Tenth Annual VSU Mathematics Technology Conference
February 25, 2005
ABSTRACTS for Workshops and Talks

WORKSHOPS:

Using a Computer Screen as a Whiteboard while Recording the Lecture as a Sound Movie

My talk will describe my lecture technique for creating notes by typing into a computer in front of the students and, while doing so, recording the entire activity of the computer screen and all that is said into a sound movie that is then made available on CDs that are ready to be picked up 15 minutes after the end of each lecture. Thus, not only is each student provided with a textbook quality set of lecture notes for each class, but any student to finds it heavy going reading through any set of lecture notes has the option of entering a virtual classroom and re-experiencing the actual lecture, or any part of it that may be needed. I have been employing this unique technique at Kennesaw State University with great success for some years. I do not think anyone else has done this sort of thing anywhere.

Dr. Jonathan Lewin
Kennesaw State University

Winplot

In this talk I will give you a quick introduction to the use of the software Winplot that is available free of charge at http://math.exeter.edu/rparris/. Winplot is a general-purpose plotting utility, which can draw and animate curves and surfaces presented in a variety of formats. I have been using this software for quite some time now and I find it very useful for writing tests and creating animations for class presentations ranging from College Algebra to Differential Equations. Winplot is neither a symbolic toolbox nor a calculator but it is much easier to use than Maple and Mathematica when it comes to plotting (especially during lectures). No programming is required. My hope is that after the talk you will have one more tool available for your class presentations.

Carlos Almada
Columbus State University

Fractals and the Geometry of Nature

B.B. Mandelbrot's 1982 manifesto, "The Fractal Geometry of Nature" was a serious challenge to the 2500 year old Euclidean geometry of lines, circles and relatively smooth shapes. The very success of Fractals in such a large variety of fields such as art, data compression and analysis of the Mandelbrot set has tended to move fractals "off message". The intent of this new geometry of scaling, self-similarity and *roughness* was to provide models for nature and the environment. That was the unmistakable mission of this upstart that burst upon the mathematical scene some 25 years ago. This presentation will attempt to nudge fractals back to their roots.

Ben Fusaro
Florida State University

Studying Numerical Methods using MATLAB

Professional software, MATLAB, which stands for Matrix Laboratory, is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment.

At Kennesaw State University, MATLAB has been used in classroom teaching, mainly in the following areas: Numerical Computation and Graphic Visualization. The talk given by students will present how they use MATLAB in studying Numerical Methods, and Computational Linear Algebra.

Joshua Z. Du, Thomas Hippchen(student), Cicero Brooks (student), Kevin Jourdain (student)
Kennesaw State University

Optimal Pacing Strategies in Bicycle Racing

Pacing is an important component of strategy in activities such as running, swimming and biking. Starting at a pace that is too fast can lead to fatigue that undermines performance. Beginning and maintaining a pace that is too slow can lead to non-optimal results.

We investigate the problem of determining the optimal pace for cycling. Models representing aerobic, anaerobic, and resistance to motion are formulated. Then Pontryagin's necessary conditions are solved using analytical and numerical methods to determine the optimal strategy for riding over flat terrain at the end of an individual race. Particular attention is devoted to how the mass of the rider-bicycle affects the optimal strategy.

Steve Blumsack, Daniel Rabb (student), Caleb Thomas (student)
Florida State University

Free Near-Clones of Useful Software

MATLAB, Stella, and Geometer's Sketchpad are commercial software products that many educators have found useful in their teaching. If you have a limited budget, you may be interested in some free near-clones of these and other useful software.

Hugh Sanders
Georgia College & State University

TALKS:

Teaching College Mathematics with the TI-83/84 Calculators

Attendees will explore solving the standard volume of a box problem using apps on the TI 84+. Other problems will use various apps of the TI 84+ to include transformation graphing of functions and inequality graphing to solve linear programming problems. An example of the study card app will be shown.

Ralph Wildy
Georgia Military College

Using Geometry in Action to Enhance College Algebra Understanding

One way to increase students' mathematical intuition about various types of equations is to construct and observe the behaviors of these equations graphically. Geometry in Action has pre-developed dynamic Geometer's Sketchpad activities to facilitate and guide student understanding. The ease of use by both the novice and proficient Geometer's Sketchpad user is an added bonus. This talk will explore and demonstrate three of the applications: 1) slope and intercept; 2) polynomials through four points; and 3) polynomials from their roots.

Peggy L. Moch and Andreas Lazari
Valdosta State University

Conjectures and Proofs in a Dynamic Geometry Environment

Students' difficulty with reasoning and justification in the context of proofs in geometry has been well documented. Studies reveal that many ideas that the students are asked to prove are known to be true, and therefore, the process of such proof is likely to remain meaningless and purposeless. The implication of this claim is that students need to be asked to prove mathematical assertions that are not known to them to be true. This puts an enormous responsibility on teachers. The purpose of this talk is to provide examples of non-traditional conjectures that can be explored in the dynamic geometry environment of computer construction programs. More specifically, the talk will discuss examples of non-traditional mathematical conjectures that can be explored with Geometer's Sketchpad.

Arsalan Wares
Valdosta State University

CAS makes learning more funs

Computer Algebra Systems (CAS) is widely used in colleges and universities. It makes our teaching and learning more effective and fun. In this note, we share some experience with our mathematics community on MathCAD. We illustrate a process of plotting the regular polyhedrons with each pair of vertices connected by a tube surface using MathCAD. This process can be applied to any smooth curves such as the knot curve and circular helix.

Weihu Hong
Clayton College & State University

On-line Calculus and the WebALT project

The Single Variable Calculus lecture notes(http://www.webalt.net/Calculus-2004/) have been used at FSU and at University of Helsinki. An experiment was performed at the University ofHelsinki in fall 2004. The same course was offered as a fully on-line course based on the on-line notes and, at the same time, as a traditional contact instruction course. The students of the on-line course took part in the same examinations as the students of the traditional course. The results were surprising: the drop-out rate was lower in the on-line course, and the on-line students fared better in the examinations.

Advanced on-line exercise delivery systems, like MapleTA, can improve on-line instruction in a significant way. The WebALT project will produce the next version of the on-line calculus notes. An advanced exercise delivery system will be integrated to the notes. The WebALT project has received over 3 million US$ from European funding agencies within the eContent Program of the European Union. The two year project will add multilingual support to the calculus lecture notes. For more information about WebALT see http://webalt.net/.

Mika Seppälä
Math -- Florida State University and University of Helsinki

Bounds on the cardinality of a minimum ½-dominating set in the king's graph

For every positive integer n, we denote by $G(n)$ the cardinality of a minimum ½-dominating set in the king's graph and let $P(n) = n^2 - G(n)$. We show that $\frac{7n^2}{11} + O(n) \geq P(n) \geq \frac{3n^2}{5} - O(n)$, conjecture a very precise formula for P(n) and present some software that helped us find minimum configurations.

Eugen J. Ionascu
Columbus State University

Coloring Between the Lines in Maple

Maple has no built-in command for coloring the area between two curves. Two ways of doing this will be explained. These will be illustrated by application to a typical lecutre example and to Dr. Donald Young's "Fool's Cap" curve."

John A. Ziegler
Southern Polytechnic State University

Physically Based Billiards Simulation Using the RenderMan API

The collision of billiard balls is an elastic collision, meaning the total kinetic energy of the system is the same before and after the collision. Using the mass, and pre-collision velocities of two colliding objects, the conservation of momentum equation can be used to determine the post-collision velocities of the objects. Basic conservation of momentum equations insufficiently describes the billiard ball collisions because they assume frictionless environments. However, these equations are commonly used to animate billiard ball collisions, and other applications in game programming. To adequately describe the collision, the friction of the table must be accounted for. When we include friction, the post-collision behavior of the billiards largely differs from before. In order to more accurately animate the collision of billiard balls, we must look at the times that are before, during, and after a collision. We adapt and modify a method to, physically more accurate, animate billiard collisions with any given initial velocity, and angle of impact for the billiard balls.

James Sharber
Valdosta State University (Student)

Analyzing Periodic Data in a Trigonometry Class

The presenters will explain an activity used in a trigonometry class at USC Aiken in which students construct a sinusoidal function to model data on the brightness of an ordinary light bulb (which fluctuates in a periodic manner). Students collect the data using a TI-83 calculator with a CBL. They are guided to examine this data to find the coefficients needed in their model. They check by making sure that the graph of their model agrees well with a plot of the data. Along the way, the students estimate the frequency of the periodically varying brightness as approximately 120 cycles per second

In a follow-up activity, the students explain the 120 cycle per second frequency of the brightness sinusoid in terms of the 60 cycle per second electrical current using the fact that the varying brightness follows power (Power = Voltage · Current). This part of the activity uses voltage and current data as well as brightness data. The explanation involves the trig identity sin(x)^2 = (1/2) (1 – cos(2x))

Michael D. May and Stephen C. King
University of South Carolina Aiken

Pendulum Data and Differential Equations

The presenters will explain an activity used in a differential equations class at USC Aiken in which students compare data collected from pendulum motion with the solution function of a differential equation model of pendulum motion. Students collect the data using a TI-83 calculator with a CBL and import the data into a computer. Then using *Mathematica*, the students graph the solution of a pendulum differential equation along with a scatterplot of the data, experimentally adjusting coefficients in the equation to get a good match between the graphs.

Thomas F. Reid and Stephen C. King
University of South Carolina Aiken

Prospects and Implications of using Spreadsheets for Analyzing Complex Mathematical Functions - A Case study using Fourier Analysis From Time Series Data

Fourier analysis is a mathematical technique for uniquely describing a time series in terms of periodic constituents and is also called spectral analysis, frequency analysis or harmonic analysis. It is one of the most powerful techniques used for signal analysis. Although several applications are known in Engineering, understanding the complex functions involved in Fourier analysis for non-mathematical students / scientists poses a challenge. Applications of Fourier analysis in biological and environmental fields are immense, such as for analyzing climatic trends, detecting onset and offset in vegetation phenology events, biological image processing, medical diagnosis and other areas. We demonstrate the utility of spreadsheets in computing the Fourier components using simple functions available in Microsoft Excel for different forest types. We highlight the importance of the use of Spreadsheets for solving complex algorithms, such as Fourier analysis and the results obtained from the data.

Anuradha Eaturu
Valdosta State University

The Curvature Problem for Sawmill Optimization

A log is scanned as it enters the line, and the data stream produced is used to make decisions to guide the saws in order to minimize less profitable products such as wood chips. Experimentation indicated that points of maximum curvature should play a key role in the decision process. Approaches to this and related mathematical problems will be discussed.

Jessica Fuller

Langdale Forest Products

An Electronic Calculus Book in Maple

David Betounes and I are writing an electronic calculus book, called *Computational Calculus*. This book is being written totally within Maple and will take advantage of some unique capabilities of a computer algebra system. The goal is to provide a unified, interactive, and exciting environment for learning calculus and understanding the importance of numerical computation and approximation. In this talk I will demonstrate some of our materials.

Mylan Redfern
Valdosta State University

Markov Chains : Applied and Theoretical Study as Part of a Mathematics Educational Digital Library

The computer program Scientific Notebook (SNB) is a Computer Algebra System possessing a Natural-Mathematics-Interface allowing for direct "pencil and paper like" symbolic mathematical language communication with a computing kernel. Presented are elementary steady-state aspects of discrete, time-homogeneous Markov Chain theory. Topics presented include the Markovian property, Markov model representations (explicit and recursive), a probability vector formula derivation, and a Markov steady-state stability theorem. Problems exemplifying the theory are shown. Particular constructs applied include: random variables, discrete probability mass functions (normalized histograms) representing probability state vectors, nth power Markov transition matrices, eigenvector solution for the steady-state vector, and digraphs. Using SNB allowed a direct, powerful means for studying Markov Chains by handling the matrix algebra calculations not practical to compute by hand. Through hypertext, and intuitive icon based mathematics "word processing," Mathematics Educational Digital Library development concerning related Probability theory, problems, and explanations is ongoing.

Theron Seebreth
Florida A&M University (student)

Using Concrete Virtual Manipulatives in Teaching Geometric Constructions for Learning Deductive Proof

One learns Geometry in part to develop logical, fruitful, and cogent reasoning skills. Several geometry proofs are broken down and presented with the aid of the computer program Geometer's SketchPad (GSP) as part of our research on elementary and secondary school pedagogy. Concrete representational aspects here aid student's mathematical communication, and explicit understanding of logical relationships. Other implicit and explicit geometric meanings are expressed in our demonstrated use of GSP's transformation (i.e., rotation, dilation, reflection, translational vector) and "compass & straightedge" construction tools. These proof compositions allow for detailed manipulative actions and constructions enhancing visualization concerning transformations and geometric invariant properties (or logical generalization). Presented are activities using Natural-Mathematics-Interfaced tools (like GSP) which facilitate a student's intellectual focus on the fine grained logical necessities required for mathematical proof by geometric construction while exploiting parallel numerical measurement and dynamic manipulation and visualization computing facilities.

Chinequa Taylor
Florida A&M University (student)

Fostering Higher-order Mathematical Thinking with Technology: A Case Study on the Sierpinski Triangle

There is no doubt that mathematics is computational and thus could be adequately explored in a technology-enhanced environment. Despite the universal presence of technologies, however, the instructional benefits depend on how technologies are used in the classroom. Computers could be affordable machines of "drill and practice", visually appealing platforms for “simulation and application”, or computationally interactive scaffolds that foster “higher-order thinking”.

Starting from the Sierpinski Triangle, the author will discuss four approaches to the problem, which is both geometrically attractive and algebraically thought-provoking. First, in a traditional lecture style, all the features of the subject would be presented to the class in full by the instructor. Second, in the paper-pencil style, students would be given construction paper and scissors in a hands-on project. Third, in the PaintBrush style, the computer would be used as a drawing board. Fourth, in the computational style, the instructor would lead a discussion of the intrinsic properties of the subject, and convert their analysis into a Mathematica program (a few lines long), keeping it running to everyone’s satisfaction.

The author would like to show that technologies, programming techniques in particular, are not only tools for multimedia presentation, but could well be integrated into existing lessons of school mathematics in fostering higher-order mathematical thinking at all levels of education. Technologies are ready; students are ready. The challenge lies on the shoulders of mathematics education researchers and teachers. In spite of the initial overhead of training and research, technology will in the long run transform the way we teach and learn mathematics as it has in the world at large.

Lingguo Bu & Rob Schoen (graduate students)
Florida State University

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Invited Address: Perspectives on the Maturation of Computer Algebra in the Academic World

The first computer algebra systems appeared in the 1960's (Macsyma) and 1970's (MuMATH79) and modern computer algebra systems were born in the 1980's. My first use of computer algebra was, as a graduate student, twenty-one years ago. It has taken almost all of this time for these software tools, and the hardware on which they run, to mature. This presentation will consist of a combination of historical milestones and personal experiences along this journey. Mathematical topics discussed will include calculus, linear algebra, differential equations, and number theory.

Douglas B. Meade
Univeristy of South Carolina

Banquet Talk: The Threat of Tsunami within the Atlantic, Gulf of Mexico, and Caribbean Ocean Basins: Can it happen here?

The northern Sumatra earthquake and subsequent Indian Ocean tsunami of December 26^{th}, 2004, has drawn recent worldwide attention to the topic of tsunami risk. While the countries of Indonesia, Sri Lanka, India, and Thailand struggle to deal with the hundreds of thousands of fatalities and millions of displaced persons following this disaster, unaffected countries have been forced to reassess their own risk to an event of this nature. Historically, the U.S. has experienced deadly tsunami mostly affecting states within the Pacific basin, especially Hawaii and Alaska. Several notable tsunamis in the past century have claimed the lives of hundreds of U.S. citizens there and those living within these areas are typically aware, though perhaps unconcerned prior to December 26^{th}, 2004, of the threat of tsunami. While tsunami have received considerable attention along the West Coast of North America, much of the U.S. public was surprised to learn in media reports of potential tsunami risks along the East and Gulf Coast of North America, where most assumed the risk of this type of disaster to be zero. Like the Pacific, the Atlantic and Caribbean basins are susceptible to tsunami generated by earthquakes, landslides, volcanic eruptions, and extraterrestrial impacts.

Clint Barineau
Department of Physics, Astronomy, and Geosciences, Valdosta State University