Abstracts of Student Talks
MAA Allegheny Mountain Section Meeting
Juniata College
Friday, April 7, 2006

Lisa Anthony , University of Pittsburgh at Johnstown
Limit-free Calculus

The famous philosopher, physicist, and mathematician Renee Descartes is well known for many things, not the least of which being his graphic treatment of the equation. His work on establishing a universal math in which geometry, algebra and arithmetic would be closely related members led to what some have called "the greatest single step ever made in the progress of the exact sciences," the concept of the coordinate system. Another of his ideas that is not quite as well known (or appreciated) is his method of approaching the problem of finding tangents to a curve. In this talk, we will explore Descartes' idea and learn a pre-calculus "limit-free" method of finding a tangent to a curve that doesn't involve limits.

Caleb Astey, Duquesne University
Scraping for 11 crossing links

In our computational studies, we always need a polygonal representative of each knot and link we wish to study. Although data for knots and links is available in many forms in books and on the web, polygonal representatives of all known knots and links are surprisingly hard to come by. Here we discuss one strategy for generating polygonal representatives from data available on the web. We will discuss the scraping of web pages to compile a local copy of the data, as well as the analysis of the numerical issues presented with transforming the data.

Andra Barraclough, Pennsylvania State University
Math is addictive and my Professor is my dealer, take this sequence for example…

Consider the sequence: 918, 183, 123, 63, 92, 112… What term comes next? Don't get hooked, come see my talk instead. After a finite number of terms this sequence repeats itself. We will show that there are only two possible outcomes, both cyclical, for all possible initial terms with nine digits or less. We also can determine which limit cycle will be reached from the first term.

Michael Beran, Duquesne University
Modeling Tension Distribution within a Polygonal Knot

One question regarding knot mechanics is: given an applied tension force on one end of an open knot, how much tension is lost due to frictional interactions between strands within the knot? One tool which may be used to analyze a knot is the discretization of the strands into edges. Recent advances in computational knot theory permit the analysis of a tight polygonal knot configuration in which all of the points of contact between edges are known. Here is presented the model that has been developed for frictional interactions within such a knot. Moreover, it can and will be shown that the model converges (as the number of edges approaches infinity) to a well known physical law for tension distribution for smooth curves.

Bryan Bischof & Andy Polack, Westminster College
Blowing a Breaker: Lights Out in Multiple Dimensions

The lights out puzzle, from Tiger Electronics has served in the past as an object of discussion on a mathematical level. Conveniently, this game can be analyzed with linear algebra in modulo 2. Visualizing the grid as a matrix one can readily see the implications and strategies involved. Using the light pattern produced from one button press, it is possible to analyze each outcome of pressing a button and construct a new matrix of light changes. Likewise, the use of reduced row echelon form will lead to the target strategy of button presses. Furthermore this is complicated for a lattice of lights, in other words in R^3. Further still it is generalized to a $n \times n \times \ldots \times n$ puzzle in R^n.

Kristin Bockstoce, Washington & Jefferson College
The St. Basil's Cake Problem

The St. Basil's Cake Problem involves finding the probability of cutting through a disk randomly located inside a larger circle. This problem is a variation of the well-known Buffon's Needle Problem.

Matt Fredrikson, Duquesne University
New Techniques for Fast Calculation of the HOMFLY Polynomial

The HOMFLY polynomial invariant is an excellent computational tool for categorizing knots and links. However, the recursive nature of the calculation severely restricts the complexity of knot data one can analyze. We will discuss methods we have been developing that make the calculation of this polynomial on very large and complex links computationally feasible. These methods include: algorithms for reducing the complexity and size of a link, the use of dynamic programming techniques for reducing the actual runtime of the HOMFLY calculation algorithm, and search heuristics for finding optimal paths to the bottom of the HOMFLY resolving tree.

Elizabeth Gregg, University of Pittsburgh at Greensburg
7th-Dimensional Nilpotent Lie Algebras

Ghanam and his collaborators have found matrix and vector field representations for low dimensional Lie algebras of dimensions less than or equal to 6. In this presentation, we study the 7-dimensional nilpotent Lie algebras. First, we take our list of 130 algebras from the paper by Craig Seeley and classify the algebras according to their invariant properties such as the dimension of the center of the algebra and the dimensions of the lower central series. Our goal is that, for each Lie algebra, a corresponding matrix Lie group is exhibited whose Lie algebra is the given one. We also exhibit a representation of the Lie algebra in terms of vector fields.

Josh Harpst, Slippery Rock University
An Algebraic Approach to a Calculus III Problem

In Calculus III we were solving maximization problems with constraints. While the professor was working the problem, I saw an easier way to solve it. In my talk I will show you how I turned the original calculus problem into an algebra problem and prove that my method works in general.

Elizabeth Hartung & Jason McCarty, Indiana University of Pennsylvania
Factorization of Polynomials over the Semified B

We introduce the semifield B and show it to be the unique finite semifield that is not a field. We examine the properties of B[x], the semiring of polynomials with coefficients in B, and contrast it with more typical polynomial rings. One would like to characterize precisely which polynomials in this semiring may be factored. To that end, we present some necessary conditions for factorization and discuss our efforts at finding such a characterization.

Matt Katz, Juniata College
On Conic Algebra

Around 300 B.C., Apollonius of Perga wrote the treatise "On Conics". In it, he defined the three main conic sections as the intersection of a cone and a plane. Since Descartes' "Geometrie", however, we have redefined these sections with algebraic equations, but are they equal and why did this transformation take place?

Michaela Kimbell, Washington & Jefferson College
A Combinatorial Approach to the Fibonacci Sequence

Along with the Fibonacci numbers come numerous identities and theorems, often proven by methods such as induction. However, using a "combinatorial approach" to these numbers, one may come up with different, more visual proofs of these same properties, illustrated with tilings of an *n*-board.

Aubrey Komorowski, Duquesne University
Independence Models, Likelihood Ratio Tests and a Side of Bacon

The game PASS THE PIGS requires a player to roll a pair of pig-shaped dice; the configuration of the rolled pigs determines points earned. Data collected from thousands of such rolls from different heights are used in conjunction with multinomial independence models to examine height effect. Likelihood ratio tests are used to compare competing independence models and reveal the most plausible dependence relations.

Anne Krinock, Indiana University of Pennsylvania
Statistical Steganalysis

Steganalysis, the detection of steganography by a third party, is a relatively young research discipline that began in the 1990's. The art and science of steganalysis is intended to detect or estimate hidden information based on observing some data transfer and making no assumptions about the steganography algorithm. The main emphasis of steganalysis relates to the detection of a hidden message rather than its abstraction. There are verious methods and techniques that are commonly associated with steganalysis. These techniques can be classified in a similar way as cryptanalysis methods, largely based on how much prior information is known.

Anne Krinock & Amanda Schiel, Indiana University of Pennsylvania
Characteristics of Factorable Polynomials in B(3,i)

We will investigate the ability to factory polynomials in the integers mod three, and also the same characteristics for two other related semi-rings. We will look at these various fields and

attempt to determine properties of each that may lead to characteristics which determine when polynomials of various degrees are factorable and when they are not. We will try to generalize these various cases as much as possible, but mainly concentrate on patterns found during our exploration of the fields.

Corey Langley, West Virginia Wesleyan College
Continued Fractions

Every college student has seen continued fractions, like $1 + (1/(1 + (1/x))$ on college entrance exams. However, continued fractions are often ignored at higher levels of study, even though they possess several alluring and intriguing properties. From finite expansions of rational numbers to patterned, infinite expansions of irrational numbers, such as *e*, continued fractions provide a unique perspective for examining advanced fields of mathematics. We will investigate some of the basic properties of continued fractions as well as a few of their applications and utilizations in mathematics.

Sam Marvit, Pennsylvania State University – Erie
A Generalized Incubation Model for the Black-capped Chickadee

Bird incubation is a function of several parameters. Generally, it is has been studied on a small scale as a function of biological tradeoffs. I propose a generalized model in the form of a difference equation to describe incubation behavior as a function of environmental temperature. This will lead to a better understanding of incubation dynamics. This talk is appropriate for students who have taken an introductory statistics course.

Joe Pleso, Pennsylvania State University
Determining Parameters For A Cooling Model

This talk will discuss two models of cooling. We look at a published model and compare it to our model. The published model is second order, whereas our model is first order. We also show our algorithm for calculating parameters for our model. This talk is suitable for people who have taken differential equations and have minimal programming experience.

Sherry Plummer, Pennsylvania State University – Erie
A Metal Alloy Problem in Linear Programming

In this talk, we provide a few examples of linear programming problems. We then examine a specific example of profit maximization with a metal alloy problem. Excel Solver aided in this process.

Pat Plunkett, Duquesne University
Probabilities of Random Links

Suppose two circles are randomly placed inside a sphere. What is the probability that they will be linked? In this talk, we investigate methods of generating random links, discuss problems in identifying linking type, and determine the probabilities of these linking types.

Jessica Riffle, West Virginia Wesleyan College
Leaps of Faith and Uniform Convergence

In his talk, "Beyond Mere Convergence," at the 2005 Allegheny Mountain Section meeting, Pennsylvania State University Professor James Sellers worked with the power series representation for the function 1/(1-x). He employed Eulerian "hand-waving" to obtain a new series, repeatedly using the xDx operator term-by-term. I will verify that his methods were valid.

Nicholas Ross, Pennsylvania State University – Erie
The Growth Degree of Vertex Replacement Rules

The growth degree of an infinite graph is defined as the degree of its counting function. A vertex replacement rule can be used to create a sequence of graphs which converges to an infinite graph. This work suggests that the growth degree of this graph is related to the Hausdorff dimension of the fractal created by scaling the infinite graph to have diameter 1.

David Spade, West Liberty State College
A Way Around the Polls

Jesse Stimpson, Pennsylvania State University – Erie
Modeling Idiopathic Intracranial Hypertension with Starling-like Resistance

In an attempt to better understand Idiopathic Intracranial Hypertension (IIH), mathematical models display the behavior of the brain's sinuses when introduced to changes in transmural pressure; the pressure difference between interior and exterior pressures. The definite causes and proper treatment of IIH escape doctors and scientists. Disturbances of the brain's blood flow system, such as sudden pressure changes, may be the origin of this disorder. We consider several models, derived from conservation equations resulting in differential equations, which describe the dynamics of pressure changes on the brain's sinuses and surrounding regions. Such changes can cause a partial collapse of the sinus, thus causing increased resistance to natural blood flow. This quality is known as Starling-like Resistance a term that increases as transmural pressure decreases. We examine upstream and downstream models by defining Starling-like resistance terms based on previously researched data. The downstream models show elevated steady states: saddle points and stable nodes. On the other hand, upstream models do not exhibit any elevated states. We conclude that IIH may be a physiological manifestation of the stable elevated state predicted to exist by the downstream model. We plan further research of the effectiveness of certain treatment regimen.

Elizabeth Ann Tiedeman, Duquesne University
A Price Prediction Model for Building Blocks

Accompanying the prices of LEGO sets displayed in the online and paper catalogs are the number of corresponding pieces in each set. Using catalog data, we implement a least-squares regression model to predict the price of a LEGO set as a function of its piece count and estimate price-per-piece. Additional predictors, such as genre, are included to enhance predictive ability and better understand pricing strategy.

Eno Usoro, Chatham College
What are the possible Isometries on a Plane?

This presentation gives an overview of a proof that there are only five possible types of isometries on the plane: identity, reflection, rotation, translation and glide-reflection. The proof will be presented visually using a Flash-based program.

Malorie Winters, Pennsylvania State University – Erie
Scavengers and Competing Species

The purpose of this research is to determine the behavior of a scavenger population when introduced into a system of competing species. Competing species are two interacting populations, x and y, that compete for a limited food supply. The behaviors of the competing species can be modeled by a system of two differential equations. Depending on the initial conditions and the growth and saturation rates of each population, each species will tend to a fixed point solution. To find the behavior of a scavenger species, a third differential equation is added to the system and analyzed. The solution to this equation depends on both x and y, the growth and death rate of the scavenger, and also the initial conditions of the scavenger species. This talk will analyze the simple case when a scavenger has no effect on the species x or y.

Jason Wood, Duquesne University
Analytical Study of Tension in Knots

A preliminary model developed for calculating tension throughout a knot is shown to converge to proven physical laws. An algorithm was written to calculate the tension for various simple knots. The results of this preliminary study agree with expected behavior, urging further refinement of the model. Such future work aims to eventually describe the mechanism by which tight knots loosen and slip.

Megan Zigarovich, Washington & Jefferson College
Game, Set, MATH!

This talk will use infinite series and stochastic matrices to compute the property and probability of winning a tennis game (set, match) with a fix property of winning a point.