2021 PME Conference Schedule

9:45–9:55: Welcome & Introduction

Jonathan Feigert, YSU PME Chapter President

	Room 1	Room 2	Room 3	Room 4	Room COMAP
10:00-10:15	Alex Schroeder	Johnathan Koch	Nikitas Missos, Derek Miller, James Lagese, Morgan Weinreber, and Madison Ricciuti	Gina Colla	COMAP-MCM (F) Micayla Schambura, Elizabeth Lees and Mikayla Dokos
10:20-10:35	Marcia Hawkins-Day	Vanessa Reilly	Jessica Harness-Koehnle		COMAP-ICM (D) Aniket Singh
10:40-10:55	Dominic Fryman	Nicholas Adduci	Joseph Grantham		COMAP-MCM (B)
11:00-11:15	Montana Ferita	Chase Reiter	Philip Cuthbertson		Dawson Brindle
11:20-11:35	Dallas Freeman	Mason Martuccio	Simon Richard		Eric Babcock
11:40-11:55	Web Charles	Aleah Hughes	Simon Richard		Vu Truong

12:00: Closing Remarks

Morning Session 10:00-10:15

10:00-10:15 **Room 1**

Alex Schroeder

Kuratowski's Closure-Complement Theorem

iSTEM/Lakeland Community College
Advised by: Dr. Carl Stitz

Both the closures and complements of a set are recurring topics used throughout topology. While often used in conjunction with other operations, some interesting results begin to occur when they are used exclusively with each other. In 1922, Polish mathematician Kazimierz Kuratowski sought to find the maximum number of distinct sets that could be produced by these two operations. His answer–Kuratowski's Closure-Complement Theorem–is what we will explore in this presentation, going step by step to prove the result.

10:00-10:15 **Room 2**

Johnathan Koch

Defining the Permutation Group

Youngstown State University
Advised by: Dr. Thomas Madsen

In this presentation, I will present and justify a definition of a cycle within the permutation group. It is then proved that there exists a formula for the order of a product of disjoint cycles and that a cycle cannot be written as the product of disjoint cycles. Finally, an alternate criterion for a cycle is established:

$$\sigma \in S_n \text{ is an m-cycle } \Leftrightarrow X_\sigma = \{\sigma(a)^i \,|\, 0 \leq i < m\} \; \forall a \in X_\sigma$$

10:00-10:15 **Room 3**

Nikitas Missos, Derek Miller,
James Lagese, Madison Ricciuti, and Morgan Weinreber

Gartley Patterns

Youngstown State University
Advised by: Dr. Moon Nguyen

10:00-10:15 **Room 4**

Gina Colla

To Major or Not To Major in Mathematics

Youngstown State University
Advised by: Dr. Richard Goldthwait

I will be doing a statistical analysis where I will make up sensible figures to represent an unbiased sample of data on the number of mathematics majors (at YSU) and the number of non-mathematics majors (at YSU), while also I will make up the percentages every year of how many mathematics majors change their majors to something else and how many non-mathematics majors change their major to mathematics. I will use Markov chains, which is an application of Eigenvalues and Eigenvectors, and the made up figures to show over the long term, how the student population (at YSU) would be distributed between mathematics majors (at YSU) and non-mathematics majors (at YSU). In this presentation, the assumption will be made that we are not dealing with certain circumstances, such as double majors (etc.).

The presentation will include

1. A brief history of Markov chains and the like.
2. A theoretical description of the mathematics involved in the process.
3. An example of a real-life application.

10:00-10:15 **Room COMAP**

Micayla Schambura, Elizabeth Lees, and Mikayla Dokos

COMAP Problem F: Checking the Pulse and Temperature of Higher Education

Indiana University of Pennsylvania
Advised by: Dr. John Chrispell

As part of the COMAP International Contest in Modeling a study of Tertiary educational systems was conducted. Tertiary education systems are responsible for educating adults to ensure a nation has continued economic and social development. Our work involved designing a model to evaluate any nation's tertiary education system. Using fifteen randomly selected countries, we ranked education systems based upon five criteria: government funding and support, the social progress index, enrollment, tuition cost, and outbound student mobility. Using our model we determined potential ways to improve the tertiary education system in the United States. We assessed our model by comparing our theoretical scores versus renowned educational ranking systems.

Morning Session 10:20-10:35

10:20-10:35 **Room 1**

Marcia Hawkins-Day
Using A Point Flow Model
to Rank the WHAC Women's Basketball Conference
Siena Heights University
Advised by: Dr. Nate Iverson

Sports teams are ranked in a variety of ways such as polling/voting, point accumulation, and win-loss records. This presentation is about using the flow of points to rank basketball teams. A unique ranking is guaranteed whenever the conditions of the Perron-Frobenius theorem are met. We expect this would be the case for most basketball conferences or divisions. As a case study, we rank the teams within the WHAC Women's basketball conference for the 2018-19 and 2019-20 regular seasons.

10:20-10:35 **Room 2**

Vanessa Reilly
How to Draw a Straight Line
Youngstown State University
Advised by: Dr. Richard Goldthwait

How does one draw a straight line? Many would argue to simply utilize a ruler or straight edge. While this technique is widely accepted as correct, how can one be sure that the ruler or straight edge is indeed producing a straight line? As every other Mathematical proposition, the idea of constructing a straight line must be proved. The idea of creating a straight line seems to be a simple concept for Math students all over the world. However, the proof and history behind this phenomenon is quite enticing. What proves to be even more interesting is the model that is used to prove this theory.

10:20-10:35 **Room 3**

Jessica Harness-Koehnle
What Are the Odds? The Math behind Egyptian Cat Slapping
iSTEM Geauga Early College High School
Advised by: Ms. Moriah Wright

Card games are an age old way to pass time. Finding ways to win at poker and Blackjack have led to elaborate mathematical strategies to help predict the odds of whether a certain action will prove favorable. Over the course of the pandemic, I spent hours busting boredom with family game nights. Motivated to win, I became curious about whether or not similar math strategies that are used in Poker and Blackjack could be applied in other card games. I selected Egyptian Cat Slapping (also known as Catalonian Cat Slapping) for study and analyzed the statistics before determining the best counting strategy with a similar idea as the Blackjack counting system. In Egyptian Cat Slapping, all the cards are dealt and then the players go around in a circle laying their cards down as the game progresses. To win a player must collect the entire deck of cards. This is done by slapping anytime a pair, a pair separated by a single card (called a sandwich) or a jack appear. Instead of using the probability of getting a card that will help, which is the major component in the Blackjack counting system, I used the system to compute the probability of pairs and sandwiches in the card game. Being better able to predict when a pair or sandwich appears since they yield a slap increases a player's chances of winning the game. Being able to predict the odds of needing to slap helps increase the probability that you will slap the cards before the other players increasing your chances of winning.

10:20-10:35 **Room COMAP**

Aniket Singh
The Music of Networks (COMAP Problem D)
Youngstown State University
Advised by: Dr. Thomas Wakefield

Complex social systems can be modeled using network graphs. In this paper, we have modeled the evolution of music and the influence of previously produced music on new music and musical artists represented through a complex directed graph network. We made three different networks to study the

music influence: musical influence among the artists, genre influence and decade wise influence in the music evolution. K-means clustering algorithm was used to classify artists and genres into different categories, and time series analysis was done to model the evolution of music and its influence.

Morning Session 10:40-10:55

10:40-10:55 **Dominic Fryman** **Room 1**

A Markov Chain Analysis of the Game Doubles and Twos

Siena Heights University

Advised by: Dr. Nate Iverson

In this talk we describe the dice game doubles and twos and use Markov chain analysis to describe the probability of winning, the average number of turns in a game, and how we could modify the game to try to make it fun.

10:40-10:55 **Nicholas Adduci** **Room 2**

An Investigation into Visual and Geometric Representations of Prime Numbers

Youngstown State University

Advised by: Dr. Thomas Wakefield

This paper will reconceptualize the natural numbers by creating a novel geometric basis for their representation. Once this is achieved, the paper will go on to describe two different visual representations of the natural numbers against a grid. The first representation will organize the natural numbers in accordance with the novel geometric basis that has been established, whereas the second representation will display the natural numbers in terms of their coprimality relationships. Both visual representations contained herein will elucidate patterns that relate to the distributions of the prime numbers. New terminology and specialized functions will be developed in order to formalize the perceived patterns in the visual arrangements. Finally, the specialized functions contained herein will be used to establish mathematical relationships with respect to the structure of the prime numbers.

10:40-10:55 **Joseph Grantham** **Room 3**

Diving into Fluid Dynamics: The Navier-Stokes Equations

Lakeland Community College

Advised by: Dr. Paul Zachlin

How can a system of equations be so simple that it can be written in a matter of seconds, but so complicated that questions about it have remained unsolved for centuries–even with a million-dollar bounty? The Navier–Stokes equations just turned two hundred years old, so let's celebrate by taking a deeper look at the system and then forming several results that are central to our understanding of fluid dynamics.

10:40-10:55 **COMAP Modeling Discussion** **Room COMAP**

All are welcome to discuss this year's COMAP problems and potential solutions. This informal session is meant to share ideas and strategies for the approach to the problems, which are provided on Page 11 of this abstract book.

Morning Session 11:00-11:15

11:00-11:15 **Room 1**

Montana Ferita
Not Your Normal Fibonacci Sequence
Westminster College
Advised by: Dr. John Bonomo

The Fibonacci sequence is perhaps the most well-known sequence in the field of mathematics. In the Fibonacci sequence each element in the series is the sum of the previous two numbers. We will denote the first two numbers in the series as a and b, where a is less than or equal to b. Given a number n we seek to find the smallest positive value b such that n appears in the Fibonacci series starting with a and b. One can determine a and b given n by performing an exhaustive search for various combinations of a and b. We investigate quicker methods than this brute force approach for n values with certain properties.

11:00-11:15 **Room 2**

Chase Reiter
Spirographs and MATLAB
Youngstown State University
Advised by: Dr. Thomas Smotzer

Spirographs are fun and interesting graphics that can be modeled using trigonometric equations. Using the engineering compiler software MATLAB, we can model various kinds of spirographs using the plot function.

11:00-11:15 **Room 3**

Philip Cuthbertson
An Asymptotic Markov Chain Analysis of Monopoly
Siena Heights University
Advised by: Dr. Nate Iverson

The popular board game of Monopoly is an interesting game to study mathematically and is the subject of this presentation. We are interested in what happens as the game goes on indefinitely, specifically we want to find the long term behaviours of player positions around the board, and the proportion of the game that a player spends on each space. In our analysis we accomplished this by using Markov Chains and their stationary distributions.

11:00-11:15 **Room COMAP**

Dawson Brindle
New Methods for the Iteration and Visualization of the Mandelbrot Set
Embry-Riddle Aeronautical University
Advised by: Dr. Mitch Hamidi and Dr. Lara Ismert

For each complex polynomial, one can define an associated Julia set by iterating the given polynomial at a "seed" and studying the boundedness of the resulting sequence. In the first part of this talk, we discuss the famous Mandelbrot set, which arises from studying certain functions' Julia sets. We introduce a new method for generating the Mandelbrot set by replacing polynomials with matrices and seeds with vectors. Last, we state a theorem that shows an interesting connection between a complex number's membership in the Mandelbrot set and the boundedness of an associated family of matrices. In the second part of this talk, we introduce an analogous matrix method for generating Julia sets and give a conjecture that would extend our result for the Mandelbrot set case.

Morning Session 11:20-11:35

11:20-11:35 **Room 1**

Dallas Freeman
Discrete Polylogarithms
Fairmont State University
Advised by: Dr. Tom Cuchta

The polylogarithm is a special function of which a special case includes the famous Riemann zeta function, and it has applications to quantum statistics and mechanics. There has been recent interest in discrete analogues of special functions, and considering the discrete analogue of the polylogarithm has led us to some interesting results. In this talk, we will define these functions, examine their similarity to the traditional polylogarithm, and consider some results that stem from their hypergeometric representations.

11:20-11:35 **Room 2**

Mason Martuccio
Generalizing 2019 Putnam Problem A4
Youngstown State University
Advised by: Dr. Thomas Smotzer

In this project we examine whether a continuous real function on $\mathbb{R}^3$ that has the property that its surface integral over any unit sphere vanishes must be identically 0. We also generalize our result to $\mathbb{R}^n$ for $n > 3$.

11:20-11:35 **Room 3**

Simon Richard
Modeling with Differential Equations: Episode 1–SCUDEM V Problem B
Lakeland Community College & iSTEM Geauga ECHS
Advised by: Dr. Carl Stitz

Have you ever wondered why pumping your legs on a swing makes you swing higher, or how the bird in this video (`https://www.youtube.com/watch?v=F1P6IWPOJ18`) manages to keep the wheel spinning? That last question was asked by SCUDEM V Problem B, the problem my team chose to answer during SCUDEM V 2020, a national differential equations competition for undergraduates.

In this presentation I will discuss the model my team developed for that competition and the results we found. The original solution video can be found here: `https://www.youtube.com/watch?v=4WnvBlyFIPk`. For a more in depth explanation of our analysis, see *Modeling with Differential Equations: Episode 2 - Numerical Analysis with Python.*

11:20-11:35 **Room COMAP**

Eric Babcock
New Methods for the Iteration and Visualization of Julia Sets
Embry-Riddle Aeronautical University
Advised by: Dr. Mitch Hamidi and Dr. Lara Ismert

For each complex polynomial, one can define an associated Julia set by iterating the given polynomial at a "seed" and studying the boundedness of the resulting sequence. In the first part of this talk, we discuss the famous Mandelbrot set, which arises from studying certain functions' Julia sets. We introduce a new method for generating the Mandelbrot set by replacing polynomials with matrices and seeds with vectors. Last, we state a theorem that shows an interesting connection between a complex number's membership in the Mandelbrot set and the boundedness of an associated family of matrices. In the second part of this talk, we introduce an analogous matrix method for generating Julia sets and give a conjecture that would extend our result for the Mandelbrot set case.

Morning Session 11:40-11:55

11:40-11:55 **Room 1**

Web Charles

Major League Baseball Statistics and Analysis

Youngstown State University
Advised by: Dr. Lucy Kerns

This study was researched and developed on determining what MLB statistics can help predict the success of a Major League Baseball team making the playoffs. There is also research and analysis on determining whether there is mathematical evidence to support claims in recent years of the official MLB baseball composition contributing to the significant increase in home runs hit. These two questions were addressed and analyzed with a logistic regression model for helping predict a team's success in making the playoffs for the 2019 baseball season. Within this model, there are three main components of an MLB baseball game that guided this regression model. Home runs, strikeouts, and fielding errors were in the chosen study variables to help guide the prediction model for the 2019 season. 2019 was also the year of the home run as the entire league once again set a new MLB record for the most home runs hit by all the batters throughout the season. 6776 home runs were hit in the 2019 MLB regular season by batters on all teams. This increase even caused the Major League front office to study if there was a change in the production and composition of the game balls used throughout the regular season. This study will not examine the baseball composition but will be using Statcast measures of exit velocity from players hitting to try and assess if the baseball is being "juiced." Meeting the minimum criteria to be considered for the study, a Wilcoxen signed-rank test and signed-rank test were conducted using SPSS to determine whether or not there was a significant difference in the average exit velocity of these 251 hitters when comparing the 2018 and 2019 seasons. Home runs and fielding were significant predictors of success in MLB teams making the playoffs in this research. There is also significance in the claims that there was a change in the MLB baseballs. The Wilcoxen signed-rank test and signed rank test provided a test statistic significant in differences between the 251 players between the 2018 and 2019 average exit velocities.

11:40-11:55 **Room 2**

Aleah Hughes

Nine Point Circle

Youngstown State University
Advised by: Dr. Richard Goldthwait

This research goes through a proof of the nine point circle in any triangle. First I will go through the proof of there is a unique circle that contains each vertex of a right triangle. This will be used to identify points of a triangle to prove they create one unique circle. I will prove that the midpoints of each side, the feet of each altitude, and the Euler points all lie on one unique circle. This proof utilizes properties of rectangles, parallel and perpendicular lines, Thales' theorem, and other properties to show the proof. The last part of this proof shows that for any triangle, the orthocenter, the circumcenter, and the nine point center all lie on one line with the nine point center being the midpoint.

11:40-11:55 **Room 3**

Simon Richard

Modeling with Differential Equations: Episode 2–Numerical Analysis with Python

Lakeland Community College & iSTEM Geauga ECHS
Advised by: Dr. Carl Stitz

Python, a dynamically typed and readable programming language, has dramatically increased in popularity over the past decade–even more so over the last five years. It has been a favorite of mine since I started learning it in 2015, and it has been indispensable to me during my high school mathematics career.

In this talk, we will explore how Python can be used to model differential equations, specifically in the context of SCUDEM V Problem B as discussed in *Modeling with Differential Equations: Episode 1.* I will also provide some resources for those who would like to learn Python and for those who would like to start using it for math modeling.

Morning Session 11:40-11:55 (continued)

11:40-11:55 **Vu Truong** **Room COMAP**

Application of Artificial Neural Network (ANN) in Predicting Weather

Youngstown State University

Advised by: Dr. Moon Nguyen

Machine Learning has been applied in predictive work including predicting and forecasting weather. Artificial Neural Network (ANN) is the key feature that stands behind this architecture. In this presentation, we will have a descriptive observation on what this model consists of and how its components come together. We will also have a look at how this model is applied in forecasting temperatures and compare results with those of other models.

2021 MCM / ICM - COMAP Modeling Problems

Continuous Modeling (Problem A)
Fungi

The carbon cycle describes the process of the exchange of carbon throughout the geochemical cycle of the Earth, and is a vital component for life on the planet. Part of the carbon cycle includes the decomposition of compounds, allowing carbon to be renewed and used in other forms. One key component of this part of the process is the decomposition of plant material and woody fibers. Some of the key agents in decomposing woody fibers are fungi. The authors of a recent research article on wood decomposition by fungi identified fungi traits that determine decomposition rates and also noted links between certain traits. In particular, the slow growing strains of fungi tend to be better able to survive and grow in the presence of environmental changes with respect to moisture and temperature, while the faster growing strains tend to be less robust to the same changes.

These researchers examined a large number of traits associated with different fungi and their role in the decomposition of ground litter (dead plant material) and woody fibers. For this MCM Problem you should focus on just two traits of a fungus: the growth rate of the fungus and the fungus' tolerance to moisture. Your primary goal is to model the decomposition of woody fibers in a given patch of land, and do so in the presence of multiple types of fungi breaking down woody fibers in the same area.

As you explore the relationship of the two traits of interest, growth rate and moisture tolerance, with the rate of decomposition, several questions may arise to include: Using these two traits, how do the different fungi interact and decompose ground litter in a fixed patch of land in different environments? Within these different environments, how will the decomposition be impacted over time as conditions vary? How do environmental changes and the variation in environmental change impact the long-term dynamics with respect to decomposition, as well as competition between fungi in a given environment?

Your paper should explore and address the following aspects.

1. Build a mathematical model that describes the breakdown of ground litter and woody fibers through fungal activity in the presence of multiple species of fungi.

2. In your model, incorporate the interactions between different species of fungi, which have different growth rates and different moisture tolerances as shown in Figures 1 and 2.

3. Provide an analysis of the model and describe the interactions between the different types of fungi. The dynamics of the interactions should be characterized and described including both short- and long-term trends. Your analysis should examine the sensitivity to rapid fluctuations in the environment, and you should determine the overall impact of changing atmospheric trends to assess the impact of variation of local weather patterns.

4. Include predictions about the relative advantages and disadvantages for each species and combinations of species likely to persist, and do so for different environments including arid, semi-arid, temperate, arboreal, and tropical rain forests.

5. Describe how the diversity of fungal communities of a system impacts the overall efficiency of a system with respect to the breakdown of ground litter. Predict the importance and role of biodiversity in the presence of different degrees of variability in the local environment.

6. Include a two-page article of your results. Your article should be appropriate for inclusion in an introductory college level biology textbook to discuss recent developments in our understanding of the roles fungi play in ecological systems.

Discrete Modeling (Problem B)
Fighting Wildfires

The 2019-2020 fire season in Australia saw devastating wildfires in every state, with the worst impact in New South Wales and eastern Victoria. The wildfires occurred during a severe drought and persistent heat wave exacerbated by climate-change.

Firefighters have used drones for surveillance and situational awareness (SSA) for several years; SSA drones carry high definition & thermal imaging cameras and telemetry sensors that monitor and report data from wearable devices on front-line personnel. Wearable devices can be used as Personal Locator Beacons or more complex environmental monitors. SSA drones help monitor the evolving situation, letting the Emergency Operations Center (EOC) best direct active crews for optimal effect and maximal safety.

Two-way radio communication allows "boots-on-the-ground" forward teams to give status reports to the EOC and allows the EOC to give orders directly to forward teams. Deployed personnel carry handheld two-way radios operating in the VHF/UHF bands. The range of handheld radios is limited by their low transmitting power, typically a maximum of 5 watts, and is determined mainly by distance and physical topography in rural areas or "building topography" in urban areas; weather has little effect on VHF/UHF signals. A 5-watt radio has a nominal range of 5 km over flat, unobstructed ground, but drops to 2 km in an urban area. Repeaters, transceivers that automatically rebroadcast signals at higher powers, can extend radio range. A repeater located between the front lines and the EOC can relay radio signals both from the front lines to the EOC and from the EOC to the front lines. The range of a repeater is also determined by distance and topography, but is significantly greater than lower power handheld radios.

Recently, hovering drones carrying repeaters have been used to dramatically extend the range of low power radios on the front lines. A 10-watt repeater, weighing 1.3 kg carried by a drone hovering well above ground level, can achieve a range of 20 km. Akme Corporation's prototype WileE-15.2X hybrid drone is projected to cost approximately $10,000 (AUD) when equipped with either a radio repeater or video & telemetry capability.

Your team of consultants has been retained to:

1. Create a model to determine the optimal numbers and mix of SSA drones and Radio Repeater drones to purchase for a proposed new division, "Rapid Bushfire Response", of Victoria's Country Fire Authority (CFA). Your model should balance capability and safety with economics, as well as consider observational and communications mission needs and topography. Your model should also incorporate fire event size and frequency as parameters.

2. Illustrate how your model adapts to the changing likelihood of extreme fire events over the next decade. Project what equipment cost increases will occur assuming the cost of drone systems stays constant.

3. Determine a model for optimizing the locations of hovering VHF/UHF radio-repeater drones for fires of different sizes on different terrains.

4. Prepare a one- to two-page annotated Budget Request supported by your models for CFA to submit to the Victoria State Government.

Interdisciplinary Modeling (Problem D)
The Influence of Music

Music has been part of human societies since the beginning of time as an essential component of cultural heritage. As part of an effort to understand the role music has played in the collective human experience, we have been asked to develop a method to quantify musical evolution. There are many factors that can influence artists when they create a new piece of music, including their innate ingenuity, current social or political events, access to new instruments or tools, or other personal experiences. Our goal is to understand and measure the influence of previously produced music on new music and musical artists.

Some artists can list a dozen or more other artists who they say influenced their own musical work. It has also been suggested that influence can be measured by the degree of similarity between song characteristics, such as structure, rhythm, or lyrics. There are sometimes revolutionary shifts in music, offering new sounds or tempos, such as when a new genre emerges, or there is a reinvention of an existing genre (e.g. classical, pop/rock, jazz, etc.). This can be due to a sequence of small changes, a cooperative effort of artists, a series of influential artists, or a shift within society.

Many songs have similar sounds, and many artists have contributed to major shifts in a musical genre. Sometimes these shifts are due to one artist influencing another. Sometimes it is a change that emerges in response to external events (such as major world events or technological advances). By considering networks of songs and their musical characteristics, we can begin to capture the influence that musical artists have on each other. And, perhaps, we can also gain a better understanding of how music evolves through societies over time.

Your team has been identified by the Integrative Collective Music (ICM) Society to develop a model that measures musical influence. This problem asks you to examine evolutionary and revolutionary trends of artists and genres.

To carry out this challenging project, the ICM Society asks your teams to explore the evolution of music through the influence across musical artists over time, by doing the following:

1. Use the influence data set or portions of it to create a (multiple) directed network(s) of musical influence, where influencers are connected to followers. Develop parameters that capture 'music influence' in this network. Explore a subset of musical influence by creating a subnetwork of your directed influencer network. Describe this subnetwork. What do your 'music influence' measures reveal in this subnetwork?

2. Use full music data and/or the two summary data sets (with artists and years) of music characteristics, to develop measures of music similarity. Using your measure, are artists within genre more similar than artists between genres?

3. Compare similarities and influences between and within genres. What distinguishes a genre and how do genres change over time? Are some genres related to others?

4. Indicate whether the similarity data, as reported in the data influence data set, suggest that the identified influencers in fact influence the respective artists. Do the 'influencers' actually affect the music created by the followers? Are some music characteristics more 'contagious' than others, or do they all have similar roles in influencing a particular artist's music?

5. Identify if there are characteristics that might signify revolutions (major leaps) in musical evolution from these data? What artists represent revolutionaries (influencers of major change) in your network?

6. Analyze the influence processes of musical evolution that occurred over time in one genre. Can your team identify indicators that reveal the dynamic influencers, and explain how the genre(s) or artist(s) changed over time?

7. How does your work express information about cultural influence of music in time or circumstances? Alternatively, how can the effects of social, political or technological changes (such as the internet) be identified within the network?

8. Write a one-page document to the ICM Society about the value of using your approach to understanding the influence of music through networks. Considering the two problem data sets were limited to only some genres, and subsequently to those artists common to both data sets, how would your work or solutions change with more or richer data? Recommend further study of music and its effect on culture.

Interdisciplinary (Problem F)
Checking the Pulse and Temperature of Higher Education

What does it mean for a nation to have a healthy, sustainable higher education system? What issues matter? Is it cost, access, equity, funding, value of a degree, quality of education, level of research, exchange of ideas of the world's brightest minds, some of the above, all of the above, or something else altogether?

A system of higher education is an important element in a nation's efforts to further educate its citizens beyond required primary and secondary education, and therefore has value both as an industry itself and as a source of trained and educated citizens for the nation's economy. As we look around the world from Germany to the United States to Japan to Australia, we see a variety of national approaches to higher education, with each of these nations not only educating their own students, but also drawing large numbers of international students every year. Each of these national systems of higher education has its strengths and weaknesses, and in the wake of adjustments required during the current pandemic, nations have had the opportunity to reflect on what is working and what could be even better. However, change is often difficult. The institutional changes required to advance any system require policies implemented over an extended period of time in order to reach a more healthy and sustainable system.

In this problem, you are to develop a model to measure and assess the health of a system of higher education at a national level, to identify a healthy and sustainable state for a given nation's higher education system, and to propose and analyze a suite of policies to migrate a nation from its current state to your proposed healthy and sustainable state. Specifically, you are being asked to:

- develop and validate a model or suite of models that allow you to assess the health of any nation's system of higher education;
- apply your model to several countries, and then select a nation whose system of higher education has room for improvement based on your analysis;
- propose an attainable and reasonable vision for your selected nation's system that supports a healthy and sustainable system of higher education;
- use your model to measure the health of both the current system and proposed, healthy, sustainable system for your selected nation;
- propose targeted policies and an implementation timeline that will support the migration from the current state to your proposed state;
- use your model(s) to shape and/or assess the effectiveness of your policies; and
- discuss the real-world impacts (e.g., on students, on faculty, on schools, on communities, on the nation) of implementing your plan both during the transition and in the end state, acknowledging the reality that change is hard.

2021 MCM-COMAP Participants from YSU

Bishal Lamichhane Aniket Singh Subham Singh	Gyaneshwar Agrahari Anup Chhetri Dikshya Niraula	Nathaniel Arthur Anthony Veri Quinn Hilton
Reece Wilson Oluwatumininu Adeeko Sean Livingston	Tafadzwa Mapiki Nathaniel Willison Morgan Scott	Thomas Williams Brandon McGill Godswill Gadzepko
	Nishan Adhikari Abhinav Giri Pradip Rimal	

Ohio Section of MAA Spring Meeting

The Ohio Section of the Mathematical Association of America will hold its annual spring meeting virtually on March 26 and 27. 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. We encourage you to give a talk at the meeting or participate in the competition.

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:

- Chatham University
- Embry-Riddle Aeronautical University
- Fairmont State University
- Indiana University of Pennsylvania
- iSTEM Geauga Early College High School
- Lake Erie College
- Lakeland Community College
- Penn State Erie, The Behrend College
- Siena Heights University
- Westminster College
- Youngstown State University

YSU Pi Mu Epsilon Officers

President: Joanthan Feigert

Vice President: Payton Linton

Secretary: Anthony Dickson

Treasurer: Nic Beike

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