MAA-SE at Belmont University, March 13-14, 2009

Poster Session

By Poster Number

Poster #1

Polynomials with All Real Zeros and Coefficients 1 or -1, Craig DeFelice, Western Carolina University
Abstract: Our goal is to find all polynomials with coefficients 1 or -1 that have only real zeros. The solution of the problem is divided in two parts. First we will show that the degree of such polynomials is less than or equal to three. Then we will determine all polynomials of degree less than or equal to three.

Poster #2

Traditional and Digraph Iterated Function Systems for Variations of Peano's Space-filling Curves, Jessica Stewart, Elon University
Abstract: This research takes two seemingly separate areas of mathematics-space-filling curves and digraph iterated function systems-and relates them to one another. Despite appearing very complex with their non-integer dimension, many fractals can easily be described using an iterated function system. Iterated function systems can also be used to describe the approximations of space-filling curves, whose limiting set is a given area in space. The path of many space-filling curves can also be described using a digraph iterated function system. The digraph iterated function system for a space-filling curve is found by mapping the individual coordinates against an independent variable, time. The digraph is formed by showing how the individual coordinate graphs against time are independent upon one another in higher approximations. The technique of finding the traditional and digraph iterated function systems for a space-filling curve was generalized for all space-filling curves, regardless of their dimension, from the example of Hilbert's two-dimensional space-filling curve. This generalized technique for finding the traditional and digraph iterated function system is applied to two-dimensional switchback and meandering Peano curves, two variations of the three-dimensional Hilbert curve, and a three-dimensional Peano switchback curve. The digraph iterated function system provided the foundation to create the parametric functions that produce the full Peano and Hilbert curves in Mathematica.

Poster #3

The 3-color problem, Ashley Sullivan, Spelman College
Abstract: The 3-color problem is a well known problem in graph theory. In this project we will use the technique of Gr'bner bases to give a condition on which a given graph is 3-colorable. We will also give some examples.

Poster #4

Pythagorean Triples and Compatible Pairs, Tim Doody, Coastal Carolina University
Abstract: This poster explores the connections between Pythagorean triples and compatible pairs of quadratic polynomials.

Poster #5

A Variation of Kayles', Natalie Walters, King College
Abstract: I use number theory to analyze and solve a problem that was recently published in a Mathematics magazine. In my paper I analyze a variation of the game called Kayles'. The goal of this game is to be able to make the last move. In analyzing the game it was necessary to use nim addition and to take a look at all the possible moves. If the player always makes a move in his advantage (plays to his/her advantage) then I have been able to determine whether or not he/she will win the game based on the value of n, where n is the number of spaces one can move at the beginning of the game.

Poster #6

Bounds for Fibonacci period growth, Alan Koch, Chuya Guo, Agnes Scott College
Abstract: The Fibonacci sequence modulo n for some positive integer n is necessarily periodic. We define Q(n) to be the ratio of the length of the period to n itself. We then study the range of Q(n) and also provide bounds for Q(n) which depend on the nature of the prime divisors of n.

Poster #7

On the Diameter of the Unidirectional Hyper-Stars, Sarah Anderson, Presbyterian College, Eddie Cheng, László Lipták*, Oakland University, Kelly Christensen, Asbury College, and Jennifer Diemunsch, University of Dayton
Abstract:
Star graphs were introduced as a competitive model to the hypercubes. Recently, hyper-stars were introduced to be a competitive model to both hypercubes and star graphs. The vertex set of the *hyper-star* $HS(n,k)$ is the set of all $\{0,1\}$-strings of length n with exactly k 1's, and two vertices are adjacent if and only if one can be obtained by exchanging the first symbol with a different symbol (1 with 0, or 0 with 1) in another position. These graphs have nice connectivity and structural properties, and their edges can be oriented to obtain unidirectional hyper-stars $UHS(n,k)$. In this paper, we will present computational results on finding the directed path between two vertices in $UHS(n,k)$, and prove an upper bound on its diameter.

Poster #8

Domination and Independence on the m by n Toroidal Chessboard by Rooks and Bishops, William Faust, Kennesaw State University
Abstract: A set $S \subseteq V$ is a dominating set of a graph $G = (V, E)$ if each vertex in V is either in S or is adjacent to a vertex in S. The domination number, $\gamma(G)$, is the minimum cardinality of a dominating set of G. A set $S \subseteq V$ is a total dominating set of a graph $G = (V, E)$ if each vertex in V is adjacent to a vertex in S. The total domination number, $\gamma_t(G)$, is the minimum cardinality of a total dominating set of G. A set $S \subseteq V$ is an independent set of a graph $G = (V, E)$ if all vertices of S are pairwise non-adjacent. The independence number, $\beta_0(G)$, is the maximum cardinality of an independent set of G. In this paper we compute these values for the rook and bishop on the toroidal $m \times n$ board.

Poster #9

Realizations of Graphs for Domination Ratios $k = \frac{\gamma_t(G)}{\gamma(G)}$ for all Rational $k \in [1, 2]$, Philip White, Kennesaw State University

Abstract: A set $S \subseteq V$ is a dominating set of a graph $G = (V, E)$ if each vertex in V is either in S or is adjacent to a vertex in S. A vertex is said to dominate itself and all its neighbors. The domination number $\gamma(G)$ is the minimum cardinality of a dominating set of G. A set $S \subseteq V$ is a total dominating set of a graph $G = (V, E)$ if each vertex in V is adjacent to a vertex in S. The total domination number $\gamma_t(G)$ is the minimum cardinality of a totally dominating set of G. An immediate bound on $\gamma_t(G)$ for graphs with no isolated vertices is $\gamma(G) \leq \gamma_t(G) \leq 2\gamma(G)$. Thus, for some rational $k \in [1, 2]$, $\gamma_t(G) = k * \gamma(G)$ or $k = \frac{\gamma_t(G)}{\gamma(G)}$. Examples of G that realize each boundary value are numerous. We show that every rational $k \in [1, 2]$ can be realized by some graph G. Total domination is just one of many flavors of domination. This poster will also present similar results for other domination parameters.

Poster #10

Graph Theory: The Alabama State University Postman Problem, Michael Wright, Alabama State University

Abstract: Graph theory is a branch of mathematics that is devoted entirely to graphical structures and their composition. Graph theory has many applications in science and industry and can be used to find a solution to any path-related problem. These applications are extended to several problems one being the Traveling Salesman problem. The Travelling Salesman problem is a Hamiltonian cycle. The purpose of this project is to find a Hamiltonian cycle for the Alabama State University Post Office thus simulating The Travelling Salesman problem.

Poster #11

Inverse Eigenvalue Problems Arising in Population Models, Tao-hsiang Chang, The Citadel

Abstract: In this project, we study the relation of a stable life-cycle model and eigenvalues of the matrix A the model is associated with. We have derived the conditions for elements of A for some stable life cycle models. Some of our proofs are based on MatLab simulation. Life cycle models of frogs with n stages (for n 3) are used to illustrate our results.

Poster #12

Solving system of polynomial equations, Anisah NuMan, Spelman College

Abstract: Let k be a field and k[x1, . . . , xn] be the polynomial ring in n-variables x1, . . . , xn with coefficients in k. We will use Gr'bner bases technique to solve a system of polynomial equations in k[x1, . . . , xn]. This is a generalization of solving a system of linear equations in Linear algebra.

Poster #13

A Registration Based Algorithm for the Classification and Identification of the Hispaniolan Amazon, Christina Camps, Thomas Redd, North Carolina A&T State University, Jonathan Bonin, Dominique Homberger, Louisiana State University

Abstract: The purpose of this research is to create an algorithm that will uniquely identify specific members of the Hispaniolan Amazon, part of the Psittacidae family, and computationally implement it. This quantitative morphology project involves pattern matching as opposed to pattern recognition due to the data being rigidly specified. We use the ridges of the cornified oral surface of the upper beak, which is diagnostic for psittaciform genera, as a basis for our match. The traditional method of identifying individual birds is a

process called "tagging" which involves securing a filament, an anchor tag, and an identification tag to the body of the birds. This is usually an invasive procedure whose results are not necessarily appropriate for pet owners and others who may be interested in identification and recovery. The approach proposed here is a non-invasive method for uniquely identifying members of the Hispaniolan Amazon. We start with a 2D image of a cast of the upper palate of an individual bird. The ridges found there are a distinctive feature of the Psittacidae family and are known to vary from individual to individual while staying consistent over time within an individual. We use genetic landmarks to represent the unique ridge structures. We then compare the birds based on these landmarks using established ridged image registration techniques. Using a sample of 27 birds, we create a database of birds based on their palate structures. We then perform single blind tests to determine if the identity of an unknown sample can be determined. As this should be independent of user, we will also investigate variability in user based landmark selection versus variability in the ridge pattern of the palates.

Poster #14

Cellular Automata, Genetic Algorithms, and Lights Out, Andrew Penland, Western Carolina University
Abstract: Structures known as cellular automata offer the prospect of using simple processes to approach complex problems. In recent years, some researchers have suggested using genetic algorithms to evolve cellular automata rules towards particular behaviors. We will explore using this approach to achieve desired states in certain systems, with applications to the classic electronic game Lights Out.

Poster #15

Modeling of the Fibonnaci Sequence in Plant Phyllotaxis, Olivia Hightower, Presbyterian College
Abstract: During the summer of 2008, four undergraduate students worked with professor Pau Atela of Smith College at the mathematical biology REU at Mount Holyoke College. We used Mathematica and Java programs to perform an in depth analysis of the appearance of the Fibonnaci sequence in plant growth. Many approaches were taken to create realistic mathematical models of the phyllotaxis. We then investigated the geometric and algebraic aspects of the models to understand the foundation of the plants' floral and leaf spiral patterns.

Poster #16

Wave Transformation, Danielle Tarpley, Coastal Carolina University
Abstract: Linear Airy Wave Theory models how waves change as they move from deeper to shallower water. This poster checks this model using data collected in Long Bay (off the coast from Myrtle Beach).

Poster #17

Determining Indeterminates Using Differentiation, Benjamin Briscoe, Cumberland University
Abstract: The goal of this work is to explore a new method of evaluating limits involving indeterminate differences. Specifically it will focus on differences of the type

$$\lim_{x\to\infty}(f(x)-g(x))$$

where

$$\lim_{x\to\infty} f(x) = \infty \text{ and } \lim_{x\to\infty} g(x) = \infty.$$

There are only three possible results: the first will be infinitely larger than the second, the second will be infinitely larger than the first, or the two will differ only by a constant. The accepted way to determine which of these occurs is to algebraically manipulate the difference into the form of

$$\lim_{x\to\infty} \frac{h(x)}{k(x)}$$

where

$$\lim_{x\to\infty} h(x) = \infty \text{ and } \lim_{x\to\infty} k(x) = \infty.$$

therefore allowing the use of l'Hospital's rule. This new method proposes that we should be able to determine which of these cases occurs by evaluating the difference of the derivatives of the two functions. The poster will provide the method for evaluation and their proofs.
The motivation behind the work is to be able evaluate these limits, which are most largely utilized in calculus and other branches of mathematical analysis, by methods which are more consistent with these areas of mathematics and require less algebraic manipulation.

Poster #18

Calculus: The Kissing Curves Connection, Natalie Rich, University of North Carolina - Asheville
Abstract: In this poster presentation, the Kissing Curves Theorem is introduced. Once established, this theorem can be used to prove the familiar differentiation shortcuts using only algebra and geometry. This approach may be more appropriate for a Calculus I audience than the traditional limit approach.

Poster #19

Variations on Conway's Game of Life, Stephen Nanney, Western Carolina University
Abstract: Conway's Game of Life is a cellular automaton that can yield periodically moving shapes and expanding patterns. The rules of the game are that any live cell with less than two or more than three neighbors dies in the next generation and any dead cell with exactly three neighbors becomes alive in the next generation. All other cells keep their state. The rules of the game determine which initial shapes grow or repeat. By changing different aspects of the rules, one can produce very different results from the same initial pattern. This shows that the outcome of the game depends sensitively both on different beginning patterns within the same set of rules and on different sets of rules using the same beginning pattern.

Poster #20

Using Modulo Properties to Show Divisibility in Different Base Systems, Michael Branson, Georgia College and State University
Abstract: The base ten system has properties that allow for easy recognition of certain numeral's divisibility. In order to easily check a numeral's divisibility by 2, 3, 5, 9, we can observe specific characteristics of the numeral's presentation. This demonstration will concentrate on the application of similar properties to show divisibility in base 12, base 20, and base 60. Historically, base 20 and base 60 were utilized by the Myans and the Babylonians, respectively, and base 12 appears in a variety of contexts.

Poster #21

Properties of Special Structured 2x2 Matrices over Z_p, Joshua Zimmer, The Citadel

Abstract: Special structured real matrices such as symmetric, skew-symmetric, orthogonal, nilpotent, idempotent, stochastic, and rank-one matrices, have many interesting properties. When a special structured matrix is over a finite field Z_p, where p is a prime number, does it still have all properties as it does in real? In this paper, we will present eigenvalue properties of 22 special structured matrices with entries in Z_p.
