographic methods have computational security, i.e., they are potentially vulnerable to computer attack using mathematical algorithms. Only cryptographic methods with “one-time pad” encryption and random keys have been proven unbreakable. The presented unbreakable cryptography was obtained by combining a pseudorandom number generator, a shift cipher and one-way modulus math processes to produce an unlimited number of “one-time pad” keys. Methods to allow secure communication without the requirement of key exchange were also developed.

Mathew Marsico* and Ron Taylor, Berry College: The limit of inscribed infinigons
Beginning with a circle of radius r, inscribe an equilateral triangle in it. Inscribe a circle in the triangle, and a square in the circle. Alternately inscribe circles and regular n-gons with n increasing in each inscription. Does the construction collapse to a point or is there a limiting circle? If so, what is the radius of the circle?

Lisa Rome, College of Mount St. Joseph: Mathematical puzzles and the magical number nine
My dad recently showed me a mathematical puzzle he had discovered on the web. He was stumped as to how the puzzle worked. We'll try out this puzzle and investigate how it works. Along the way, we'll learn some interesting magical facts about the number nine. Hopefully we'll all go away with some amazing tricks with which to impress our friends and family! (Come prepared with pencil and paper, so you can participate!)

Christopher Ryan, University of Dayton: Linear alignment in binary images
Even in a seemingly random spattering of dots, an order can exist beyond human perception. I will describe a method for finding linear patterns in scatterings of dots. Using this process, detection of a preferred orientation of the points is possible, as well as rating how well aligned the points are along it. Furthermore, I will discuss ways that the terms ‘well aligned’ and ‘preferred orientation’ were mathematically defined and quantified for use in this analysis.

Jennifer Seitzer, University of Dayton: Using simple graph theory to identify truth
Logic programming semantics produce the sets of all logically deducible propositions from a set of logic formulas called a logic program. In effect, these sets answer the question of "what's true now?" The stable and well-founded semantics give meaning to logic programs containing rules with negative hypotheses such as "the specimen is not a mammal." Computation time of these semantics in the propositional case is exponential and quadratic, respectively. In this talk, we will first discuss how computer scientists mathematically characterize how long it takes to run their programs as well as offer some research that presents special classes of logic programs for which computation of their semantics can be done extremely quickly.

Ron Taylor, Berry College: The equal length stick number of the 8_19 knot
Knot theory has many applications to the physical sciences besides being a very interesting topic in its own right. Some scientific applications are based on a knot being made of sticks and this talk will focus on how to find the minimum number of equal length sticks required to construct a particular knot.

Mark Walters* and Mark Smith, Miami University: Arc length and surface area - are we on the same page?
In calculus textbooks, formulas are developed for the length of a curve in the plane and for the area of a surface in three-space. Many textbooks, including Stewart's calculus book that we use at Miami University, take different approaches to these two very similar mathematical situations. One approach connects the dots along a curve to get a polygonal approximation, while the other

approximates via tangential considerations. This raises the question of why we don't take the same approach in both situations. We shall look at these differing approaches, compare them, and prove that each leads to the expected mathematical conclusions.

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