# 2014 PME Conference Schedule

### 9:00–9:40: Registration & Breakfast - Third Floor, Room 3427/3422

### 9:40–9:50: Welcome & Introduction - Third Floor, Room 3422

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<th>Time</th>
<th>Room 2201</th>
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<td>10:00-10:15</td>
<td>Jordan Awan</td>
<td>Luke Carabbia</td>
<td>Monica Ciarniello</td>
<td>Michael Baker</td>
<td>Elias Thompson,</td>
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<td>and Jonathan Ouimet</td>
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<td>Alex Walter-Higgins</td>
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<td>and David Poling</td>
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<td>10:20-10:35</td>
<td>Reuben Jarrell</td>
<td>Timothy Lorion</td>
<td>Curtis Shilling</td>
<td>Sarah Fugate</td>
<td>Emily Hoopes</td>
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<td>and Jenna Wise</td>
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<td>10:40-10:55</td>
<td>James Munyon</td>
<td>Corinne Sidor</td>
<td>Michael Bauer</td>
<td>Brandon Mosley</td>
<td>Jennifer Glaspell,</td>
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<td>11:00-11:15</td>
<td>Shane Bradford</td>
<td>Anthony Brzozowski</td>
<td>Amber Hill</td>
<td>Josiah Banks</td>
<td>Eric Shehadi</td>
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<td>and Lamar Bigsby</td>
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<td>and Tim Shaffer</td>
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<td>11:20-11:35</td>
<td>Dorothy Klein</td>
<td>Christian Rotko</td>
<td>Emily Waller</td>
<td>Shawn Doyle</td>
<td>Jordan Ewing</td>
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<td>11:40-11:55</td>
<td>Megan Chambers</td>
<td>Jenna Huston</td>
<td>Anthony Massaro</td>
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### 11:55–12:50: Lunch - Third Floor, Room 3422

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<td>12:50-1:05</td>
<td>Jenna Gordon</td>
<td>Danielle Faggioli</td>
<td>Greg Clark</td>
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<td>1:10-1:25</td>
<td>Elliot Golias</td>
<td>Gabrielle Jennings</td>
<td>Sarah Ritchey</td>
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<td>1:30-1:45</td>
<td>Megan Kunst</td>
<td>Blain Patterson</td>
<td>Kristi Yazvac</td>
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### 1:50: Closing Remarks - Third Floor, Room 3422
The card game SET serves as an excellent model for the finite geometry $AG(4,3)$. Using that model, previous researchers have found partitions of $AG(4,3)$ into 4 disjoint maximal caps along with a distinguished point/card. We define a new geometric object, a demicap—a maximal cap can be written as the union of two disjoint demicaps. We will present results about these demicaps, which provide insight into the maximal cap partitions of $AG(4,3)$.

In this talk we will discuss the mathematics behind the setup of the board of Connect Four and the strategy for playing and winning a perfect game.

In this talk, we solve Pi Mu Epsilon Problem 1276 proposed by Mihaly Beneze. The problem considers when real numbers $a, b, c > 0$ can be side lengths of a triangle, and is based on satisfying an inequality.

Employing linear algebra, we shall use the Transfer Matrix Method to study the amplitude and phase of transmitted light in each layer of films obtained from Case Western Reserve University, highlighting profound dispersive effects in the reflection bands of the films.

Presenting our solution for COMAP question B. Our team is David Poling, Alex Walter-Higgins, and Elias Thompson. This year’s COMAP problems are provided on Page 13 of this abstract book.
10:20-10:35

Reuben Jarrell
A Locally Euclidean Space Need Not be Hausdorff
Edinboro University
Advised by: Dr. Rick White

After giving some preliminary definitions, an example of a locally Euclidean space which is not Hausdorff will be given.

10:20-10:35

Timothy Lorion and Matt Lysyj
Students Teaching Students: Really, How?
Cleveland State University
Advised by: Dr. Susan Carver

Exploration of the concept of undergraduates teaching other undergraduates as peer mentors in mathematics. This includes a multitude of benefits for both the teacher and student, which tend to be long lasting. To some extent we have all experienced this benefit resulting from peer-to-peer interaction, and we’d like to share with you our experiences!

10:20-10:35

Curtis Shilling
\[
\sum_{i=1}^{\infty} i = -\frac{1}{12}
\]
Clarion University
Advised by: Dr. Michael McConnell

I watched a video online of a physicist from the University of Nottingham going through a process of showing that the summation of the natural numbers to infinity is equal to a negative one twelfth. I will show this process and then go back through the steps and show where there are flaws in his reasoning.

10:20-10:35

Sarah Fugate
Fractals and Fractal Dimension
Westminster College
Advised by: Mr. James Anthony

According to John Hart, a fractal is a geometric pattern or figure that is recurring. Fractal X was created using two functions: a scaling function and a rotating function combined with a translation. Once Fractal X was created, the fractal dimension was calculated. In this talk, the techniques and process of calculating the fractal dimension of Fractal X will be discussed.

10:20-10:35

Emily Hoopes, Cassandra Shaffer, and Jenna Wise
Making the Grade: Best Coaches of All Time
Youngstown State University
Advised by: Dr. Paddy Taylor

This year’s COMAP problems are provided on Page 13 of this abstract book.
NFL team data from the 2013–2014 regular season was used to attempt to create a rating system for the teams that reflects scoring differences between pairs of teams when they played each other. These “point spreads” are different than the point spreads that people in the betting world are familiar with, which are designed to maximize betting activity and bookmaker profit, not to accurately predict game score differences. We instead are interested in team ratings reflecting team scoring differences as closely as possible.

Operation STEM is a forthcoming program that is significantly improving the way math is learned and taught. After only one semester of implementation, Operation STEM has tremendously impacted statistics and other aspects one would not have imagined. With such great results, this program is one worth keeping.

An educational talk discussing Fibonacci numbers, Fibonacci type sequences, and the generation of these sequences will first be given. Then, a console application project will be executed that can generate any Fibonacci type sequence given the value and location of two numbers in the sequence.

We will, through the use of probabilities and statistical analysis, examine whether the sacrifice bunt in baseball actually increases the chance of scoring a run, and formatted to look at the games events as a Markov chain. The calculations will done using computer simulated games, expected run probabilities, and the concept of a break even percentage. It is expected that in most cases it is better not to bunt.

There is a policy on most multilane highways stating that drivers must remain in the rightmost lane unless they are passing another vehicle. We propose an alternative method in which each lane is assigned a minimum speed and passing is not allowed. By modeling the traffic flow in both cases, we have shown that our method is more efficient and continues to work in higher traffic density.
Morning Session 11:00-11:15

11:00-11:15 Room 2201
Shane Bradford
Topological Properties of an Arithmetic Metric Space
Edinboro University
Advised by: Dr. Rick White

A metric using divisibility properties is defined on the set of natural numbers. Several topological properties of the resulting metric space are investigated.

11:00-11:15 Room 2202
Anthony Brzozowski and Lamar Bigsby
Operation STEM: Changing How Students Tackle Math
Cleveland State University
Advised by: Dr. Candice Quinn

Have you ever wondered what is missing from a traditional math class? By organizing more time for hands-on, engaged learning with STEM Peer Teachers students are demonstrating an improved mastery of material. Stop by and hear what techniques and materials Operation STEM is using to improve the quality of math education at Cleveland State University.

11:00-11:15 Room 2203
Amber Hill
Rational Numbers and Their Decimal Expansions
Westminster College
Advised by: Dr. David Offner

The topic of this talk is the decimal expansions of rational numbers. We clarify when these rational numbers produce terminating decimals and the exact point at which termination occurs. We show why other rational numbers have eventually repeating decimals and explain the characteristics of their periods and prefixes. An application of Abstract Algebra is shown to aid in determining the period of a decimal expansion. Once the period of a unit fraction of a prime denominator is determined, we use other methods to identify the period of a fraction when given the prime factorization of the denominator. Despite much research and the methods suggested in this talk, determining the exact period of a unit fraction with a prime denominator still remains a very difficult problem within the realm of number theory.

11:00-11:15 Room 2204
Josiah Banks
An Algebraic Theorem of Frobenius and its Applications
Youngstown State University
Advised by: Dr. Thomas Wakefield

Frobenius is a widely known mathematician that has provided many great theorems. Frobenius’ Algebraic Theorem states that if \( d \) is a divisor of the order of a finite group \( G \), then the number of solutions of \( x^d = 1 \) in \( G \) is a multiple of \( d \). In this talk we will discuss this theorem and many of its applications in number theory and group theory.
In this paper, a cellular automaton based model is presented that tests the viability of left lane passing laws, which require drivers to stay in right hand lanes unless passing other drivers, under various conditions. This situation lends itself to modeling with cellular automata because of the roughly grid-like layout of multi-lane highways and because of the local decision making processes employed by drivers on a road, which include consideration for nearby drivers, highway surface conditions, distractions, etc. The cellular automaton model, written in LISP, is tested under variable conditions tuned using published experimental data. General trends were observed in averages of trials performed using Monte Carlo techniques that elucidate probable relationships between actual, observable variables. The most thoroughly studied variable was the effect of left lane passing laws on traffic systems. Due to the nature of left lane passing laws, an increase in variability for drivers on the road is observed in the model. Drivers pass each other more frequently and the model reflects this with worse safety conditions and more congestion for drivers. The safest laws would have no restrictions on driver lane choice, reducing the variability of the traffic system and positively affecting driver experience.
When looking at a polynomial $p$ of degree $k$ with $n$ variables, we want to know if there is a way to estimate the maximum value of the polynomial when $x \in [0, 1]$ using the leading coefficients of the simple terms. While finding the maximum of polynomials with low degree and few variables can be solved through calculus, finding the maximum of more complex polynomials becomes increasingly difficult. We studied homogeneous polynomials of degree 2 where the leading coefficients were all positive and homogeneous polynomials of degree 4 with both positive and negative leading coefficients in order to find more accurate coefficient estimates.

Brazilian Jiu Jitsu is a martial art based around the idea that someone of a smaller stature is able to defeat a larger opponent. This consists of submission moves including joint-locks and choke holds. This study inspects a move from each category: the arm bar, a subgroup of the joint-locks, and the strangle chokehold. Both are viable ways to submit an opponent. The arm bar can be looked at as applying torque about the elbow to make your opponent uncomfortable or end up with a broken arm. The strangle chokehold are slightly more complex considering you have to apply enough pressure to reduce the blood flow to their brain and either have them pass out of tap. Using conversions and percentages we can see how quickly it can take to pass someone out.

By the Four Color Theorem, we know all maps can be face-4-colored and edge-3-colored. There is a one to one correspondence between the number of edge-3-coloring and face-4-colorings. By a result of Gwynn, we know that a map that is uniquely colorable contains exactly three Hamiltonian circuits. In this paper, we will explore the properties of maps that contain exactly three unique Hamiltonian circuits. In addition, we will prove that maps that contain exactly three Hamiltonian circuits and have less than 12 vertices must be uniquely colorable.

We will explore representatives of finite group families to gain a better understanding of how a group’s center affects its classification. Appeals are made to Lagrange, Sylow, and Abel to create a typology for finite groups of small order.
We are going to show that forcing drivers to follow the Keep-Right-Except-To-Pass Rule is more effective for traffic flow, more economically favored, and saves more lives per year than allowing drivers to choose either lane. This will be proven by relating the amount of times that an automobile shifts lanes to pass a car in scenarios with and without the Keep-Right-Except-To-Pass Rule to the amount of accidents that are likely to occur. The main variables we will focus on are the density of traffic and the varying amount of space between clusters of cars on the highway.

In order to properly assess the performance of the rule all outside factors must be controlled. To make this possible our model is a hypothetical one mile strip of highway where only the two most valuable pre-mentioned variables that are able to have an effect. These two variables are allowed to change over a certain range, determined as the limits of our model, to display the effectiveness of the rule. We ran the model multiple times with the same changes in variables and the only variance was Keep-Right-Except-To-Pass rule, to gather data on the differences between them.

Displaying our results graphically highlights the benefits of the rule. With the assumptions made throughout the model design, the amount of money that gets saved is approximately $1000 dollars for every accident that was prevented. Congestion can be reduced by roughly 2 hours per accident. Finally, when using our model at the highest rate of traffic, nearly 5 lives a day can be saved. Along with justifying these claims we will be looking at other uses for our model, such as the implementation of robotically controlled vehicles, and the ability for other countries, such as Great Britain and Australia, to use this same model through simple adjustments. Overall, the KRETP rule is not only more economically favored and leads to better traffic flow, but it is also a way to save lives and needs to be preserved.
Morning Session 11:40-11:55

11:40-11:55  
Room 2201  
Megan Chambers  
Queuing Systems at Disney World  
Youngstown State University  
Advised by: Dr. Thomas Wakefield

Queuing theory is the mathematical study of queues, or waiting lines. It is a subject that strongly lends itself to real-world applications. This talk discusses one of these applications: examining wait times for attractions at Disney World. A mathematical model of a Disney attraction will be presented and implemented, and Disney's current operations research technology will be discussed.

11:40-11:55  
Room 2202  
Jenna Huston  
Neural Network Hidden Layer Size  
Westminster College  
Advised by: Dr. David Offner

Artificial neural networks (ANN) are computational models inspired by the brain. This talk will give a brief overview of ANNs including how networks learn through weight changing schemes and details about network configuration. Determining the optimal number of nodes in the hidden layer(s) of an ANN is a very difficult problem. Rules of thumb have been determined, but there is not an exact way to decide this. We seek to find the optimal hidden layer size of a data set by simulating training ANNs with 2-7 nodes in the hidden layer to a mean squared error of 0.01 and 0.1. We then eliminate some of the training data and use it as test data to test the network for overtraining. We find the optimal hidden layer size is 3 nodes when using a mean squared error of 0.01 or 0.1. We also found a correlation between very large and very small connection weight values for networks that did not train to the desired mean squared error and got stuck at the same mean squared error.

11:40-11:55  
Room 2203  
Anthony Massaro  
An Intersecting Chords of a Circle Problem  
Youngstown State University  
Advised by: Dr. Thomas Smotzer

In this talk Pi Mu Epsilon Journal Problem 1281 is solved. The problem is concerned with the property of circles, mainly intersecting chords and the triangles they produce.

11:40-11:55  
Room 2205  
COMAP Modeling Discussion

All are welcome to discuss this year’s COMAP problems and potential solutions to both the discrete and continuous problems. This informal session is meant to share ideas and strategies for the approach to the problems, which are provided on Page 13 of this abstract book.
The mathematical card games Set and Planet are introduced and explained. Then, various properties of a comet from the game Planet are explored.

The Fibonacci sequence is a well-known sequence to those familiar with mathematics. However, the sequence has some interesting characteristics not known to many. The Fibonacci sequence appears in nature in the most fascinating ways.

Given two sets of integers, \( A \) and \( T \), we define the operation of set addition to be \( A + T = \{ a + t : a \in A, t \in T \} \). Suppose that \( A \) is finite in size and \( T \) is constructed such that \( A + T = \mathbb{Z} \). In this talk we will explore the relationship between \( A \) and the density of \( T \). In particular, we will present a new proof technique for proving the density of \( T \) for a fixed \( A \).
Afternoon Session 1:10-1:25

1:10-1:25 Room 2201
Elliot Golias
Going Beyond a Putnam Problem
Kent State University
Advised by: Dr. Fedor Nazarov

With many Putnam problems presenting ideas beyond the scope of a sufficient solution, we investigate a solution to such a problem that reveals the eigenvalues, eigenvectors, and determinants of circulant matrices.

1:10-1:25 Room 2202
Gabrielle Jennings
Folding Cubes
Edinboro University
Advised by: Dr. Douglas Pularic

This presentation investigates the maximum size of a cube that can be folded from a given rectangular sheet of paper. The 11 nets of a cube were considered as the base for folding the cube. The discovery incorporated the use of Geogebra to conclude which net is to be used to maximize the size of the cube given the dimensions of the rectangular sheet of paper.

1:10-1:25 Room 2203
Sarah Ritchey
Duplicate Bug Detection
Youngstown State University
Advised by: Dr. Alina Lazar

Open source projects heavily rely on users to report technical issues or bugs in the software. Occasionally, multiple users will report the same bug. The extra effort to fix these duplicate bugs puts a tremendous strain on software developers. Therefore, detecting duplicates before assigning them to be fixed is essential. This presentation describes an improved method for automatic duplicate bug report detection based on new textual similarity features and binary classification.
This presentation is about how math relates to the linear perspective used in art. It explains how to use mathematical perspective as outlined in “Viewpoints: Mathematical Perspective and Fractal Geometry in Art” by Marc Frantz and Annalisa Crannell. This involves first plotting points on a three-dimensional grid and then using similar triangles to translate the 3D data into two dimensions. This process results in an image that corresponds with the rules of linear perspective drawing traditionally utilized by artists. This presentation specifically describes how I utilized mathematical perspective and, with the aid of Excel, created two paintings of the same still life with different intended viewing distances. It also points out the distortions caused by viewing a painting or drawing from a viewing distance that the artist did not intend.

We will discuss some common examples of transcendental numbers, such as $e$ and $\pi$, and prove that they are in fact transcendental. By first showing $e$ is transcendental and using Euler’s formula, we quickly prove the transcendence of $\pi$.

In this talk, we will use the digits of $\pi$ to generate sounds using MATLAB. We will talk about sampling, the physics of sound, and how to program the digits. We will be using a 12-tone scale, representing the 12 different notes in the chromatic scale. Also, we will program other famous numbers.
Continuous Modeling (Problem A)
The Keep-Right-Except-To-Pass Rule

In countries where driving automobiles on the right is the rule (that is, USA, China and most other countries except for Great Britain, Australia, and some former British colonies), multi-lane freeways often employ a rule that requires drivers to drive in the right-most lane unless they are passing another vehicle, in which case they move one lane to the left, pass, and return to their former travel lane.

Build and analyze a mathematical model to analyze the performance of this rule in light and heavy traffic. You may wish to examine tradeoffs between traffic flow and safety, the role of under- or over-posted speed limits (that is, speed limits that are too low or too high), and/or other factors that may not be explicitly called out in this problem statement. Is this rule effective in promoting better traffic flow? If not, suggest and analyze alternatives (to include possibly no rule of this kind at all) that might promote greater traffic flow, safety, and/or other factors that you deem important.

In countries where driving automobiles on the left is the norm, argue whether or not your solution can be carried over with a simple change of orientation, or would additional requirements be needed.

Lastly, the rule as stated above relies upon human judgment for compliance. If vehicle transportation on the same roadway was fully under the control of an intelligent system—either part of the road network or embedded in the design of all vehicles using the roadway—to what extent would this change the results of your earlier analysis?

Discrete Modeling (Problem B)
College Coaching Legends

Sports Illustrated, a magazine for sports enthusiasts, is looking for the “best all time college coach” male or female for the previous century. Build a mathematical model to choose the best college coach or coaches (past or present) from among either male or female coaches in such sports as college hockey, football, baseball or softball, basketball, or soccer. Does it make a difference which timeline horizon that you use in your analysis, i.e., does coaching in 1913 differ from coaching in 2013? Clearly articulate your metrics for assessment. Discuss how your model can be applied in general across both genders and all possible sports. Present your model’s top 5 coaches in each of 3 different sports.

In addition to the MCM format and requirements, prepare a 1-2 page article for Sports Illustrated that explains your results and includes a non-technical explanation of your mathematical model that sports fans will understand.

2014 MCM-COMAP Participants from YSU

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2014 PME National Meeting at MAA MathFest

Please join us at this year’s meeting to be held August 6 through August 9, 2014, in Portland, Oregon. This meeting will be the official celebration of PME’s Centennial and will include special celebratory events. 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.

Ohio Section of MAA Spring Meeting at the University of Toledo

The Ohio Section of the Mathematical Association of America will hold its annual spring meeting at the University of Toledo on Friday, April 4 and Saturday, April 5, 2014. The meeting consists of talks by mathematics faculty, graduate students, and undergraduates from around the state. The Section especially welcomes talks and participation by undergraduate students. In addition to student talks, there is an undergraduate problem solving competition with cash prizes, and a pizza party. We encourage you to give a talk at the meeting or participate in the competition or pizza party.

If you are participating in the problem solving competition, we ask that you register at: http://constum.ohiomaa.org/

If you have any questions, please do not hesitate to contact Tom Wakefield by phone 330-941-1395 or by email tpwakefield@ysu.edu.
A Warm Welcome to the Participating Schools:

- Boardman High School
- Capital University
- Case Western Reserve University
- Clarion University of Pennsylvania
- Cleveland State University
- Edinboro University of Pennsylvania
- Fairmont State University
- Franklin Area Middle/High School
- Howland High School
- John Carroll University
- Kent State University
- Lake Erie College
- Penn State Erie
- Slippery Rock University
- The University of Akron
- University of Georgia
- West Liberty University
- Westminster College
- Youngstown State University

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Dr. Thomas Wakefield
Dr. George Yates

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Special thanks to the Department of Mathematics and Statistics and the Center for Undergraduate Research in Mathematics (CURMath) at Youngstown State University.