Abstracts of Student Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
University of Pittsburgh,
Friday April 11th, 2008

Benedum Hall, Room 424

7:30-7:45

J. Zachary Klingensmith, Washington and Jefferson College
Van Roomen's Equation: Solving a 45th Degree Polynomial Equation...And How to Make Your Own!

Students today are taught to solve basic polynomials, mainly of degree two and three, using algebraic methods such as factoring. In an interesting historical problem, François Viète looked at a 45th degree polynomial and immediately came up with one solution, shortly followed by the other 22 recognized at the time. I will show Viète's procedure for solving this equation using trigonometry and a second, more modern approach, unavailable to Viète. Finally, I will also show how anyone with basic trigonometric background can come up with their very own equation that may look impossible to solve, but is actually quite simple.

7:50-8:05

Jeffrey Smith, Washington & Jefferson College
Forwards and Backwards: A Method Influenced by Gauss

Summations of $\sin(n\theta)$ and $\cos(n\theta)$

8:10-8:25

Timothy Muller, Indiana University of Pennsylvania
Maximally non-matching covered graphs

Let G be a graph. G is said to be matching covered if for every edge e in G, there exists a perfect matching containing e. Infinite families of matching covered graphs are presented and proven. Let graphs be defined as "maximally non-matching covered" if they have only one edge not contained in any perfect matching. Conditions for which graphs are maximally non-matching covered are investigated and preliminary results are presented.

8:30-8:45

Jason L. Carney, Indiana University of Pennsylvania
A Sierpinski Curve Julia Set from 3-Circle Inversion

We will investigate a map derived from 3-circle inversion. Three circles of radius r are placed at the cube-roots of unity. Points z are inverted about each circle individually obtaining three inversion images. We define the image of z under "3-circle inversion" to be the arithmetic average of these three inversion images. For the parameters we will discuss, the geometric interpretation is weakened because the radius is purely imaginary. Finally, we will discuss the proof that the Julia set for our function with parameter $r = \frac{\sqrt{3}}{\sqrt[3]{2}} i$ is a Sierpinski Curve. Sierpinski curves are interesting from a topological point of view because they are a universal curve in the sense that there is a homeomorphic copy of any 1-dimensional curve embedded in any Sierpinski curve.

8:50-9:05

Paul Rossman and Jason Smith, Indiana University of Pennsylvania
Location of EMS Centers in Indiana County

Locating emergency medical service centers is a concern in any region of the country and also here in western Pennsylvania. EMS centers need to be placed in locations where medical personnel can reach the most people in the shortest amount of time. However, a cost is associated with building these centers. In our analysis, we examined this problem for Indiana County, Pennsylvania, using the centers for each of the county's 38 municipalities as locations. We used integer programming and set covering models to explore two versions of this problem. We first used the distances (in minutes) between the municipalities, and we then used populations of each municipality to weigh our original model to find optimum placement of EMS centers in the county.

Benedum Hall, Room 426

7:30-7:45

Alison McNary, Westminster College
Infinity and Beyond

The presentation will include a brief overview of the history and concept of infinity. Special attention will be brought to the different cardinalities (or sizes) among sets. These different sizes are often determined by whether or not a one-to-one correspondence between elements of two sets can be found. For example, the natural numbers have cardinality denoted $\aleph_0$, whereas the cardinality of the set of real numbers is often referred to as the continuum which is larger in "size." Focus will be put on a specific proof that will show that the continuum is equal to $2^{\aleph_0}$.

7:50-8:05

Randy T. Sylvester, Westminster College

Is Your Favorite Pitcher Going To Have A Winning Season?

I look at models of Major League Baseball pitcher's winning percentage from a math journal, then I try to recreate their model but, I run into problems and thus, I have to come up with a different way to model Major League Baseball pitcher's winning percentages using a different method which ends up being a better model in the end.

8:10-8:25

Andrew Polack, Westminster College

NURBS Curve Interpolation of Artistic Data

Non-Uniform Rational Basis Spline (NURBS) curves and surfaces have been used in the Computer Aided Design (CAD) industry since the early 1970s. Pixar's first major blockbuster, Toy Story, utilized NURBS to model all of the characters in the movie. While they are clearly highly powerful and expressive constructs, NURBS also are limited in some ways. The most pertinent limitation is that NURBS are an approximate technique which does not guarantee interpolation of a fixed number of data points. This makes converting polygon-specified artistic data into a set of NURBS curves and surfaces very difficult. Typically, NURBS are generated by artists using programs to manipulate the placement of the control points needed to specify the curves and surfaces. There are many existing artistic models which are not specified as a NURBS. How could one convert such a model (automatically, without human intervention) into a NURBS surface? I will explore one such answer to this question by examining a method to determine a NURBS curve from previously specified discrete artistic data via the analysis of mathematical curvature.

8:30-8:45

Andrew Perriello, Penn State New Kensington

Prime Number Boundaries

A well known theorem frequently studied in an undergraduate course on elementary number theory states that the nth prime number p is less than or equal to $2^{2^{n-1}}$ for all $n \geq 1$. Since this bound is so extremely weak, it gives one the feeling that this boundary can be improved upon. In this talk, that is precisely what we shall accomplish.

8:50-9:05

Kirsten Lockhart, Carnegie Mellon University

Candidate Series and Convergeability

This lecture outlines the properties and behavior of candidate series, a class of conditionally convergent series, some of which can be permuted to converge by rearrangements employing a finite number of blocks (summands).

Benedum Hall, Room 523

7:30-7:45

Mary Tryon, Penn State Behrend

The Growth Degree of a Limit of Replacement Graphs and its Connection to Fractals

A sequence of graphs may be generated by repeated iterations of a vertex replacement rule. In this talk, we define vertex replacement rules. We also define and calculate the growth degree of the limit of a particular sequence created by a vertex replacement rule. We observe that the growth degree coincides with the fractal dimension of a fractal related to this sequence and its limit. We conjecture that the growth degree of the limit of a sequence obtained by a vertex replacement rule always coincides with the fractal dimension of its related fractal.

7:50-8:05

Joe Pleso, Penn State Erie

Surreal Analysis of Go

The focus of this talk will be the application of surreal analysis to the game of Go. Surreal numbers are a superset of the real numbers, and can be explained through the use of sequences of trees. The game of Go is a two player board game, where the object is to capture the most territory. The motivation for this research was the lack of a superior computer algorithm to play the game. Our approach utilizes theories from surreal analysis to decompose the board into smaller boards to simplify the analysis. Using this technique will allow a larger class of positions to be analyzed. It is believed that with a better understanding of more positions, a more advanced artificial intelligence (AI) can be constructed. The results of this technique will be presented and explained. This talk is intended for a general audience.

8:10-8:25

Kyle White, Penn State Erie

Adding a Random Walk in Carrying Capacity to a Surplus Production Model

Pacific halibut are large flatfish weighing up to 500 pounds and a highly important commercial fishing industry. Currently the International Pacific Halibut Commission (IPHC) regulates halibut fishing levels in 6 regions of the Northern Pacific Ocean. We considered a difference equation model to predict commercial harvest based on biomass surplus production. Maximum likelihood techniques were used to fit each of the 6 regions simultaneously, comparing observed and predicted harvests. We attempted to improve the model by allowing the carrying capacity to take a bounded random walk from year to year. Markov chain Monte Carlo methods were used to determine prediction intervals for future halibut biomass levels, and the two models in general.

8:30-8:45

Zhiying Sun, University of Arizona

Propagation of Patterns on Plants

Plyllotaxis, namely the arrangement of phylla (leaves, florets, etc) has intrigued natural scientists for over four hundred years. Current theories and models of the formation of phyllotactic patterns at the plant apical meristem focus on either transport of the growth hormone auxin or the mechanical buckling of the plant tunica. Each of the mechanisms alone can give rise to an instability that leads to patterned states. However, it is known that the two mechanisms interact with each other instead of acting independently. We (Alan C Newell, Patrick Shipman and I) develop a model that incorporates the coupling of biochemistry and mechanics. Analysis of these equations shows that the coupling of the two mechanisms acts like a positive-feed-back system and relaxes the condition for primordium initiation. Also, on real plants, the pattern doesn't form all at once. Rather, the primordia are formed sequentially over time and gradually add to the existing pattern. Therefore, between the stable patterned state and the unstable non-patterned state, there exists a front that propagates with some finite velocity into the non-patterned state. I will discuss how this idea of front propagation coincides with a well-accepted conceptual model for phyllotaxis proposed a long time ago by Hofmeister and Snow&Snow.

8:50-9:05

Suzanne Pohland, University of Pittsburgh at Greensburg

Modeling the Number of Submitted College Applications as a Growth Curve

A model first introduced by Gompertz in 1825 to describe mortality tables has also been adapted to describe growth and aging. We use the Gompertz growth model to describe the number of applications submitted to our institution. Characteristics of the data are interpreted using the model parameters.

Benedum Hall, Room 525

7:30-7:45

Nicole Pernischova, Duquesne University

A Finite Element Approach to Model Electromagnetic Fields Scattered by a Buried Cavity

The talk will present a finite element solution for scattering of an incident plane wave by a cavity in a metallic sheet which is covered by a dielectric medium. The talk will provide an introduction to Maxwell's equations and their reduction to a two dimensional Helmholtz equation. Numerical examples which compute the scattered field distribution and the radar cross section will be provided.

7:50-8:05

Teresa Sano, Duquesne University

Sparsity and Redundancy in MRI Denoising

Recent work in the vision community has shown that images can be represented by a linear superposition of basis functions for which they admit a sparse representation. Finding such a representation can aid in many image processing problems. In this talk, we will examine how determing an optimal sparse, redundant representation of MRI (magnetic resonance imaging) images can aid in the denoising process. This involves solving a constrained optimization problem which can be solved using Orthogonal Matching Pursuit and Singular Value Decomposition, as proposed by Elad and Aharon. We will also discuss some of the challenges in extending this work to vectorial MRI images.

8:10-8:25

Yifan Zhao, Clarion University of PA

On the Unit Root Property of Some Celebrated Mathematical Constants

This paper examines the stationarity property in terms of a unit root in the framework of autoregression. We apply the ADF, PP, and KPSS models to the decimals of the three mathematical constants: π, exponential function with x=1(e^x=e) and φ. The results of the ADF test show that π, e and φ (α =1% and 5%) all exhibit nonstationary behavior in the first 400 decimals. Applying the PP test statistic, we reject the null hypothesis of existence of a unit root, for all three constants at 1%, 5% and 10% significance levels. The result of the KPSS test statistic indicates that all of the three constants' decimals are trend stationary except for e at α =10% where it may not be trend stationary. The results suggest that the widely-used unit root tests gives rather conflicting results on the three famed mathematical constants. As we take first differences on randomly wandering decimals, they become indeed stationary in all cases. It signifies that even if the decimals walk randomly without a purpose, their first differences are stationary with finite first and second moments. The conflicting results are puzzling as the ADF and the PP models are so widely used and share the same distributional properties.

8:30-8:45

Matthew Katz, Juniata College

The Many Tilings of a 2 x n Board

Tilings are a fun and visual way to view certain combinatorial problems. For example, the Fibonacci numbers can be represented as the number of tilings of 1 x n boards using dominos and squares. We can also define the Fibonacci numbers as the number of tilings of a 2 x n board using only dominos. Stemming from this, a question arises: do any patterns occur if we try to tile the 2 x n board using dominos and squares? What about dominos and squares of any number of colors or types?

8:50-9:05

Eric O. Korman, University of Pittsburgh

Clifford Algebras

In this talk we define Clifford algebras and talk about where they come up. Specifically, we discuss their algebraic significance in relation to the four real division algebras, their geometrical significance in relation to the orthogonal groups, and their use in mathematical physics.