

Mathfest 2001
Madison, WI



MAA and Pi Mu Epsilon
Student Paper Sessions
August 2 - 3, 2001

PME Session #1

Hall of Ideas H

1:00 P.M. - 2:35 P.M.

1:00 - 1:15

ANALYZING THE AREA OF FRACTAL TILINGS

Miyuki Breen

University of Akron - Ohio Nu

Tilings of the plane are generated using a 2×2 integer matrix A . If $m = |\det A|$, a tile T is the attractor of the iterated function system $\varphi_j(x) = A^{-1}x + A^{-1}d_j$, $1 \leq j \leq m$. The set of vectors $D = \{d_j : 1 \leq j \leq m\}$ can be selected so that T has a fractal boundary. A wavelet basis can arise from such a tile T having area one.

1:20 - 1:35

CAN YOU FOLLOW OUR "TRAIN" OF THOUGHT?

Tonya Kim and Nancy Nichols

Randolph-Macon College - Virginia Iota

We develop a queueing model (based on the Borel-Tanner distribution) for maximal queue length at a railroad crossing in our small college town. We show that the increase in traffic that a new Wal-Mart is expected to bring will dramatically increase the likelihood of saturated traffic conditions.

1:40 - 1:55

QUATERNIONS

Bob Shuttleworth

Youngstown State University - Ohio Xi

William Hamilton invented quaternions as an algebra in which quotients of vectors are well defined. Today, computer graphicists use quaternions, represented by orthonormal matrices, to rotate objects and spline camera paths. Examples of real-time interactive quaternionic animation will be presented. This research was developed at IlliMath 2001, an NSF-VIGRE supported REU program at UIUC.

2:00 - 2:15

KAIROMONE

Lorna Salaman

University of Puerto Rico via Illinois Alpha

The corn rootworm *Diabrotica* is a serious agricultural pest. As part of IlliMath 2001, a VIGRE supported REU program at UIUC, a mathematical model using real-time interactive animations was developed based on finite-element methods. *Diabrotica*'s behavior is influenced by the diffusion of chemical food attractants and drift.

2:20 - 2:35

NARNIA

Alison Ortony

University of Illinois Urbana-Champaign - Illinois Alpha

"Narnia" is an adaptation of Ken Brakke's "Polycut" to CAVE and CUBE virtual environments. Three-manifolds branched over knot and link complements will be navigated in real-time interactive animation developed at IlliMath 2001, a VIGRE supported REU at UIUC. In this project knot theory leads to a generalization of classical Riemann surfaces.

PME Session #2

Hall of Ideas I

1:00 P.M. - 2:55 P.M.

1:00 - 1:15

FACTORIZABLE GROUPS
Tom Wakefield
 Youngstown State University - Ohio Xi

A factorizable group G has two proper nontrivial subgroups H and K such that $G = HK$. This presentation examines some factorizable groups and identifies their common properties. In particular, S_n and A_n are shown to be factorizable for certain n .

1:20 - 1:35

DIVISIBILITY ALGORITHMS FOR EUCLIDEAN RINGS
Laura Hitt
 Samford University - Alabama Gamma

I developed algorithms that enable one to determine the divisibility of any element M in a Euclidean ring by another element n , where M and n are relatively prime. After creating a computer program to implement the algorithms, I compared the execution time of these divisibility algorithms with that of traditional methods. Finally, I proposed an encryption algorithm that is based on these divisibility algorithms.

1:40 - 1:55

EXPLORING GRAPH THEORY THROUGH CONJECTURES OF "GRAFFITI"
Barbara Chervenka
 University of Houston - Downtown - Texas Nu

As an introduction to Graph Theory, I examined conjectures generated by an educational version of the computer program "Graffiti". Most were related to bounds on the sum of the independence and clique numbers of a graph. In this presentation, I will discuss several of these conjectures and the tools I acquired through my efforts.

2:00 - 2:15

GRAPH THEORY: DECOMPOSITIONS
Enyinda Onunwor
 Youngstown State University - Ohio Xi

A *graph decomposition* of a graph G is a list of subgraphs of G such that each edge in G occurs in exactly one subgraph in the list. An S_k design is one with exactly one vertex that is adjacent to k vertices on the graph G . This talk concentrates on decomposing graphs into k -stars.

2:20 - 2:35

THE OPTIMAL ORIENTED DIAMETER OF THE 3×5 TORUS
 AND JOINS OF GRAPHS
Camillia Smith
 Michigan State University - Michigan Alpha

One can define the optimal oriented diameter of a connected, bridgeless graph to be the minimum diameter over all strong orientations for that graph. I study this quantity for the torus – resolving one case of a conjecture by König, Kumme and Lazard – and also for classes of joins of graphs.

2:40 - 2:55

ON THE NUMBER THEORY OF QUATERNIONS AND OCTONIONS
Mohammed Abouzaid
 University of Richmond - Virginia Alpha

I will present results about the number theory of the quaternionic and octonionic equivalents of the set of rational numbers in the real numbers, and the set of Gaussian integers in the complex numbers. This subject is particularly interesting because it requires an understanding of the algebraic and geometric structure of these 4-dimensional and 8-dimensional spaces which often sheds new light on the number theory of the real and complex numbers.

PME Session #3**Hall of Ideas H****3:00 P.M. - 4:55 P.M.**

3:00 - 3:15

INTERNATIONAL PARITY RELATIONS AND REAL INTEREST RATES

Teresa Selee

Youngstown State University - Ohio Xi

What implications do international parity relations have for real rates of interest in different countries, and are the theories supported by data? The method used to test the data will be detailed, and the results will be given, with attention to real world applications for investors.

3:20 - 3:35

PROTECTING THE PUBLIC HEALTH: PREDICTING PM FINE IN FORSYTH COUNTY

Kathy Woodside

North Carolina State University - North Carolina Gamma

PM fine is a harmful air pollutant that consists of both liquid and solid particles that are less than 2.5 micrometers in diameter. In this presentation I will discuss the forecasting of PM fine. I will explain the process of developing the model and discuss different tests of its accuracy.

3:40 - 3:55

COOK'S THEOREM

Joel Lepak

Youngstown State University - Ohio Xi

A problem in class NP is one whose solution can be verified in polynomial time (but not necessarily one which can be solved in polynomial time). Cook's Theorem states that any problem in class NP can be reduced to a problem of determining whether an assignment of truth-values exists which will satisfy a set of Boolean clauses. This is one of the most important results of theoretical computer science. A proof of Cook's Theorem will be given, and its implications and related concepts will be discussed.

4:00 - 4:15

PERIODICITY AND LONG TERM EVOLUTION OF CELLULAR AUTOMATA

Nicole Miller

Salisbury University - Maryland Zeta

In this paper, cellular automata are discrete dynamical systems generated by group multiplication for the local update rules. We will discuss the periodicity, transient phase, and long term effects of finite cellular automata by varying the grid size, initial conditions, and underlying group of the automata.

4:20 - 4:35

FROM MATHEMATICS TO KRYPTON: THE PURSUIT OF RANDOM NUMBERS

Neda Khalili and Janeen Peretin

Duquesne University - Pennsylvania Upsilon

Random number generation is an integral component of many fields, including the computational sciences which conduct simulation-based research. However, due to the limitations of the modern computer, generating truly random numbers is a formidable task. We will compare the properties of popular "random" number generating algorithms, assess the quality of the random numbers which they produce, and demonstrate their usefulness.

4:40 - 4:55

BANDWIDTH OF A PRODUCT OF CLIQUES OF UNEVEN SIZE

Eric Appelt

Miami University - Ohio Delta

The problem of the bandwidth of a product of two cliques of equal size was solved in 1992 by U. Heinrich and M. Stiebitz. In 2001, Z. Miller and I have developed a preliminary solution to the problem of the bandwidth of a product of two cliques of unequal size utilizing methods found in the previous problem, as well as ideas from three-dimensional calculus. This solution will be presented, along with applications of this problem to multi-channel communications and Internet communications.

PME Session #4

Hall of Ideas I

3:00 P.M. - 4:55 P.M.

3:00 - 3:15

NON-EUCLIDEAN GEOMETRY FROM 1820 TO 1920

Tracy Pirkle

Miami University - Ohio Delta

This paper traces the history of non-Euclidean geometry by looking at attempts to prove Euclid's parallel postulate, the discoverers of non-Euclidean geometry, its reception in the mathematical community, and its emergence in the collegiate mathematics curriculum.

3:20 - 3:35

EXPLORING MELODIC PATTERNS IN DIATONIC AND CHROMATIC MUSIC

Amy Joanne Herron

Miami University - Ohio Delta

Music consists of a variety of repeated patterns. Using the inclusion-exclusion principle, it is possible to count 1) how many patterns exist in diatonic music (a seven note system) and chromatic music (a twelve note system) and 2) how many of these patterns include all the differently named notes of the systems.

3:40 - 3:55

THE ERDŐS SUM OF RECIPROALS CONJECTURE

John T. Griesmer

Miami University - Ohio Delta

Some time ago Erdős conjectured that any subset A of the positive integers such that $\sum_{n \in A} \frac{1}{n} = \infty$ must contain arbitrarily long arithmetic progressions. He offered \$3000 for a proof or counterexample, and it is still unknown whether such a sequence must contain 3-term arithmetic progressions. The conjecture would imply that the set of prime numbers contains arbitrarily long arithmetic progressions. This talk covers the background of the conjecture, some possible approaches to solving it, and raises some related issues.

4:00 - 4:15

SCHEDULING TOURNAMENTS USING COMBINATORIAL DESIGNS

Dave Gerberry

Youngstown State University - Ohio Xi

At first glance, the process of scheduling a season or tournament does not seem to be a mathematical one. However, when facing a list of conditions a schedule must satisfy, one quickly realizes that a systematic approach is needed to attack the problem. I will discuss how combinatorial designs can be used to create tournaments that satisfy various criteria.

4:20 - 4:35

TRACING A STIRLING APPROXIMATION: DERIVATIONS OF STIRLING'S FORMULA

Steve Mehlo

Youngstown State University - Ohio Xi

Stirling's formula gives an asymptotic approximation for the $n!$ function. Although it has a variety of applications, deriving and proving this gem is a bit of a challenge. In this presentation, a brief proof will be presented in addition to some background information on the formula itself.

4:40 - 4:55

DISJUNCTIVE RADO NUMBERS

Brenda Johnson

South Dakota State University - South Dakota Gamma

The study of Rado numbers is part of Ramsey Theory, which is an area of combinatorics. We will introduce a variation of the classical Rado numbers which we call disjunctive Rado numbers. The presentation is based on the results of ongoing undergraduate research.

PME Session #5**Hall of Ideas H****1:00 P.M. - 2:35 P.M.**

1:00 - 1:15

EXPLORING FINITE TIME BLOW-UP

Jared Williams

Hendrix College - Arkansas Beta

When a solution to a differential equation "reaches" infinity in finite time, the solution is said to "blow up" in finite time. This project includes techniques for determining whether the solution to a differential equation blows up in finite time without solving the differential equation analytically.

1:20 - 1:35

MODELLING POSITIVE ASSORTATIVE MATING

Elissa Pfannenstein

College of St. Benedict - Minnesota Delta

We investigate long-term distributions of phenotypes under positive assortative mating. In positive assortative mating, individuals select mates based on the similarities of their observable characteristics (phenotypes). This model is more realistic than traditional random mating models. Our non-linear model uses probabilities to account for varying strength of mating preferences.

1:40 - 1:55

RECONSIDERING THE ANDERSON AND MAY MACROPARASITIC MODEL

Adam Singleton

Jacksonville University - Florida Lambda

This study provides a complete analysis of the three dimensional model proposed by Anderson and May in August 1979. A treatment term is introduced in this model which provides insight into the system dynamics. A stability analysis is performed, and the qualitative and quantitative effects of the critical values of lambda are considered. We plot some numerical solutions of the system for various values of parameters.

2:00 - 2:15

PATTERN FORMATION IN BIOLOGICAL SYSTEMS

Yakov Kronrod

Worcester Polytechnic Institute - Massachusetts Alpha

Many models exist to describe patterns found in biological systems. Alan Turing proposed that diffusion could act as the destabilizing influence leading to patterns in a reaction-diffusion model. Using linear stability analysis and numerical simulations, we investigate patterns based on parameters proposed by Meinhardt and Gierer.

2:20 - 2:35

NEW METHODS FOR COLLISION DETECTION

Jonathan Moussa

Worcester Polytechnic Institute - Massachusetts Alpha

Efficient collision detection algorithms are required to analyze complex geometric scenes with as little computation as possible. Certain restrictions, such as temporal coherence or uniformity of objects in a scene, dictate which algorithms are most efficient for a given situation. Here we are presenting a new algorithm for collision detection and comparing it with ones that are presently used.

PME Session #6**Hall of Ideas I****1:00 P.M. - 2:35 P.M.**

1:00 - 1:15

ORIGAMI AND MATHEMATICS

Erin M. Bergman

St. Norbert College - Wisconsin Delta

Everybody is familiar with origami, the art of paper folding. Less familiar are the connections between origami and mathematics. We will explore some of these connections, both by presenting an introduction to the theory and by giving some demonstrations

1:20 - 1:35

SAVE A LOT OR A LITTLE?

Sarah Grove

Youngstown State University - Ohio Xi

When you go out into the world and start to make pricier purchases, is it worth your while to pay in full or to make payments? Of course we all know that with interest you will end up paying more if you take out a loan. However, is that extra money worth the hassle of saving up until you can make a purchase in full? How does this decision affect your financial status for the rest of your life?.

1:40 - 1:55

AUTHORSHIP OF THE FEDERALIST PAPERS

Abby Mroczenski

St. Norbert College - Wisconsin Delta

The Federalist Papers were written in 1787-1788 by Alexander Hamilton, John Jay and James Madison to persuade the citizens of the State of New York to ratify the Constitution. Of these papers we are confident of the authorship of all but twelve. Presented here will be the results of a statistical analysis exploring the authorship of these 12 papers, using stepwise regression and logistic regression on variables created by DocuScope.

2:00 - 2:15

BINOMIAL BASKETBALL: SUCCESS STRING PROBABILITIES

Brian Muscia

Elmhurst College - Illinois Iota

An unpublished paper dealt with the problem of finding the probability of making a specified string of successes in ten free throw attempts. The original author's expressions were simplified and a general formula was found for some restricted cases of a string of i successes in k attempts.

2:20 - 2:35

DISSECTIONS: PLANE AND FANCY

Julie Jones

Moravian College - Pennsylvania Omicron

This presentation demonstrates and explains many geometrical dissections from Greg N. Frederickson's *Dissections: Plane and Fancy*. A detailed proof of H. Dudeney's dissection and rearrangement of an equilateral triangle into a square will also be shown.