2024 PME Conference Schedule

9:00–9:45: Registration & Breakfast - Williamson 3422/3423

9:45–10:00: Welcome & Introduction - Williamson 3422/3423

Matthew Commons, YSU PME Chapter President

	Williamson 2212	Williamson 2205
10:00-10:15	Aran Bybee	Kieran Clark (COMAP)
10:20-10:35	Carolyn Klima	James McGlone (COMAP)
10:40-10:55	Justin Atkinson	COMAP-MCM
11:00-11:15	Natalie Dando	COMAP MCM
11:20-11:35	Zach LaFrankie	COMAP MCM
11:40-11:55	Asia Morgenstern	COMAP MCM

11:55–12:50: Lunch - Williamson 3422/3423

	Williamson 2212	Williamson 2205
12:50-1:05	Leah Brennen	Jay Lugo
1:10-1:25	Isabelle Seewald	Jacek Strotz and Zachary Perrico
1:30-1:45	Liam Yates	Benjamin Phillips

1:45: Closing Remarks - Williamson 3422/3423

Morning Session 10:00-10:15

10:00-10:15 **Aran Bybee** **Williamson 2212**

Is the Solar System Stable?

Slippery Rock University
Advised by: Dr. Joshua Ballew

In 1885, King Oscar II of Sweden announced a challenge consisting of four mathematical problems, one of which asked whether the solar system would continue its clock-like motion, or would it stray from that, to either fly off into the void or crash into the Sun. The selected winner for this problem, Henri Poincaré, showed that even for a 3-body system, the orbits could behave so chaotically that it would be impossible to predict their long term futures. This work laid the seeds for what would become the branch of mathematics known as chaos theory, in which the ideas of stability, instability, and chaos became formalized. This talk aims to explain some of the background knowledge needed in order to determine whether a system is stable or is chaotic, and how that can be applied to celestial bodies such as Pluto.

10:00-10:15 **Kieran Clark** **Williamson 2205**

Searching for Submersibles

Youngstown State University
Advised by: Dr. Paddy Taylor

This paper presents a method for finding a lost submersible after it has lost contact with its host ship. This was accomplished using an ordinary differential equation, to predict the location of a submersible after some time from only knowing its location and velocity when the communications were lost. After this, we developed a system to search for the submersible that goes in an Archimedes spiral centered at the point we predicted, and implemented it in Matlab, to model the movement of the submersible and the area we are searching in. We used our simulator to determine how accurate our models were for both searching and locating. We also looked into different equipment that could be useful in searching for the lost submersible. Through an examination of trial results, we found that our model becomes less applicable the longer it takes to get started with the search. The model we designed took the form of:

$$x(t) = (1/0.315)\ln(0.31t + (1/v(0))).$$

When we tested our model using MATLAB we returned a 19% success rate in finding our submersible, we believe this to be a result of a fault in our method of analysis rather than our model.

Morning Session 10:20-10:35

10:20-10:35 **Carolyn Klima** **Williamson 2212**

The Quarterback Quandary: A Clustering Approach

Cleveland State University

Advised by: Dr. Sandra Hurtado Rua

Teams in the National Football League (NFL) have outwardly demonstrated an affinity for collecting information on college draft prospects in order to predict quarterback performance since the inception of the NFL Combine. With the high prevalence of sports media and the increasing legalization of sports betting, a rising number of audiences besides the 32 NFL teams now hold stakes on the accomplishments of the team signal caller. This provides motivation to develop better quarterback performance prediction models, along with improved methods of defining quarterback success. While prior models focused on quantitative explanatory variables to predict quarterback success, we considered additional qualitative factors such as the quarterback's college major, what college division their school belonged to, and whether or not they were recipients of certain collegiate achievement awards. Using unsupervised learning and a comprehensive dataset, we will cluster the data and determine which explanatory variables are useful in partitioning the quarterbacks into clusters. We will also assess the correlation between the clusters and three measures of quarterback success: games played, Pro Bowl selection status, and ESPN total QBR.

10:00-10:15 **James McGlone** **Williamson 2205**

The Search for a Lost Submersible

Youngstown State University

Advised by: Dr. Joshua Ballew

This model is to be used in the search and rescue of underwater submersibles in the Ionian Sea, particularly in the bay off the coast of Greece. This is where the majority of shipwrecks have occurred. The submersible will follow a route to see these shipwrecks, which ensures that the model knows what direction the sub will drift towards using tangent calculations of its last known location. The model will use sonar and last known locations of the sub, as well as kinematics equations based on the calculated drag that the water induces on the wandering sub to calculate the location of the sub at a given time. Using these calculations, the tracking ships on the surface of the water will be able to deploy submersible sonar detectors near this calculated position to search for the submersible at any depth. The bay is relatively shallow, so the submersible will be found in this radius of the given point and safely secured by the ships. This model is extremely general, but it can be expanded upon with different routes. It is mainly focused on the business side of MCMS because of the importance of the bay between the Ionian islands and Greece.

Morning Session 10:40-10:55

10:40-10:55 | **Justin Atkinson** | **Williamson 2212**

A Statistical Analysis of Home Field Advantage in the NFL

Youngstown State University

Advised by: Dr. Lucy Kerns

Many experts believe the National Football League (NFL) is a league in which being the home team poses a significant advantage. Home field advantage (HFA) is a widely debated topic because of the many different factors that affect HFA. The main purpose of this study is to investigate if home field provides a statistical advantage in the NFL, measured by a significant difference between the average winning percentage of games played at home and on the road. The data set used in the analysis consists of 320 football games from the 2013-2022 seasons for the National Football Conference (NFC). Two-way Analysis of Variance (ANOVA) was conducted to determine if there is a significant difference between winning percentages at home and away. Our results indicate that the average winning percentage at home is significantly higher than that on the road, suggesting a statistically significant home field advantage. We further performed t-tests to see if location affects the outcome for each individual team in the conference, and we found that two teams, Minnesota Vikings and Green Bay Packers, experienced a home field advantage.

10:40-10:55 | **COMAP Modeling Discussion** | **Williamson 2205**

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.

Morning Session 11:00-11:15

11:00-11:15 | **Natalie Dando** | **Williamson 2212**

Applications of Google's PageRank Algorithm: Predicting Tennis Outcomes

Youngstown State University

Advised by: Dr. Paddy Taylor

Google's PageRank is the algorithm developed by Larry Page and Sergey Brin to sort search results by relevance based upon the link structure of the Internet. The mathematical backbone of PageRank is Perron's Theorem, and the Power Method is used to implement the algorithm. While Google uses PageRank to rank its webpages, our project uses the algorithm to rank American men's tennis players. Our tennis ranking system can compete with the current systems in predicting tennis match outcomes, even outperforming the other systems at predicting American vs. American matches.

11:00-11:15 | **COMAP Modeling Discussion** | **Williamson 2205**

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.

Morning Session 11:20-11:35

11:20-11:35 | **Zach LaFrankie** | **Williamson 2212**

Directed Graph Burning

Westminster College

Advised by: Dr. Adam Blumenthal

Graph burning is an iterative process on graphs that serves as a simplified model for the spread of a contagion or influence throughout a network. Directed graph burning is an extension of this process which adapts the use of directed edges to represent interactions in unilateral relationships. The directed burning number of a graph $\vec{G}$, denoted $b(\vec{G})$, is the minimum number of iterations needed to burn all vertices in the graph. In this presentation we will prove bounds for $b(\vec{G})$ for a large family of general directed graphs.

11:20-11:35 | **COMAP Modeling Discussion** | **Williamson 2205**

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.

Morning Session 11:40-11:55

11:40-11:55 | **Asia Morgenstern** | **Williamson 2212**

Leaky Power Domination: Solving the 1-Leaky Tree

Westminster College

Advised by: Dr. Adam M. Blumenthal

Power domination was first introduced as a way to model how phasor measurements units observe a network. We say that a set of initially colored vertices S is a power dominating set if and only if we can color an entire graph by iteratively applying a color-change rule akin to zero forcing. The power domination number $\gamma_P(G)$ is the smallest number of vertices that must be initially colored to ensure that the entire graph is colored. In this talk, we will introduce a variant of power domination called ℓ-leaky power domination and will determine the 1-leaky power domination number of trees.

11:40-11:55 | **COMAP Modeling Discussion** | **Williamson 2205**

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.

Afternoon Session 12:50-1:05

12:50-1:05 **Leah Brennen** **Williamson 2212**

Factors Contributing to College Dropouts:
A Logistic Regression Analysis

Youngstown State University
Advised by: Dr. Lucy Kerns

Student dropout is a common problem that poses a major concern for all types of education. In this study, we employ logistic regression to investigate important factors that may affect student dropout in higher education. For the purpose of this study, dropout is defined as students either leave their initial field of study or transfer to another institution. We use data collected from Portalegre Polytechnic Institute (PPI) between 2008/2009 and 2018/2019, which contain information on five factors: field of study, age at enrollment, displacement status, scholarship status, and gender. Results show that while displacement status lacks significance, gender, scholarship status, age at enrollment, and field of study are significant predictors. Male students, older enrollees, and those in IT/engineering are more likely to drop out, whereas females, scholarship recipients, younger students, and those in health/social sciences or education are more likely to graduate. These findings emphasize the importance of tailored interventions to improve retention rates and inform policymakers and institutions on strategies to support students and enhance educational outcomes. Ongoing research will refine these strategies to adapt to changing educational needs.

12:50-1:05 **Jay Lugo** **Williamson 2205**

Modeling and Printing Solids
from Calculus II 'Volume by Slicing' Problems

Siena Heights University
Advised by: Dr. Nathaniel Iverson

With the increasing accessibility of 3D printing, models and ICT tool use are seeing more serious consideration for educational applications. We explore the application of 3D modeling and printing to Calculus II 'volume by slicing' problems. In these problems, students use integration to find the volume of an object given its base shape and the shape of a cross-section which remains consistent throughout the object. These objects are difficult to visualize for students and difficult for instructors to represent further than a sketch. We have developed a Sage program that generates 3D models of these types of objects based on the parameters a user provides. We have generalized our model to work with any regular polygon cross-sections. Our findings will be published as a free resource for use by educators and students. We hope this will improve this topic's instruction by making the modeling and printing process more accessible.

Afternoon Session 1:10-1:25

1:10-1:25 **Isabelle Seewald** **Williamson 2212**

Factors Influencing the Choice of Seeking
Formal Mental Treatment for Tech Employees in the United States

Youngstown State University
Advised by: Dr. Lucy Kerns

Mental illness is becoming much more prevalent in today's society. Many people have mental illnesses that they refuse to get treatment for. People who suffer from mental illness may have trouble with everyday tasks and work. In this study, we examined survey data collected from 750 tech employees in the United States, including age, gender, family history, number of employees at the company and more. Multiple logistic regression analysis was conducted to identify various factors that play a large role in employees seeking treatment for their mental illness.

From our logistic regression analysis, we found that gender, family history of mental illness, work interference of mental illness, and the care options provided by the company are significant factors in how often employees seek treatment for their mental health. Specifically, we found that males are more likely to seek treatment than females. Having a family history of mental illness is significant in people seeking treatment. People that found their mental health interferes with work often and rarely are more likely to search for treatment than those whose work is never interfered with. Those who know what care options are provided by their company have more of a tendency to look for treatment than those who don't know the care options and those who have no care options at work.

1:10-1:25 **Jacek Strotz and Zachary Perrico** **Williamson 2205**

Unlocking the Potential:
Exploring Multidimensional Turing Machines for Advanced Theoretical Computation

University of Mount Union
Advised by: Dr. Katie Ritchey

In this research endeavor, we embark on an exploration of multidimensional Turing Machines (MTMs), a fascinating frontier in computational theory. Unlike traditional Turing Machines confined to a one-dimensional tape, MTMs extend computation into infinite dimensions, opening up promising avenues for tackling intricate problems. Our investigation delves into the intriguing traits of MTMs, probing their computational ability and efficiency. Through both analysis and hands-on experimentation, we seek to explore MTMs, unraveling their theoretical foundations and practical implications across diverse domains such as basic arithmetic, cellular automata, and image construction. By investigating the intricacies of MTMs, we aspire to discover more about a theoretic model of computation and how it relates to pure mathematics, graph theory, and hyperspatial geometry.

Afternoon Session 1:30-1:45

1:30-1:45 **Liam Yates** **Williamson 2212**

Explaining and Expanding The Hawk Dove Problem

University of Pittsburgh at Greensburg
Advised by: Dr. Gary Hart

Using slight changes to traditional game theory models of economic interaction, modeling new and unmodeled interactions becomes possible. The hawk-dove game is traditionally used to model the development of predatory behavior in nature. If the rules of the game are changed to reflect that resources are, in some instances, limited, can other predatory behaviors can be modeled?

1:30-1:45 **Benjamin Phillips** **Williamson 2205**

Self-Referential Paradoxes, Superposition,
and the Pinch Points of Logic

Pennsylvania Western University–Clarion
Advised by: Dr. Daniel Shifflet

Our methods of logical, scientific, linguistic, and mathematical reasoning suffer from a common but basal flaw. This flaw leads consistently to paradoxes of a common structure and of a common behavior. These paradoxes all result from the extremes of self-reference, and lead to either the oscillation of truth, or the super-position of truth. We have taken examples from a wide swathe of fields in order to demonstrate both the similarity of these paradoxes, as well as the generalizable nature of these failures to logic as a whole. Analyzing this we have come to the conclusion that our logical syntax is lacking. This could be by way of misrepresentation via false dichotomization, or through the complete foundational weakness of our reasoning.

2024 MCM-COMAP Participants from YSU

Ty Holland Hayden Landfair Dac Gia Phu Ho	Caitlin Schumann Jacob Wolf
Shrijan Aryal Ayden Marbaugh Jayanta Pandit	Charles Kaufman Chris McCrimmon James McGlone
Kieran Clark Daniel Roch Drew Stworzydlak	

Ohio Section of MAA Spring Meeting at Ashland University

The Ohio Section of the Mathematical Association of America will hold its annual spring meeting at Ashland University on Friday, April 5 and Saturday, April 6, 2024. 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 `330-941-3302` or by email `tpwakefield@ysu.edu`.

A Warm Welcome to the Participating Schools:

- Carlow University
- Cleveland State University
- Lake Erie College
- Lakeland Community College
- Pennsylvania Western University - Clarion
- Penn State Erie, The Behrend College
- Siena Heights University
- University of Mount Union
- University of Pittsburgh at Greensburg
- Westminster College
- Youngstown State University

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Dr. Thomas Madsen

Dr. Thomas Wakefield

Funding for this conference is provided by the YSU College of STEM and National Pi Mu Epsilon Honor Society.

Special thanks to National PME, Dean Wim Steelant, the College of STEM, the Department of Mathematics and Statistics, and the Center for Undergraduate Research in Mathematics (CURMath) at Youngstown State University.