MD/DC/VA Spring 2001 Meeting Contributed Paper Abstracts

* Indicates an Undergraduate Student Paper

** Indicates a Graduate Student Paper

Indicates a Modeling Competition in Mathematics Outstanding Team Award Project

# Indicates a Modeling Competition in Mathematics Meritorious Team Award Project

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First Contributed Papers Session 8.40 AM (Nine Papers)

EVADE'M: Emergency Ventilation Adaptive Dynamic Evacuation Method, (COMAP competition award)

Robert Knapik, Timothy Myers, and Eugene Kitamura, James Madison University

The problem modeled addresses the evacuation of Charleston, South Carolina during 1999's Hurricane Floyd. Maps, population data, and other specific details were given to the teams. They were tasked with constructing a model to investigate potential strategies. In addition, they were asked to submit a news article that would be used to explain their plan to the public.

Elliptic Curves, Doughnuts, and 49/20

Ezra Brown, Virginia Tech

What is so special about the number 49/20, and why is an elliptic curve like a doughnut? For the answers to these and other questions, come to the talk and find out. All the background you need is some familiarity with infinite series and a little willing suspension of disbelief.

Undergraduate Computational Science Via Computational Fluid Dynamics

Dave Pruett, Jim Sochacki, James Madison University

With support from an NSF CCLI grant, JMU's Departments of Mathematics/Statistics and Physics are developing an undergraduate program in computational science in collaboration with North Carolina Central University. Computational science, an emerging national key technology, is characterized by three inter-related areas of expertise: mathematical modeling of physical phenomena, numerical methods, and scientific visualization. Computational fluid dynamics, which is normally in the domain of graduate education, properly taught is accessible to undergraduate students and provides an ideal vehicle for the development of the triad of skills that define computational science.

Getting The Most Out Of Histograms In Basic Stat

Alexander White, American University

In non-calculus based basic statistics classes the histogram should play an important role in helping students understand the meaning of the density of a continuous random variable. In addition histograms aid conceptualization of the distribution of a random variable and its properties. I will present a series of exercises which force the students to use histograms fully and hopefully deepen their understanding of the fundamental concepts in statistics.

Linear Fractional Transforms With Integer Coefficients

Gregory Dresden, Washington & Lee University

Consider the linear fractional transforms, functions of the form (ax+b)/(cx+d), with ad-bc not 0. These form a group under composition. Which finite groups can we get if we only allow integer coefficients? It turns out that there are exactly nine possible groups.

(A) Surprising Sequence(s)

A. Gordon Willimas, VMI

A problem in the MONTHLY turned out to have some interesting connections to trigonometry, positive integers expressed in base 3, and trifurcation.

A Stochastic Cellular Automata For Three-Coloring Penrose Tiles

Mark McClure, UNC at Asheville

We present a stochastic cellular automata which quickly three-colors tilings by Penrose kites and darts, Penrose rhombs, and Penrose pentacles.

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*Winnie the Pooh and Elections Too: A Look at Voting Theory

Amanda Tracey, Hood College

An overview of vote counting techniques, including Plurality, Single Transferable Vote, Condorcet, Borda Count, Runoff Elimination, followed by a discussion of the four desirable properties of social choice procedures and Arrows Theorem. Finally a look at data obtained in an "election" which asked participants to rank Winnie the Pooh characters.

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*A Coloring Problem

Adrien Treuille, Georgetown University

Draw a closed curve, possibly with self-intersections, on a sheet of paper without lifting your pencil from the paper. A simple geometric argument shows that the resulting regions are 2-colorable.

Second Contributed Papers Session 11.40 AM (Nine Papers)

Hurrican Evacuation Plans for Coastal South Carolina Counties, (COMAP competition award)

Tony Kirilusha, Jonathan Robbins, Adam Weaver, University of Richmond

During the evacuation of several coastal South Carolina counties due to Hurricane Floyd in September 1999, an enormous amount of traffic was generated, slowing progress on I-26 and other inbound highways to a crawl. Our problem was to construct a model that would help us analyze the evacuation and investigate many different strategies that could have reduced the traffic observed in 1999. We modeled the evacuation routes as a flow diagram and developed a simple yet surprisingly effective equation to describe the traffic flow along inbound highways.

Our investigation revealed that the key to achieving a rapid evacuation and to minimizing the driving time for evacuees is to utilize all of South Carolina’s hurricane evacuation routes, rather than relying on I-26W. One very important result is that the highways have a maximum capacity, which is independent of velocity, which means if evacuations are staggered properly, an evacuation can be carried out in a minimal amount of time and also keep travel time low. We also show that reversing I-26E and restricting the number of vehicles per family are effective ways to improve traffic flow when minimizing evacuation time becomes critical.

To Disk Or Not To Disk, (COMAP competition award)

Daniel Robinson, Florin Nedelciuc, Justin Lacy, James Madison University

The problem modeled is about bicycle wheels and what edge they may give to a race. "Before any contest, professional cyclists make educated guesses about which one of two basic types of wheels to choose for any given competition. The team’s Sports Director has asked them to come up with a better system to help determine which kind of wheel – wire spoke or solid disk – should be used for any given race course."

A Problem of Kaplansky

William P. Wardlaw, U. S. Naval Academy

Kaplansky posed the following problem: Prove that, if an element of a ring with an identity has more than one right inverse, then it has infinitely many. The problem is discussed, a solution is given, and then an example of such a ring is given.

First Return Limiting Processes: A Little Information Goes A Long Way

Michael J. Evans, Washington and Lee University

I shall review the first return limiting concept, which has its roots in chaotic dynamical systems and show how it has been exploited to capture complete information about functions in certain classes, based on only using countably many points on the graph of the function. Then I shall explain a method recently developed by Professor Udayan Darji and me which enables one to compute the Lebesgue integral of a function, again using only countably many data points.

Generalizations of the Concept of State

Andrew Vogt, Georgetown University

The notion of state, stemming from such sources as Aristotle, Galileo, and Newton, has been generalized in science to include such notions as derivatives, fields, and delays. We give examples that illustrate the breadth of usage, and suggest still other generalizations, some having a category theoretic flavor.

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*Meetin' in the City of New Orleans: An Undergraduates View of the 2001 Joint Meetings

Amanda Tracey, Jennifer Webb, Laura Pugh, Hood College

Join three undergraduate students for a look at a typical day during the 2001 Joint Meetings in New Orleans. Discussion will center on lectures, receptions, accommodations and walks through the city. Discover if you want to attend the 2002 Joint Meetings in San Diego, California!

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*Generating Bandt's Aperiodic Mixed Self-Similar Fractiles and Their Boundaries

Dominic Braun, UNC at Asheville

Bandt and Gummelt described an aperiodic fractal tiling of the plane in their paper in Aequationes Mathematicae 53 (1997, pp.295-307). This talk focuses on generating images of those tilings using Mathematica.

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*Modeling Animal Behavior

Michael Gwinn, Georgetown University

An account is given of an ethnological study relating fly counts and comfort movements in feral ponies to physical and environmental variables. Modeling techniques include backward stepwise regression, multiple linear regression, and neural networks.

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*Normal Matrices and Polar Decompositions in Indefinite Inner Products

Patrick Meade, College of William & Mary

In the paper that is accepted for publication in Linear and Multilinear Algebra (Lins, Meade, Mehl, Rodman) the full structure of normal matrices with respect to an indefinite inner product is studied and then applied to the study of polar decompositions. This talk will focus on one result proved in the paper that every normal matrix with respect to an indefinite inner product defined by an invertible Hermitian matrix having at most two negative eigenvalues, admits a polar decomposition

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Third Contributed Papers Session 1.30 PM (Eleven Papers)

A Mathematical Model of a Storm Evacuation Plan for the South Carolina Coast, (COMAP competition award)

Jonathan Charlesworth, Finale Doshi, and Joseph Gonzalez, Governor's School, Richmond, VA

We investigate the optimal approach to evacuating the South Carolina coast. Applying safety regulations and flow-density equations, we first find the maximum rate of traffic flow through a road lane. Next, using a computer simulation and a modified genetic algorithm, we attempt to optimize the South Carolina road network by reversing opposing lanes on various roads and determining when to start evacuating a certain city. Our model also considers the effects of other secondary factors, such as out-of-state traffic and hurricane shelters, on evacuation efficiency.

Three Parabola Problems And Some Historical Notes

Parviz Khalili, Christopher Newport University

We propose three problems related to parabolas that are inspired from reading "The Historical Development Of The Calculus" by C.H. Edward. We consider two points A and B with |AB| = p, on a parabola. Then the three problems are to find: 1) maximum of the area between the parabola and AB, 2) extrema of arc length AB, and finally 3) the minimum distance from the midpoint of AB to a point Q (to be defined) on the axis of the parabola.

From Discrete Least Squares Approximation to Data Smoothing: The Path Less Traveled

Robert P. Bennell, Virginia Military Institute

We are presented with a set of discrete data (x(i), y(i)) ; i = 1,2,.....,n , where the {y(x(i))} are measured observations of some unknown function f(x). Additionally, we are informed that the {y(x(i))} are contaminated by experimental noise {e(i)}, assumed to be Gaussian with a zero mean and a common but unknown variance s**2. We have been asked to compute a smooth approximation F(x) to f(x). Such a description would normally have us reaching for the polynomial or spline least-squares routine in our library of data fitting software. Is there an alternative? Is the alternative as user-friendly as polynomial least-squares? Is the alternative efficient? The answer is, of course, yes**3!

Merlot: Online Teaching and Learning Resources (MERLOT)

Kevin Peterson, Lynchburg College

In this talk we describe the mission and intent of MERLOT as well as give several examples of interactive resources that can be found on the MERLOT website. Merlot (Multimedia Educational Resource for Online Learning and Teaching) is a free and open resource designed primarily for faculty and students in higher education. With a continually growing collection of online learning materials, assignments and reviews, MERLOT helps faculty enhance instruction as well give a way for faculty to get (tenure and promotion) credit for creating these instructive tools.

Orientations of 5-Wheel-Free Graphs To Avoid Having An S3 Minor

Glenn Berman, Lynchburg College

The digraph S_3 is obtained by replacing every edge of a 3-point star with a pair of arcs in opposite direction. This talk will show that every 3-connected graph without a 5-wheel-minor has an orientation with no S_3 minor.

The Mathematics of GPS

Craig Bailey, U S Naval Academy

Some of the mathematics involved in how a Global Positioning System receiver figures out its position will be explored. This includes some geometry of the ellipse, along with latitude and longitude. Time is the real key to all of this.

**Using Maple for Solving Fluid Dynamics Model

Kendrick D. Smith, Hampton University

A number of aerodynamic problems can be modeled mathematically as fluid dynamics problems. The model considered here is a superimposed flow governed by Navier-Stokes equations. An attempt is made to solve these equations using Maple.

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*CS/Math Project: gtk/OpenGL interactive 1st Order ODE Solver

Amy Pollard, St. Mary's College of Maryland

The talk will demonstrate my computer graphics program for specific first order ODEs. A user can interact with the program using the mouse and perform a variety of operations. The new aspects of this software are the use of gtk and OpenGL. of operations.

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*On A Variation of the Lotka-Volterva Prey-Predator Model

Danielle Boyd, Morgan State University

We will present a new model of predator-prey system. Analyzing the stability of its equilibrium points will also be discussed.

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*Multiplicative Generation of Integral Matrices via Elementary Bidiagonal Matrices, Charles R. Johnson, Dani N. Machado, and Patrick X. Rault, College of William and Mary

It is shown that the n-by-n matrices of determinant 1 are generated by certain subsets of the elementary bidiagonal matrices of cardinality 2(n-1) and that each subset is minimal. Using this fact, it is shown how to generate the unimodular matrices and all integral matrices. The totally nonnegative matrices of determinant 1 that are generated by elementary bidiagonal totally nonnegative matrices are also discussed.

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*Can You Follow Our Train Of Thought? Analyzing The Effects Of A Railroad Crossing On Traffic Flow, Nancy Nichols and Tonya Kim, Randolph-Macon College

We observed and analyzed traffic patterns at two intersections in Ashland, VA to investigate the consequences of future growth. In particular, we developed and utilized a queuing model (based on the Borel-Tanner distribution) for maximal queue length at a railroad crossing in the center of town. We found that slight increases in traffic density will dramatically increase the likelihood of saturated traffic conditions.
