2010 Conference Schedule

9:00-10:00: Registration-Atrium

10:00-10:30: Breakfast and Introduction-Atrium

	Room 1062	**Room 1111**	**Room 1106: Mathematical Biology**
10:30-10:45	Jodi Haponski	Mario Sracic	Joshua Mike
10:50-11:05	Kyle Jury	Jamie Parker	Moriah Wright
11:10-11:25	Emily Cunningham, Josh Fitzgerald & Aron Siegel	Sarah Ritchey	Ian Morrison
11:30-11:45	Zachary Hopkins	Ben Mackey	Lisa Curll

11:50-12:50: Lunch-Atrium

	Room 1062	**Room 1111**	**Room 1106**	**Room 1120: COMAP**
1:00-1:15	Benjamin Pearce	Paul Kuberry	Timothy Clos	MCM-A
1:20-1:35	Katherine Varga	Ben Nowicki	Matt Grimm	MCM-A/B
1:40-1:55	Paul Havens	Kristen Hendershot		MCM-B

2:00: Closing Remarks-Atrium

Morning Session 10:30-10:45

10:30-10:45 **Jodi Haponski** **Room 1062**

The Application of Markov Chains in the NFL

Clarion University
Advised by: Dr. Dana Madison

Markov Chains are a powerful tool in predicting outcomes in a variety of interest areas. They consider probabilities from one event to another regardless of the occurrence of any previous events. Due to this characteristic, Markov chains are commonly used to predict an outcome after a given event occurs. I created two Markov chains in application to the Pittsburgh Steelers' offense. These Markov chains contain properties that are helpful in determining the probabilities of each play, comparing games, and determining the likelihood and expected values of sequences of consecutive plays.

10:30-10:45 **Mario Sracic** **Room 1111**

Finding Volume and Surface Area of Hyperspheres

Youngstown State University
Advised by: Dr. J. Douglas Faires

The volume of a sphere of radius R in $\mathbb{R}^3$ is $V_3(R) = 4/3\pi R^2$ and the surface area of this sphere is $SA_3(R) = 4\pi R^2 = D_R V_3(R)$. We consider whether it is true that for all positive integers n, the derivative of the volume of a hypersphere in $\mathbb{R}^n$ with respect to its radius gives it surface area. While doing so we discover an interesting inconsistency in standard calculus.

10:30-10:45 **Joshua Mike** **Room 1106**

The Senktide Effect on the Dynamics of Pyramidal Neurons

Youngstown State University
Advised by: Dr. Jozsi Jalics

Senktide is a drug that increases firing activity in prefrontal cortex layer V pyramidal neurons. In order to investigate this response, we developed a biophysically based model incorporating the multiple currents affecting the firing activity of these neurons. This model was compared to our experimental data, obtained from whole cell patch recordings of the neurons ín vitro,ín order to determine the currents sensitive to senktide. Additionally, the model was analyzed using dynamical systems techniques to determine the mechanisms of the senktide response.

Morning Session 10:50-11:05

10:50-11:05 **Room 1062**

Kyle Jury
Interval Arithmetic Computation of Julia Sets
Edinboro University
Advised by: Dr. John Hoggard

Fractals are complex images that do not reduce in complexity upon magnification of small sections. The image itself is typically defined by a simple function which is calculated repeatedly on a computer. Unfortunately, the nature of computers leaves the accuracy of these computations up in the air. All computers have some machine epsilon under which numbers cannot be represented, unless arbitrary precision coding is implemented. Even with arbitrary precision, the memory of the machine is limited, and thus the precision. This project seeks to guarantee accuracy of the computed fractal by using interval arithmetic. The interval arithmetic is implemented using the C-XSC library for scientific computations. Future plans include the optimization of the program, as well as implementing the ability to do side-by-side comparisons of different methods for computing the fractals.

10:50-11:05 **Room 1111**

Jamie Parker
Formula for Evaluating Cecil Rousseau's Trigonometric Sum
Youngstown State University
Advised by: Dr. Thomas Smotzer

I will present the process in finding a formula to calculate the sum of

$$\cos^{(2n)} 1^\circ + \cos^{(2n)} 2^\circ + \ldots + \cos^{(2n)} 89^\circ$$

where n is a positive integer.

10:50-11:05 **Room 1106**

Moriah Wright
Mathematically Modeling Cardiac Myocytes
Youngstown State University
Advised by: Dr. Jozsi Jalics

Life-threatening cardiac arrhythmias are caused by irregular firing (electrical) activity in cardiac myocytes, muscle cells. Long QT Syndrome is one such condition that increases susceptibility to arrhythmias in which cells have longer action potential durations and EADs (Early After Depolarizations), abnormal increases in membrane potential during the plateau phase of the action potential.

We investigate the mechanisms for arrhythmogenic activity through to a biophysically based mathematical model of cardiac action potentials that accounts for the numerous types of currents involved as well as calcium dynamics.

Morning Session 11:10-11:25

11:10-11:25 **Room 1062**

Emily Cunningham, Josh Fitzgerald and Aron Siegel

Factoring Using Alternative Arithmetic

Clarion University
Advised by: Dr. Jon Beal

We will be discussing the alternative arithmetic devised last year known as "Circle Math". We have taken the basic arithmetic operations devised in this method and have applied them to polynomials. We will focus on factoring these alternative polynomials using our derived quadratic formula.

11:10-11:25 **Room 1111**

Sarah Ritchey

Determining an n^{th} Degree Polynomial From Only Two Points - Is This Possible?

Youngstown State University
Advised by: Dr. Nathan Ritchey

Students of mathematics learn how to determine an equation of the line that intersects two particular points and how to determine an equation of the parabola that intersects three particular points. Some students even learn how to determine the equation of an n^{th} degree polynomial that intersects $n+1$ distinct points.

It turns out that if the coefficients of an n^{th} degree polynomial are all non-negative and if two specific points where the polynomial intersects are known, then it is possible to completely determine an equation that completely represents that polynomial. In this presentation, a method for determining these coefficients is given, along with an outline of a proof that the method works.

11:10-11:25 **Room 1106**

Ian Morrison

Brain Size to Body Mass Ratios in Primates

Cleveland State University
Advised by: Dr. Leah Gold

One area of interest in the biological sciences is exploring the mathematical relationship between brain size and body mass in animals. The primates are a large order with over 233 species, and their body masses and brain sizes vary greatly between species. A 375 lb gorilla's body is 4000 times as massive as a 1.5 oz mouse lemur, but that gorilla's brain is not 4000 times as large. However, a gorilla's brain is obviously much larger overall. Is there a measurable relationship between body mass and brain size in primates? In 2008, Isler, et al. collected large amounts of high-quality data in order to create a database for comparative analysis of primate brain size. I reproduced one of Isler's results, calculation of the exponent of the power function in the body mass/ECV relationship using least squares regression curve fitting and logarithmic scale plots of the data.

Morning Session 11:30-11:45

11:30-11:45 **Zachary Hopkins** **Room 1062**

Predicting Patterns in the Rolls of a Single Die

Slippery Rock University

Advised by: Dr. Richard Marchand

The purpose of this presentation is to show how to compute the expected number of rolls required for all faces of a 6-sided die to appear at least once. I make use of the properties of the geometric probability distribution and the linearity property of the expected value operator to derive the result. Supporting simulations are also presented.

11:30-11:45 **Ben Mackey** **Room 1111**

Singular Value Decompositions of Tridiagonal Nearly Normal Matrices

Kent State University

Advised by: Dr. Laura Smithies

The behavior of normal matrices is very well studied. In particular, nearly normal matrices can be completely characterized by their singular value decomposition. In this talk, we define a class of matrices to be nearly normal if its commutant with their Hermitian adjoint has rank 2. In the case of tridiagonal matrices, we explore the eigenvalues and eigenvectors of these matrices and prove a result concerning their singular value decompositions analogous to what we know about normal matrices.

11:30-11:45 **Lisa Curll** **Room 1106**

Response to Toxic Metals - The Process of Survival

Youngstown State University

Advised by: Dr. George Yates

As a nuclear weapons plant rushed to outproduce the Soviets during the Cold War, it knowingly released tons of toxic material into the environment. How did the local bacteria deal with this sudden rush of lethal metal? We will focus on the element Selenium and its affect on a wild-type and mutant strain of Enterobacter. Their growth will be detailed in response to toxic selenite using a system of ordinary differential equations.

Afternoon Session 1:00-1:15

1:00-1:15 **Room 1062**

Benjamin Pearce

Deal or No Deal?

Slippery Rock University
Advised by: Dr. Robert Buck

This is a statistical analysis of the game show, "Deal or No Deal?" The expected values of the remaining dollar amounts on the playing board throughout the game will be compared to the actual offer made by the banker. Trends will be discussed and a regression and residual analysis will be presented. While the exact formula for how the banker comes up with his offer has not been found, one can come up with a very good idea has as to what he will offer each contestant after each round.

1:00-1:15 **Room 1111**

Paul Kuberry

Interesting Patterns in Cantor's Matrix

Clarion University
Advised by: Dr. Dana Madison and Dr. Michael McConnell

When Cantor proved a one-to-one correspondence between the natural numbers and the rational numbers, he used a matrix in which each entry was defined with the numerator equal to the column number, and the denominator equal to the row number. By traversing the diagonals of this matrix he established the one to one correspondence he was seeking. When this same matrix is turned clockwise 45°, it forms a triangle with each new row taking the form:

$$\frac{1}{(n)}, \frac{2}{(n-1)}, \ldots, \frac{n}{1}.$$

The locations of reducible and irreducible fractions create a triangle with interesting patterns in the rows, columns, and diagonals. Some of these patterns can be used to eliminate the possibility of a number having certain factors.

1:00-1:15 **Room 1106**

Timothy Clos

The Differential Geometry of Gear Teeth

Cleveland State University

Gear tooth profiles must meet certain requirements to ensure they mesh properly with minimal vibration. Surfaces that ensure this are called conjugate surfaces. Although conjugate surfaces are developable surfaces with zero Gauss curvature, they have other defining characteristics, such as the proportionality between the normal curvature and the speed of the directrix of the surface. We will investigate how ruled surfaces are conjugate surfaces and in particular when they have an involute profile. Then we will examine the relationship between the curvature of the involute profile and its speed. We will conclude by showing how all three types of gears (rollers, spur and helical) have certain generalizations that can be inferred from a mathematical perspective.

Afternoon Session 1:20-1:35

1:20-1:35 **Room 1062**

Katherine Varga

Greater Than Sudoku and Partially Ordered Sets

Kent State University
Advised by: Dr. Stephen Gagola

Greater Than Sudoku, a variation of the Sudoku game you all know and love, provides inequalities rather than number clues. In this talk we will explore the mathematics of partially ordered sets in order to learn more about the inequality arrangements within the blocks of a Greater Than Sudoku puzzle.

1:20-1:35 **Room 1111**

Ben Nowicki

Molecular Symmetry: An Application of Group Theory

Youngstown State University
Advised by: Dr. Angela Spalsbury

Chemistry and abstract mathematics may seem to be unrelated but one link between these subjects exists in molecular symmetry. Chemists often consider a molecule's symmetry which reveals properties of the molecule. When chemists want to represent a molecule's symmetries they use a branch of mathematics called group theory. We will demonstrate the symmetry operations on common molecules and determine the group associated with a molecule's symmetries.

1:20-1:35 **Room 1106**

Matt Grimm

Undirected Graphs of Hermitian Matrices that Admit Only Two Distinct Eigenvalues

Kent State University
Advised by: Dr. Charles R. Johnson and Dr. Paul McMichael

We consider the problem of determining those n-vertex graphs that admit a Hermitian matrix with only two distinct eigenvalues, k and $n-k$. After giving some general algebraic characterizations of such dual multiplicity graphs, two major graph theoretical necessary conditions are given. The dual multiplicity graphs on fewer than 6 vertices are also determined.

Afternoon Session 1:40-1:55

1:40-1:55 **Room 1062**

Paul Havens
History of Continuity
Kent State University
Advised by: Dr. Beverly Reed

A brief history of continuity, beginning with Ancient Greek perspectives and leading up to modern definitions. Highlights include the abandonment and subsequent acceptance of infinitesimal-defined continuity.

1:40-1:55 **Room 1111**

Kristen Hendershot
Exploration of Level Sequences in Labyrinths
West Liberty State University
Advised by: Dr. Hollie Buchanan

We will discuss labyrinths and a specific type of maze. Counting these is generally (famous and) quite difficult. However, a particular collection I considered was tractable, interesting, and may shed light on the general problem.

2010 MCM / ICM - COMAP Modeling Problems

Continuous Modeling (Problem A)

Explain the "sweet spot" on a baseball bat. Every hitter knows that there is a spot on the fat part of a baseball bat where maximum power is transferred to the ball when hit. Why isn't this spot at the end of the bat? A simple explanation based on torque might seem to identify the end of the bat as the sweet spot, but this is known to be empirically incorrect. Develop a model that helps explain this empirical finding.

Some players believe that "corking" a bat (hollowing out a cylinder in the head of the bat and filling it with cork or rubber, then replacing a wood cap) enhances the "sweet spot" effect. Augment your model to confirm or deny this effect. Does this explain why Major League Baseball prohibits "corking"?

Does the material out of which the bat is constructed matter? That is, does this model predict different behavior for wood (usually ash) or metal (usually aluminum) bats? Is this why Major League Baseball prohibits metal bats?

Discrete Modeling (Problem B)

In 1981 Peter Sutcliffe was convicted of thirteen murders and subjecting a number of other people to vicious attacks. One of the methods used to narrow the search for Mr. Sutcliffe was to find a "center of mass" of the locations of the attacks. In the end, the suspect happened to live in the same town predicted by this technique. Since that time, a number of more sophisticated techniques have been developed to determine the "geographical profile" of a suspected serial criminal based on the locations of the crimes.

Your team has been asked by a local police agency to develop a method to aid in their investigations of serial criminals. The approach that you develop should make use of at least two different schemes to generate a geographical profile. You should develop a technique to combine the results of the different schemes and generate a useful prediction for law enforcement officers. The prediction should provide some kind of estimate or guidance about possible locations of the next crime based on the time and locations of the past crime scenes. If you make use of any other evidence in your estimate, you must provide specific details about how you incorporate the extra information. Your method should also provide some kind of estimate about how reliable the estimate will be in a given situation, including appropriate warnings.

In addition to the required one-page summary, your report should include an additional two-page executive summary. The executive summary should provide a broad overview of the potential issues. It should provide an overview of your approach and describe situations when it is an appropriate tool and situations in which it is not an appropriate tool. The executive summary will be read by a chief of police and should include technical details appropriate to the intended audience.

2010 PME National Meeting at MAA MathFest

Please join us at this year's meeting to be held August 5 through August 7, 2010, in Pittsburgh, Pennsylvania. Students are invited to give fifteen minute talks on any mathematical topic or application in areas such as statistics, computing, or operations research. Topics including expository research, interesting applications, problems, etc. are also welcome. Transportation reimbursement is also available to those who qualify. Visit the National Pi Mu Epsilon website at `http://www.math-pme.org` for more details.

A Warm Welcome to the Participating Schools:

- Clarion University of Pennsylvania
- Cleveland State University
- Edinboro University of Pennsylvania
- Kent State University
- Lakeland Community College
- Slippery Rock University
- West Liberty State College
- Westminster College
- Youngstown State University

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