2019 - 2020 Annual Report

WOOSTER MATH & COMPUTER SCIENCE

The College of Wooster Launches Major

in Statistical and Data Sciences

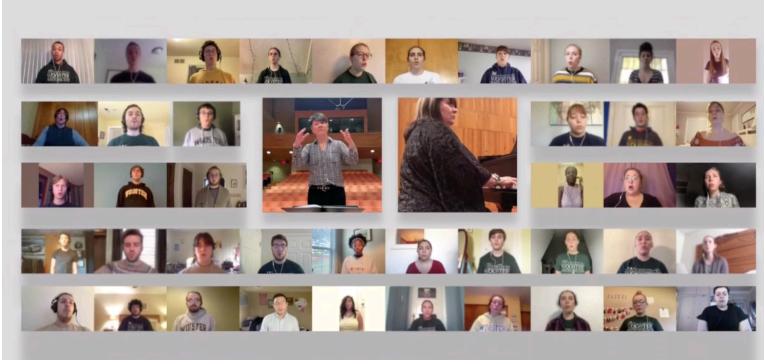
Starting Fall Semester 2019

Trained Data Scientists find employment in a variety of fields, from business and finance to health care and biotechnology.

2020 VIRTUAL COMMENCEMENT

THE COLLEGE OF WOOSTER

Forever Scots!

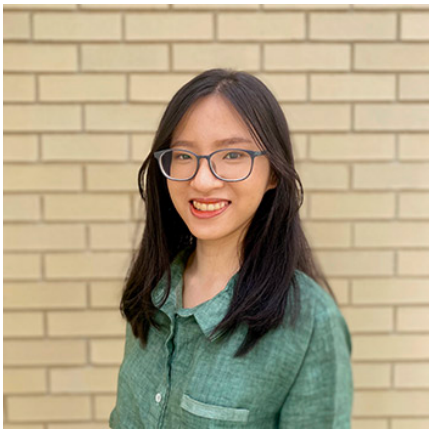


Monday, May 11, 2020

SENIOR INDEPENDENT STUDY

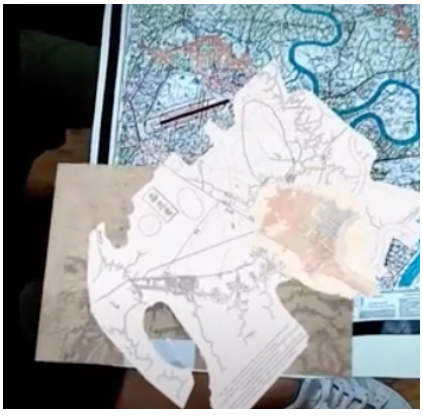
***Thuy (Tammy) Dinh** (Computer Science & History Major from Ho Chi Minh City, Vietnam). Remembering the City: An Augmented Reality Deconstruction of Memory, Power & Identity in Ho Chi Minh City through Cartography & Architecture*
(advised by Denise Byrnes & Margaret Ng)

CoRE Award for Critical Digital Engagement-1st Place (tie)



This project explores urban memory and its formation, using critical augmented reality (AR) as a tool for visualization. The AR component considers the computational theory and development tools for digital historical narratives. As this study investigates the complicity of science in colonialism, imperialism, and nationalism, it also critiques the use of AR in historical processes. AR offers great potential for history thanks to its accessibility and performance; however, it requires developers and users to remain aware of the implications behind each design.

"I consider the question of memory and city building from an ideological angle, by investigating physical sites of memory including maps and buildings. To examine how cartography and architecture have been employed by different governments and enterprises to create memory, this study investigates their use of symbology, design, function, and technology to convey the builders' intentions. In addition, this research employs a digital spatial medium to visualize the process of memory in Ho Chi Minh City, using critical augmented reality."



SENIOR INDEPENDENT STUDY

***Maya Lapp** (Math Major from Pittsburgh, PA)*

SimCity meets The Lorax: Simulating Community Forest Management

(advised by Colby Long)

Melissa Schultz I.S. Research Prize in Sustainability and the Environment — 1st Place

As the human population grows and climate change accelerates, sustainable resource use is becoming an international concern. Community-based natural resource management (CBNRM) is a method of conserving resources while simultaneously empowering traditionally marginalized communities. Because classical equation-based modeling fails to capture CBNRM complexity, Agent-Based Modeling (ABM) is becoming the primary method of modeling CBRNM. We evaluate an existing CBNRM ABM, modify the ABM to improve the model's realism, and analyze the new model.
While this model remains imperfect, we hope future work will use the model to help us understand CBNRM and apply this understanding to propagate successful CBNRM systems worldwide.

https://www.comses.net/codebases/7d6b7c3d-373f-444d-b00c-37055abd2451/releases/1.0.0/

SENIOR INDEPENDENT STUDY

***Margaret McGuire** (Math Major from Washington, NC)*

What a Mouthful! Modeling Geographic Tongue as a Reaction Diffusion System

(advised by Drew Pasteur & Niklas Manz, Physics)

CoRE Award for Critical Digital Engagement—1st Place (tie)

Geographic tongue is a condition of unknown cause characterized by chronic lesions on the surface of the tongue. The condition's appearance of wave fronts suggests the condition can be modeled as a reaction-diffusion system. Here we construct a model of geographic tongue using reaction-diffusion equations and Objective-C to suggest that the underlying cause of geographic tongue may be a reaction-diffusion system. We demonstrate and explain the model's behavior on a sinusoidal surface and on a hemisphere to illustrate its qualitative similarities to laboratory experiments. We show our final model of reaction diffusion waves propagating on the tongue and compare it to patients who have geographic tongue. We then identify next steps in modeling and future projects that would extend our work.

- Simulate more scenarios
- Collect time-series data from patients and compare to simulation
- Publish a paper someday!

SENIOR INDEPENDENT STUDY

***Pedro Oliboni** (Math & Philosophy Major and Economics Minor from Novo Hamburgo, Brazil)*

On The Long-Term Future Importance of Investments in Economic Growth and Global Catastrophic Risk Reduction

(Advised by John Ramsay & Garrett Thomson)

Melissa Schultz I.S. Research Prize in Sustainability and the Environment—3rd Place

This is a study about the optimal allocation of resources between investments in economic growth and global catastrophic risk reduction. "I discuss different ways of conceiving of the value of economic growth. I outline some important concepts for understanding global catastrophic risks and the challenges in modeling such risks. I categorize and clarify philosophical presuppositions that are important to the project. I present a novel argument for why improving the far future may be our moral priority. I discuss at length the Ramsey approach to optimal allocation of resources. I provide an introduction to continuous Optimal Control Theory, a method for solving problems of dynamic maximization. I then use this method to develop my own model for the optimal investing in economic growth and global catastrophic risk reduction. This model illustrates how standard mathematical-economics methodology can be used to tackle my research objective while incorporating the philosophical positions discussed."

GLOBAL CATASTROPHIC RISKS

A global catastrophic risk (GCR) is the risk of large scale catastrophe, such as one that "caused 10 million fatalities or 10 trillion dollars worth of economic loss" (Bostrom & Ćirković 2008).

A few kinds of GCRs are Environmental change, Emerging technologies, Pandemics, Natural disasters.

Courtesy of Advance Local Archive

SENIOR INDEPENDENT STUDY

Robert Alvarez (Computer Science Major from Fort Washington, MD)

Machine Learning Playoff Predictions: Predicting the Football Greats (Advised by Denise Byrnes)

American Football has risen to new levels of popularity in America. At the pinnacle of the industry is the NFL. The NFL is not only extremely popular, but very lucrative. One of the biggest aspects of the NFL today, is Fantasy Football. Websites like FandDuel and DraftKings have millions of players each week betting on which players will perform best and, in states where it's legal, fans can gamble on which teams will make the playoffs and win games. In this project we provide a deep exploration into finding a model that can accurately predict which NFL teams will make the playoffs, using only statistics from each team. We explain which statistics are most important in predicting well-performing teams from a professional opinion, and from data analysis. We investigate these statistics using analytics and machine learning to both model and analyze past data. The main goals of the investigation are to gain a better understanding of what statistics, machine learning model, and methods most accurately predict which NFL teams will make the playoffs. Through the investigation, we present our findings on the impact of past statistics and against other models.

Yash Bajaj (Computer Science & Economics Major from Kolkata, India)

Using Monte Carlo Simulations to Study the Effects of Subsidies on the Market-Share of Electric-Vehicles (advised by Sofia Visa & Amyaz Moledina)

Electric Vehicles are an increasingly accepted form of transport in the passenger- vehicles market due to increasing environmental awareness. Conventional gasoline vehicles are a leading source of air-pollution across the globe, and governments as well as a large number of consumers believe that electric vehicles are a temporary solution to the harmful levels of tail-pipe emissions. In order to promote the adoption of this technology, governments in a number of countries introduce policies which promote this technology by offering subsidies, and other benefits to consumers. This study simulates the effect of subsidies on the market-share of electric vehicles in the U.S passenger-vehicle sector using Monte-Carlo simulations in a game-theory duopoly framework, and constant-returns Cobb-Douglas production functions. We find that using per-unit price subsidies increases the market share of electric-vehicles in the U.S passenger vehicle sector.

SENIOR INDEPENDENT STUDY

Jemal Jemal (Computer Science Major from Addis Ababa, Ethiopia)

Managing Inventory: A study of databases and database management systems

(advised by Tom Montelione)

Databases play an important role in the storage and manipulation of data. Databases and database management systems allow for fast and efficient data querying that has recently become increasingly important in most companies and organizations. This paper introduces a few of the different types of database management systems that are in widespread use today. It introduces some important terminology related to databases and database management systems. This paper also briefly discusses web user interfaces, highlighting important user interface design principles. Finally, an inventory management system is implemented for a local stationery store and is integrated with a web application to serve as the front end.

Tam Nguyen (Computer Science Major from Ha Noi, Vietnam)

SkillSHARE: An Advisor Consulting Web-app - Making Sure the Users Matters

(advised by Denise Byrnes)

This project focuses on examining the importance of user experience in web-design and how conducting usability tests can improve website performance. Since designers often design based on their own intimate knowledge of the product they are creating, compared to the limited knowledge of the user, major usability issues arise. In order to bridge the gap between the designer's conceptual model and the end user 's mental model, a website, SkillSHARE, is created to help Vietnamese youth unleash their potential and start on the path to global citizenship by connecting with experienced mentors overseas. They can see details of international students, where they have studied and are studying, where they are working, living, etc. Therefore, students can choose mentors that fit their situation and desires and who will answer questions and give them helpful advice. Three usability tests are conducted to measure the usability, or ease of use, of the web application, whereas general human–computer interaction studies attempt to formulate universal principles for the design of the website.

SENIOR INDEPENDENT STUDY

Aedan Pettit (Computer Science & Math Major from Round Hill, VA)
Developing A Web-Based Application for Finding Meeting Places (advised by Nathan Fox)

Midway: Meeting Place Finder is a web application which allows users to supply three or more locations and provides them with a place to meet that minimizes their total driving time. Using techniques from graph theory, an algorithm is developed in order to make this service possible. Then, using Python, this algorithm is implemented into the backend of the web application along with a simple, user-friendly interface. This application has exciting potential to be continually expanded and improved in the future beyond this initial version.

Nathan Devereux (Computer Science Major from Finksburg, MD)
Collision Detection in a Top-Down Zombie Shooter (advised by Nathan Fox)

This paper discusses different types collision detection algorithms and compares them in both theory and in a top down 2D survival shooter game called Survive the Night. The two main families of collision detection algorithms compared are a posteriori and a priori collision detection algorithms. The first type refers to late collision detection algorithms. These algorithms are very simple and efficient; however, they have a large room for error. The latter type refers to early collision detection algorithms. These type of algorithms are very accurate; however, they do suffer in efficiency due to the complexity of the calculations. So, to test these algorithms we build Survive the Night in Unity. Unity is a free (for non-commercial use) gaming engine that uses C\# for scripting that implements its own variations of the two different families of collision detection in 2D and 3D. While this paper discusses both the 2D and 3D cases, collision detection algorithms are only implemented in the 2D case becasue it is easier to build from a graphical standpoint. These algorithms are tested in Survive the Night, for both accuracy and efficiency to compare to their theoretical advantages and disadvantages. Survive the Night could not display any of the disidvantages of the a priori algorithm. However, it was able to graphically display missed collisions for the a posteriori collision detection algorithm.

SENIOR INDEPENDENT STUDY

Harry Dunham (Math & Computer Science Major from Princeton Jct, NJ)

Cheat Detection using Machine Learning within Counter-Strike: Global Offensive

(advised by Nathan Fox)

Deep learning is becoming a steadfast means of solving complex problems that do not have a single concrete or simple solution. One complex problem that fits this description and that has also begun to appear at the forefront of society is cheating, specifically within video games. Therefore, this paper presents a means of developing a deep learning framework that successfully identifies cheaters within the video game CounterStrike: Global Offensive. This approach yields predictive accuracy metrics that range between 80-90% depending on the exact neural network architecture that is employed. This approach is easily scalable and applicable to all types of games due to this project's basic design philosophy and approach.

Reid Thomas Golnik (Computer Science Major from Blue Ash, OH)

Pushing the Limits of a Raspberry Pi

(advised by Nathan Fox)

The Raspberry Pi is a small inexpensive computer that is praised for those traits. Said traits also come with steep trade-offs. This project seeks to investigate if those trade-offs are worth it all in all. To do this, a Raspberry Pi 3 is stress-tested using machine learning and memory stress. The performance of the Pi during these tests is recorded, discussed, and compared to better analyze the tests. To better understand the Pi and machine learning, the project also explores the applications and architectures of the Pi and basic machine learning information.

SENIOR INDEPENDENT STUDY

***Madeleine Ferguson** (Math Major & Environmental Studies Minor from West Windsor, NJ)*

Optimizing Crop Rotations and Pest Management Strategies in Agriculture (advised by John Ramsay)

The goal of this project is to investigate how operations research techniques, specifically dynamic programming, can be applied to crop rotation decisions in agriculture. One major concern that farmers face is pests. This project seeks to respond to this by solving optimization models that represent scenarios in which pests are present and pose a threat to potential yield. The final model discussed in this paper optimizes field crop rotations for five years in an ecosystem in which soybean cyst nematodes and soybean aphids are present. When aphids infest in the first and fourth years of our five year system, the optimal crop rotation is as follows: corn, susceptible soybean, corn, corn, susceptible soybean. A sensitivity analysis is then performed to help explain why this rotation is chosen.

“My independent study focused on field crops rotations in agriculture, specifically with the presence of pests. Agricultural pests are a major concern to farmers and in bad years can cause major profit loss. After replicating relevant previously published models, I created my own model for soybean cyst nematodes and soybean aphids. Soybean cyst nematodes are microscopic organisms which create the cysts their name implies on the roots of soybeans. In contrast, aphids impact the leaves of soybean crops. Both are economically important pests for soybean crops in the Midwest.”

SENIOR INDEPENDENT STUDY

***Erika Goetz** (Computer Science Major from Honey Brook, PA)*

Breaking AI: When Even Google Fails
(advised by Nathan Sommer)

In 2016, Alex Graves, Greg Wayne and others at DeepMind published a paper in Nature proposing a new model for neural networks: the differentiable neural computer (DNC) [14,25]. This model is a type of neural memory network designed so that "[. . .] memory can be selectively written to as well as read, allowing iterative modification of memory content." Utilizing external memory, DeepMind's network achieved the lowest error rate yet published on the bAbI dataset, a dataset composed of short stories followed by questions on the stories. This dataset demonstrated the DNC's ability to reason deductively and process natural language. But the dataset itself is quite limited: it possesses only — words, all of which have at least –instances and which are in the lexicon of a small child. Moreover, each of the twenty question types in the dataset has 10,000 training examples and no question requires more than a single type of reasoning. These dataset limitations suggest that the ground breaking results published by DeepMind may mask the deep and pervasive limitations of not only the differential neural computer but also of neural networks as a whole.To push the DNC to the limits of its capabilities, we introduce it to the DREAM dataset, a dataset originally presented by Kal Sun et al [27]. This dataset is much smaller than the bAbI dataset, it contains only 10,197 questions split into five different types. Additionally, the dataset is makes use of – words, where many words have as little as – instances. While Sun et al originally publish the dataset in multiple-choice format, we train the DNC in question and answer format— which is comparable to the bAbI dataset and further increases the difficulty of answering correctly. We expect that— provided this dataset— the DNC will experience task failure.What we did not expect is just how pervasive that failure would be.

SENIOR INDEPENDENT STUDY

Brodie Hufnagel (Computer Science & Math Major from Gambier, OH)

Cheat Detection using Machine Learning within Counter-Strike: Global Offensive
(advised by Nathan Fox)

Deep learning is becoming a steadfast means of solving complex problems that do not have a single concrete or simple solution. One complex problem that fits this description and that has also begun to appear at the forefront of society is cheating, specifically within video games. Therefore, this paper presents a means of developing a deep learning framework that successfully identifies cheaters within the video game CounterStrike: Global Offensive. This approach yields predictive accuracy metrics that range between 80-90% depending on the exact neural network architecture that is employed. This approach is easily scalable and applicable to all types of games due to this project's basic design philosophy and approach.

Nicholas Hunter (Computer Science & Math Major from Phoenixville, PA)

Computer Vision Gesture Recognition for Rock Paper Scissors
(advised by Mircea Ionescu)

This project implements a human versus computer game of rock-paper-scissors using machine learning and computer vision. Player's hand gestures are detected using single images with the YOLOv3 object detection system. This provides a generalized detection method which can recognize player moves without the need for a special background or lighting setup. Additionally, past moves are examined in context to predict the most probable next move of the system's opponent. In this way, the system achieves higher win rates against human opponents than by using a purely random strategy.

SENIOR INDEPENDENT STUDY

Kendall Lloyd (Math & Education Major from Apple Creek, OH)

Calculators in the High School Classroom: Anxiety Levels and Attitude Towards Mathematics (advised by Jillian Morrison)

Students often fear failure in the math classroom, especially when performing various algebra calculations. Seeing equations with both numbers and letters can be very intimidating at first when the math skills are already weak, and a student typically uses a calculator. This Independent Study aims to focus on three factors related to students' calculator use: Anxiety, Attitude, and Time. The research studied the self-rated anxiety levels when performing algebra problems using or not using a calculator and how this affects students' attitude toward mathematics. The data was collected from Wayne County math students using an online survey during class time. The results conclude that relying on a calculator does affect student attitude towards math but does not influence a student's anxiety levels. A student's favorite subject and year of school is correlated with anxiety in a math classroom.

Emily Skerl (Computer Science Major from University Heights, OH)

Teaching Basic Python Programming Using the LEGO Mindstorms Robot (advised by Sofia Visa)

This senior independent study focuses on the educational potential of hands-on activities using the LEGO Mindstorms EV3 robot. The paper describes the history of the LEGO Mindstorms collection, focusing on the capabilities of the LEGO Mindstorms Education EV3 Core Set. It starts with a discussion of how to operate the LEGO programmable brick, the sensors, and the motors included in the set. It implements the programs using Visual Studio Code's EV3 MicroPython extension and describes various functions in the classes that the extension supports. This is followed by several activities written in EV3 MicroPython that investigate the capabilities of the robot using two different robot models. The paper also includes a discussion of artificial intelligence and chatbots, including the history of each, modern chatbots, chatbot software, and two chatbot implementations. The chatbot programs' goal is to provide assistance in operating the Mindstorms robot and MicroPython.

SENIOR INDEPENDENT STUDY

Kyndalanne Pike (Math & Chemistry Major from Willoughby, OH)

What's in the Water?: Examining Contamination by Poly- and Perfluoroalkyl Substances in Rainwater

(advised by Jillian Morrison & Jennifer Faust)

Poly- and perfluoroalkyl substances (PFAS) are emerging environmental contaminants of concern detected in waters around the world. These chemicals, used for food packaging and firefighting foams, have leeched into the environment, where they don't degrade. This is of concern as PFAS have been linked to several serious health issues including cancer and neurogenerative diseases in children. This project focused on detecting PFAS in rainwater collected at seven sites during the summer of 2019. PFAS were detected in all of the samples collected. There were higher concentrations detected at some sites than others. This highlights the prevalence of these contaminants in our environment and the importance of local sources of PFAS.

David Pfeffer (Computer Science Major from Deerfield, IL)

Sending Mixed Signals: Feature Extraction for Gendered Emotional Speech Classification and Modeling

(advised by Sofia Visa)

This study seeks to analyze waveforms of gendered, emotional human speech to extract acoustic features from the RAVDESS emotional speech dataset. After a phase of preprocessing using min-max normalization, qualitative and quantitative signal analysis is performed on the samples in which maximum amplitude, average amplitude, and summed amplitude features are extracted. We find that the summed amplitude feature is the most informationally-rich and compelling of the features extracted, and move forward with its use in the classification phase. We deploy two clustering algorithms to perform classification on the speech samples: k-means and agglomerative clustering. The results of the clustering show similarities between some gendered emotion samples, but fail to cluster along gender or emotion type. Model prototypes are then created through the inclusion of more samples, and through further qualitative analysis performed on a variant of the summed amplitude feature. These reveal similarities in the volume shifts within each emotion variant, and a marked increase in volume for happy male speech and sad female speech specifically. Finally, we propose a framework for an automated speech classification algorithm.

SENIOR INDEPENDENT STUDY

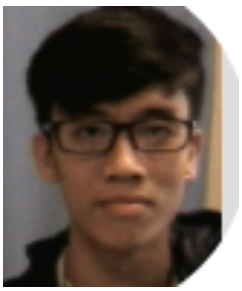
Henry Potts-Rubin (Math Major from Yellow Springs, OH)

The Planar Rook Algebra (advised by Rob Kelvey)

This Independent Study is concerned with examining the diagrammatic algebra known as the planar rook algebra CPn. The planar rook algebra consists of complex linear combinations of specially defined bipartite graphs together with an operation called "diagram stacking." Using tools from representation theory, we decompose CPn into the direct sum of Pn-invariant irreducible subspaces, thereby show that it is semi-simple. We look to further expand the topic by coloring the diagrams in CPn by assigning elements of a given "palette" group to their edges. Different results arise when coloring CPn with finite abelian versus finite non-abelian groups.

Hieu Tran (Computer Science & Math Major from District 10, Vietnam)

SkillSHARE: An Advisor Consulting Web-app utilizing a Hybrid Recommender Engine (advised by Denise Byrnes & Colby Long)



Recommender Systems are successfully applied in predicting user preferences. For instance, Recommender Systems have been used in many areas such as e-commerce (for online shopping), entertainment (music, movie, videos recommendations), and in education (learning resource recommendation). Because of their usefulness and popularity, Recommender Systems have become an interesting and hot research topic. They are widely used for building intelligent systems, especially decision support systems. In this work, we introduce the Recommender System and the current techniques that are commonly used in these systems. We then thoroughly describe and conduct a hybrid recommender system using in a consulting web-app and present experimental results.

SENIOR INDEPENDENT STUDY

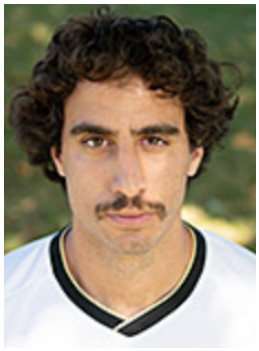
Eli M. Samuelson (Math Major from Rockville, MD)

A Predictive Model for Coach Firings in NCAA Division I Men's Basketball (advised by Drew Pasteur)

Within men's major college basketball there is a high turnover rate of coaches for teams, either due to retirement, new job prospects, or a firing. Retirement is usually the result of old age, and leaving for a new job comes from the offer of more money or more prestige, but what causes a coach to get fired? This is a common sports question: why does a coach get fired? This question is so common it has become commonly known as the "hot seat" question. The "hot seat" question has been examined in many of the major league sports such as the MLB, and the NFL. We took the question and apply it to NCAA Division I men's basketball.

Zacharias Andreou (Math Major from Nicosia, Cypress)

Who will be crowned king of Europe? A predictive model for the UEFA Champions League (advised by Drew Pasteur)



The UEFA Champions League is the biggest annual soccer competitions in Europe. Our goal was to predict the outcome of the tournament. We used data from 2004 up to 2020 and we first used Elo rankings to rank our teams based on their abilities. We have also introduced home-advantage and showed how big of an impact the teams have by playing at home. We then ranked the sixteen teams that qualified for the round of sixteen of the competition. We did that by over-weighting the Champions League results of each team, rather than their corresponding league's results. We then used Poisson distribution to predict the goals scored by each team. We showed that the goals scored by each team are approximated by a Poisson distribution. We then used what Dixon and Coles did in their model and introduce a time-decay model that over-weighted the most recent results. We then found offensive and defensive strengths for each of the sixteen teams. Finally, we simulated the tournament and we had results for both models and we compared them with each other, as well as with the results found from fivethirtyeight.com.

SENIOR INDEPENDENT STUDY

Isaac Weiss (Math and Political Science Major & Computer Science Minor from Louisville, KY)

Compactness Measures for Legislative Districts
(advised by John Ramsay and Bas van Doorn)

A Gerrymandering has been around for centuries and the past few decades have seen dramatic changes in the way that it has shaped our democracy. In this project, we will explore how the Supreme Court has shaped how we can utilize tools to help us examine gerrymandering, and, more importantly, we focus on building a compactness measure that will allow us to test constitutionality. We find that a weighted average of nearly six-tenths times a convex hull score plus four-tenths of the Polsby-Popper score should be our measure. We also discover a cut off system for determining constitutionality. Any district scoring less than 0.45, we should say is unconstitutional. We, finally, examine why we may not want to consider compactness measures at all.

D'Andre E. Brown (Math Major from Atlanta, GA)

Predicting Major College Football All-American teams & NFL Draft Value
(advised by Drew Pasteur)

The main topic of this independent study is to find ways to predict NCAA Division 1 FBS football All-Americans and predict players' draft values. Quarterbacks, wide receivers, and running backs were the position groups we performed this study on. For All-Americans we looked at college statistics to determine which were most significant. We looked at players' draft value because we wanted to see if the All-Americans would have a better draft value than players that were not All-Americans. We also wanted to see which stats would be important in deciding draft value. In order to predict correctly, we had to used several mathematical models with an end goal of finding the most important factors for both deciding All-Americans and players' NFL draft value. The techniques we used were logistic regression in order to predict the All-Americans and multiple linear regression in order to predict NFL draft values. These models led to the the assumption that being in a power-five conference was most important for All-Americans, and being an All-American was most important for a player's draft value.

SENIOR INDEPENDENT STUDY

Tianyi Cai (Math Major from Shanghai, China)

Finding a Satisfying Way of Healthy Eating – A Diet Model that Cares about Personal Preferences

(advised by John Ramsay)

Linear programing, an optimization technique that is widely applied to solve diet problems, is usually designed to minimize the cost of foods while ensuring a healthy diet. Goal programming, an extension of linear programming, is advanced to handle multiple objective measures. A diet model that cares about personal food preferences by applying the goal programming optimization technique is introduced in this paper: starting from one's current diet, the model is aimed at satisfying all nutrient targets while minimizing the changes to the original diet.

Nicole Driver (Math Major from Philadelphia, PA)

The Art Gallery Problem (advised by Jillian Morrison)

The Art Gallery Problem is a computational geometry and surveillance problem proposed by Victor Klee in 1973, after mathematician Václav Chvátal asked for an interesting problem. It has since been solved in various ways and lead to the creation of many variations and extensions of the problem. My Senior Independent Study looks at this problem and its original solutions as well as exploring a couple of the variations later proposed. These solutions are then applied to the College of Wooster Art Museum and Ebert Art Center's McKenzie Gallery.

SENIOR INDEPENDENT STUDY

Carson Geissler ***(Math Major from Delaware, OH)***

A Mathematical Analysis of the Game of Santorini

(advised by Nathan Fox)

Santorini is a two player combinatorial board game. Santorini bears resemblance to the graph theory game of Geography, a game of moving and deleting vertices on a graph. We explore Santorini with game theory, complexity theory, and artificial intelligence. We present David Lichtenstein's proof that Geography is PSPACE-hard and adapt the proof for generalized forms of Santorini. Last, we discuss the development of an AI built for a software implementation of Santorini and present a number of improvements to that AI.

Vi Huynh ***(Math Major from Morrow, GA)***

Computational Analysis of PsAvh172 Data to Investigate the Targets of Phytophthora sojae in Soybean Host A Hierarchical Clustering Evaluation of Yeast RNA-Seq Data

(advised by Colby Long & Erzsebet Regan)

The annual devastation of soybean agriculture by the Phytophthora sojae pathogen has caused worldwide concern in the past decades. This loss accumulates billions dollars in cost each year. A previous ndependent Study by Matthew Reeder in 2014 investigated the targeted conserved biological network of this pathogen. PsAvh172 an RxLR proteins was expected to greatly inhibits host cells growth and function. To characterize the response of the target host in the release of PsAvh172 protein, an RNA-Seq analysis was performed, but no denite conclusion could be drawn from this analysis. In this study, we use linkage-based hierarchical clustering to further characterize the data from Reeder's research to analyze Phytophthora sojae infection process. This not only provides insight into CCD but also adds to the literature of models of interacting species, in which mutualisms have been less of a focus.

SENIOR INDEPENDENT STUDY

Hyong-gu (Alex) Hwang (Math & Economics Major from Seoul, Republic of Korea)

A Theory of Fire Service Provision: With an empirical analysis of response time, suppression time, and service output

(advised by Marian Frazier & Jim Burnell)

We introduce a two-stage theoretical framework of fire services that justifies the status of response time as a factor input. In the first stage, the provincial government distributes a budget to its cities, resulting in varied numbers of firefighters and fire engines in each city. In the second stage, each city fire department places its fire stations at spatially optimal locations that minimize expected response times. When a fire occurs, the outputs from these two stages are actualized into dispatch level, response time, and suppression time. These intermediate outputs are then transformed into inputs for producing service output, which is measured in terms of fire spread. Using a data set of 49,000 fire dispatches that occurred in Gyeonggi Province, South Korea in 2014-2018, we estimate a set of models for the above outputs. We find evidence for increasing returns to population scale, while empirically showing that response time and suppression time are indeed inputs for the production of fire services.

Yifan Jiang (Math & History Major from Bejing, China)

Yijing and Its Mathematical Thinkings

(advised by Rob Kelvey & Margaret Ng)

The *Yijing* is one of the oldest classics in China and is listed as the first classic in the *Five Classics*. It has more than three-thousand-year history and so far, there is no scholar know specifically who wrote this text. This research project has both historical and mathematical goals. Historically, it traces the evolution of the *Yijing* from the Zhou to the Han dynasty and From the Song to the Qing dynasty. Mathematically, it looks at how the *Yijing* can be associated with the binary system and the Boolean Algebra. The *Yijing* first was used as a manual for divination but it was transformed into a philosophical text, showing how one can follow the Way of Heaven and Earth, and a guide on the patterns of the universe. Ten Wings played a significant role in this process. After this transformation, the *Yijing* was also used to legitimize the rulership and was later introduced to the west after the seventeenth century. During this period, Gottfried Wilhelm Leibniz theorized and proved that there might be some connections between the *Yijing* and the binary systems. Into the twenty-first century, more mathematical researches have been down related to the *Yijing* and discovered that Boolean Lattice can be applied to represent some characteristics of trigrams.

SENIOR INDEPENDENT STUDY

Christian Santos (Math & Computer Science Major from Lansdowne, PA)

Ordinal Data Analysis: Determining the Effectiveness of Domestic Abuse Intervention in Adolescent Teens

(advised by Marian Frazier)

The goal of this thesis is to determine the effectiveness of my non-profit organization, Open Door Abuse Awareness Prevention (ODAAP), in the fight to break the cycle of domestic abuse, by mentoring adolescent teens. Using data we collected over the 2019 summer, we conducted several non-parametric statistical examinations using the Kruskal Wallis and Wilcoxon signed-ranks test. We find significant differences between the male athletes before and after the training. The results indicate that the preventative methods taught through our programs, do indeed alter the responses, mindsets, and behavior of our young men. We interpreted our results through the lenses of Peter Sprent and Nigel C. Smeeton and concluded that teens are less likely to perpetuate abusive behavior if they are educated and taught healthy habits at an earlier age. This study contributes to the fight in ending domestic abuse in the United States.

Lily Richardson (Math Major from Canton, OH)

Rings & Things: Localization, Discrete Valuations, and Completion in Ring Theory

(advised by Rob Kelvey)

The study of rings plays a vital role within abstract algebra, as well as in other mathematics topics. Many disciplines draw from abstract algebra and ring theory: for example, number theory focuses on the ring of integers, and algebraic geometry draws from techniques used in ring theory.

In 1993, Raymond Heitmann published an article titled “Characterization of Completions of Unique Factorization Domains”. Despite being published a relatively long time ago, Heitmann’s article is by no means easily accessible. Thus, this paper seeks to explore just a small part of Heitmann’s article. The first chapter seeks to give the reader a solid foundation for rings, ideals, quotient rings, and homomorphisms. Following that, the second chapter will use those foundations to define localizations, discrete valuations, and generalized completions. Finally, the last chapter will focus on making sense of part of Heitmann’s proof of Theorem 1 in the article. The paper concludes with a consideration of the further work needed to further understand the article, as well as references to similar articles that cite “Characterization of Completions of Unique Factorization Domains”.

SENIOR INDEPENDENT STUDY

Jacob I. Lewis (Math Major from Silver Creek, NY)

Optimization of a Hybrid Clean Energy System (advised by John Ramsay)

Utilizing multiple forms of energy is the best way to create a cleaner energy grid system. Solar, wind, and diesel generation, together can reduce pollution of the system while providing sufficient energy to the grid. At base efficiency values both wind and solar appear cheaper than diesel but with real world ramifications, that changes. To make up for the lack in efficiency we can add batteries to the system. Optimally minimizing both cost and pollution emissions while considering actual efficiencies is possible. Depending on what would rather be emphasized, cost or emissions, changes the result of the optimization providing multiple optimal solutions.

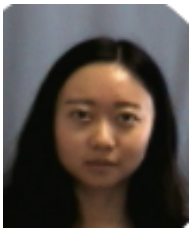
Harriet Sudduth (Math Major from Louisville, KY)

An Exploration of Retention and Persistence in STEM Fields at the College of Wooster, (advised by Marian Frazier)

The STEM Success Initiative was a grant supported program that entered its pilot year in 2014 at The College of Wooster. This program aims to particularly help students who are considered to be part of underrepresented (UR) groups in science, technology, engineering, and mathematics (STEM) courses, and keep them in STEM, as they have historically been at a higher risk to leave than their white peers. This paper aims to look specifically at students who are being retained and where they are persisting in introductory levels in three departments: chemistry, biology, and mathematics. We want to see if students are retained, in other words if they stay in STEM fields through graduation; this helps us see more long term which students are choosing to stay. Seeing where students persist: where they are continuing from one course to the next, gives us a much more in depth and specific look at our departments. To analyze these measures, we used logistic regression to build models for binary outcomes (successes and failures/being retained or not, or persisting or not). Once we built many multiple logistic regression models, we used two evaluation processes for general linearized models: drop in deviance test and misclassification tables. In analyzing retention, we found that while ratios of male and female identifying students stays consistent from our initial pool of students to graduating majors, we did find a slight drop in students who are considered UR. We found a number of indicators as to if a student is retained or not, including if a student was a first generation college student, and how many STEM courses a student takes in their first year. We found a combination of grades, what term students took certain courses, gender, and UR status to all be indicators of persistence when analyzing Chemistry, Biology, and Mathematics Departments. Grades were the most consistent across the board, and gender came up very rarely, although twice in higher persistence levels in two different departments. Overall, analysis was conducted to provide more insight and understanding of the inner workings of STEM fields at The College of Wooster.

SENIOR INDEPENDENT STUDY

Yinxi Zhao (Math Major from Beijing, China)



Minimize Return Risk: –Using NLP Model to Select a Desirable American and European Options Portfolio (advised by Jillian Morrison)

The overall purpose of this thesis is to find an optimal portfolio with American options and European options, which minimizes the risk associated with the portfolio and satisfies a certain level of expected return and constrained budget. The design of the Nonlinear programming model is based on Harry Markowitz and William Sharpe's *Portfolio Theory*, and their model for portfolio selection. This procedure includes a Single-Option model and a Multiple-Options model, which solve for the number of option contracts that need to be included in the portfolio. The conduction of sensitivity analysis on the budget, acceptable expected return, risk and return implies that option portfolio selection is more susceptible to the change of risk. In this thesis, I find that American options are more risky and costly than European options, so investors should put more money in purchasing European options to minimize their risks based on my model.

Daniel Zuchelkowski (Math Major from Uniontown, PA)

A Time Series Analysis of the Relationship between Agriculture and Economic Growth in Southeast Asia from 1960-2018 (advised by Colby Long)

East Asia has experienced dramatic economic growth from the latter half of the 20th century to the present day. Some economists attribute this growth to a series of pre-industrial agricultural reforms implemented by Northeast Asian countries; however, the countries of Southeast Asia have not implemented these policies to the same degree, and thus have not experienced as drastic of an economic transformation. In this study, we examine the long-run relationship between agriculture and economic growth from 1960-2018 in the four Southeast Asian countries of Indonesia, Malaysia, the Philippines, and Thailand using the time series technique of cointegration. In applying time series analysis, the issue of spurious regression due to nonstationary variables arises. To test for nonstationarity, we employ the Augmented Dickey-Fuller test. We then utilize two methodologies, Engle-Granger and Johansen, to test for cointegration. The results of the two cointegration methodologies show that countries in Southeast Asia have not used agriculture as a driver of growth to the same degree as countries in Northeast Asia.

RESEARCH

Wooster CS Students Computationally Analyze DNA to Trace the Evolution of the Domesticated Tomato

~ their work is published in a journal paper ~

Congratulations to our students,

Erika Goetz'20 (CS Major) and

Angelo Williams'21 (Math and CS Major)!

Professor Sofia Visa & two Wooster students computationally analyzed DNA of cultivated tomatoes in Latin America

The College of Wooster's Department of Computer Science played an integral role in a National Science Foundation (NSF) study that helped uncover the evolution of the tomato, as students Erika Goetz and Angelo Williams worked with Associate Professor of Computer Science Sofia Visa to examine the DNA of 245 tomato varieties. They provided data analysis to biologists/geneticists Esther van der Knaap of the University of Georgia and Hamid Razifard at the University of Massachusetts Amherst among other faculty collaborators, which resulted in a paper published in the journal *Molecular Biology and Evolution*.

Goetz, a senior computer science major, and Williams, a junior mathematics and computer science double major, wrote computer programs in Python to compare structural variants such as DNA insertions, deletions, and inversions, and then clustered these structural variants in a phylogenetic tree with 10 geographical groupings.

HONORS
MATH/CS MAJORS

Latin Honors

Summa cum laude
Thuy Dinh
Carson Geissler
Jemal Jemal
Maya Lapp
Margaret McGuire
Pedro Oliboni
Kyndalanne Pike
Henry Potts-Rubin
Hieu Phuoc Tran

Magna cum laude
Zacharias Andreou
Tianyi Cai
Harry R, Dunham
Erika Goetz
Alex Hwang
Yinxi Zhao
Daniel Zuchelkowski

Cum laude
Jacob Denbeaux
Gillian Gregory
Yifan Jiang
Aedan Pettit
David Pfeffer
Isaac Weiss

Phi Beta Kappa
Zacharias Andreou
Margaret McGuire
Kyndalanne Pike
Henry Potts-Rubin

AWARDS
MATH/CS MAJORS

The William A. Galpin Award for General Excellence in College Work
Isaac Weiss '20, 2nd

The Vivien W. Chan Prize in Interdisciplinary Sciences
Kyndalanne Pike '20

The Endowed Faculty Scholarship
Jemal Jemal '20

The Josh Farthing Endowed Prize
David Pfeffer '20

The Lyman C. Knight, Sr. Prize in Physical Education & Mathematics
Morgan Kromer '22

The Barbara Ward McGraw Memorial Prize
Kendall Lloyd '20

The Elizabeth Sidwell Wagner Prize in Mathematics
Henry Potts-Rubin '20

The Jonas O. Notestein Prize
Maya Lapp '20
Henry Potts-Rubin '20

The Foster Prize in Mathematics
Christian Santos '20
Harriet Sudduth '20

The William H. Wilson Prize in Mathematics
Maya Lapp '20
Margaret McGuire '20
Henry Potts-Rubin '20

PI MU EPSILON

Pi Mu Epsilon is a non-secret organization whose purpose is the promotion of scholarly activity in mathematics among students in academic institutions. It aims to do this by 1) electing members on an honorary basis according to their proficiency in mathematics, 2) engaging in activities designed to promote the mathematical and scholarly development of its members, and 3) taking any other measures which will further the purpose stated above.

Chapter advisor: Dr. Robert Kelvey
2019-2020 PME Officers: Isaac Weiss, Henry Potts-Rubin, Daniel Zuchelkowski

New Inductees

Class of 2020
Thuy Dinh
Carson Geissler
Anna Hartig
Jemal Jemal
Yifan Jiang
Shengjia Kang
Andrew Richardson
Hope Siegel
Wesley Wagner

Class of 2021
Rephael Berkooz
Manh Bui
Emma Busch
Aditi Chowbey
Hung Dao
Molly Hutter
Zachary Myers
Nicole Powell
Morgan Thompson
Duc Trinh
Shayna Vicker
Yang Yu
Jingyi Zhou

Class of 2022
Shivam Bhasin
Pavithra Brahmananda
Abigail Breitnebucher
Justin Clement
Teague Curless
Brendan Dufty
Sky Gill
Maxwell Hosler
Ivan Jaramillo
Sai Kwan Khal
Morgan Kromer
Kien Le
Alon Liberman
Pragya Mittal
Matthew Ochlis
Anjolaoluw Olubusi
Xiangping Ouyang
Jeremy Sorkin
Li Tian
Hung Vu
Melita Wiles

Current Members

Zacharias Andreou
Tran Anh Vu Bui
Tianyi Cai
Harry Dunham
Erika Goetz
Zhen Guo

Current Members

Vi Huynh
Alex Hwang
Alayt Abraham Issak
Minjoo Kang
Shivam KC
Jordan Kirsch
Maya Lapp
Minwa Lee
Margaret K McGuire
Brianna M McKeen
Kevin Miller
Tam Nguyen
John Patrick Nugent
Pedro Oliboni
Carlos Owusu-Ansah
Aedan Pettit
David Pfeffer
Micah Phillips-Gary
Kyndalanne Pike
Carter J Rogers
Henry Potts-Rubin
Eli Samuelsom
Katherine G Shideler
Brett A Stern
Regan Szalay
Hieu Tran
Isaac Weiss
Angelo N Williams
Xinchen Xie
Yinxi Zhao
Daniel Zuchelkowski

2019-2020 COLLOQUIUM SERIES

1. Dr. Daryl Deford, Postdoc in Moon Duchin's Metric Geometry & Gerrymandering Group
   "Graphs, Geometry, and Gerrymandering" September 24, 2019
2. Karen Pearson, College of Wooster Alum, PhD Candidate at the University of Maryland College Park in Geology studying seismology
   Pursuing Statistics & Data Science in Academia & Industry
   "The M4.2 Dover, DE, Earthquake and Aftershock Analysis"
3. Heather Guarnera, Kent State University
   "Hyperbolic Graphs and Applications" November 11, 2019
4. Paul Hyunjin Kim, The Ohio State University
   "Design-Centric Maze Generation" November 13, 2019
5. Tamaike Brown, North Dakota State University
   "Improving Learning & Engagement in Computer Science" November 15, 2019
6. Dr. Jason Wilson, Northwestern University
   "Designing Robots That Are Socially Aware" November 18, 2019
7. Robert Ashmead, PhD, Research Scientist & Wooster Alum,
   Ohio College of Medicine Government Resource Center
   "Differential Privacy: An Introduction & Discussion of Real-World Applications"
   January 21, 2020
8. Mauricio Gomez Lopez, University of Oregon
   "Matroid Theory: A Generalized Theory of Independence" February 24, 2020
9. Nandita Sahajpal, The University of Kentucky
   "Quadratic Forms over Local and Global Fields" February 26, 2020
10. Subhadip Chowdhury, Bowdoin College, Brunswick, ME
    "Rotation Number and Dynamics on the Circle" February 28, 2020

FACULTY

Pamela Pierce, Professor of Mathematics

Dr. Pierce with Dr. Laurent Moonens in the Jardins du Palais royale

On research leave Fall Semester 2019-Spring Semester 2020

****

Dr. Pierce was on a research leave during 2019-2020. She was fortunate to be able to travel to Paris in the fall semester, where she began work with a colleague at Université de Paris-Sud. In February she was a guest lecturer at Weber State University in Ogden, Utah, and she also completed a project in Real Analysis with a colleague there. Some further trips and conferences were canceled due to COVID. Dr. Pierce is excited to be working with students again, despite the unusual circumstances this fall. She is currently serving on the Teaching Staff and Tenure committee of the College, and she continues her service on the Editorial Board of Math

A bulletin board at the Pie Pizzeria in Ogden, Utah

The Institut Henri Poincare

A sculpture by Rodin

FACULTY

Jennifer Bowen, Professor of Mathematics

TEACHING

Linear Algebra
First-Year Seminar
On research leave Spring Semester '20

****

Dr. Bowen had two publications appear: "Lessons Learned Mentoring Senior Theses" in Notices of the American Mathematical Society (August 2019) and "Look for the Helpers" in Living Proof: Stories of Resilience Along the Mathematical Journey (2019).

She is also an invited editor on an associated professional blog: 'Living Proof: Stories of Resilience Along the Mathematical Journey'.

On research leave in Spring 2020, Jen completed collating, editing, and contributing to the forthcoming volume "Mathematical Themes in a First-Year Seminar" (published by the Mathematical Association of America Notes Board). Jen also served as an external reviewer to university programs in Applied Mathematics (in Virginia) and Data Analytics (in Iowa). She evaluated entries for the Mathematical Contest in Modeling and Interdisciplinary Contest in Modeling sponsored by the Consortium for Mathematics and its Applications (COMAP). Jen was also a key coordinator for the Association for Women in Mathematics' (AWM) Notable Women in Math Playing Cards project. The project is to commemorate the 50th anniversary of the AWM. The deck will be released at the 2021 Joint Mathematics Meetings in Washington DC with preorders from Kickstarter. Jen also homeschooled her preschooler and 2nd grader. Finally, in July, Jen participated in HERS Leadership Institute: Higher Education Leadership Development Program. The leadership institute is a transformational, leadership development program for women in higher education, founded to fill leadership pipelines across the United States with dynamic women, each capable of ushering their respective institutions into a more inclusive and equitable future.

***Dr. Bowen was named as the college's new Dean for Curriculum and Academic Engagement, to serve a three-year term as a full-time dean, beginning in summer 2020. She was also promoted to the rank of (full) Professor this year.**

FACULTY

Drew Pasteur, Associate Professor of Mathematics

TEACHING

Numerical Analysis
Differential Equations
Math in Contemporary Society
DataFest Seminar
5 Senior Independent Study advisees

****

With much support from his predecessor Dr. Bowen and other senior colleagues, Dr. Pasteur transitioned into the department chair role. He is excited to help lead at a time when the department is undergoing rapid growth and being transformed by many dynamic young faculty. At the 2019 MAA MathFest conference in Cincinnati, Dr. Pasteur gave a research talk entitled, *Envy-Free March Madness Bracketing*. He recently concluded a term on the board of the Sports SIGMAA, a national group focused on encouraging sports-related research and curriculum in mathematics, especially undergraduate research. Dr. Pasteur also continues to serve in the role of Faculty Athletic Representative, a liaison between Wooster's intercollegiate athletic programs and the academic side of the college.

Marian Frazier, Assistant Professor of Statistical & Data Sciences

TEACHING

Introduction to Statistics
Statistical Theory
Data Visualization
4 Senior Independent Study advisees

****

Dr. Frazier began a research collaboration with Scott Perkins (Neuroscience, '20) into the clinical effectiveness of the Wooster Community Care Network (Wooster Health Coach program). Their research indicates that patients have significantly fewer hospital visits in the year following enrollment in the CCN. Mr. Perkins presented these results at the Unite For Sight Global Health & Innovation Conference. Dr. Frazier's paper with two colleagues, "Preparing for Sperm-Targeted Contraception: College Students' Perceptions and Intentions Related to Non-Hormonal Intravas Injectable Gel" was published in *Public Health Nursing*. In addition, she presented "System Dynamics of Medicaid Enrollment: a new approach to inform policy" at the International Conference on Health Policy Statistics. She spoke about "Lying with Data" to a full crowd at the Wooster Science Cafe. Dr. Frazier also stepped into a new role as Assistant Director of the Applied Methods and Research Experience (AMRE) program during its first all-remote summer.

FACULTY

Sofia Visa, Associate Professor of Computer Science

TEACHING

Scientific Computing
Data Structures and Algorithms
Multimedia Computing
Computer Networking and Communication
Senior Independent Study Advisor
****

Dr. Visa worked with Max Hosler ’22 on an NSF-sponsored research project. Together they developed a ReactNative-based phone app that classifies tomato fruits into one of the nine shape categories shown in Fig. 1. This app illustrated in Fig. 2 will be used in the greenhouse for taking pictures and classifying many tomato fruits. This data will be used later by our geneticist collaborators for linking tomato fruit shapes to genetic data.

This year Dr. Visa, together with two Wooster students, Erika Goetz ’20 and Angelo Williams ’21, had results of their research published in a journal and a conference paper, co-authored with collaborators from Univ. of Massachusetts and Univ. of Georgia. This paper incorporates their recent work on finding 34,980 structural variants in tomato genomes of 142 tomato varieties. These structural variants allowed the geneticists to reconstruct the tomato domestication and to identify genes that are associated with tomato taste. Further, these structural variants will be used to identify traits in wild tomatoes that have been lost through domestication, but which still might be desirable in the domesticated tomato.

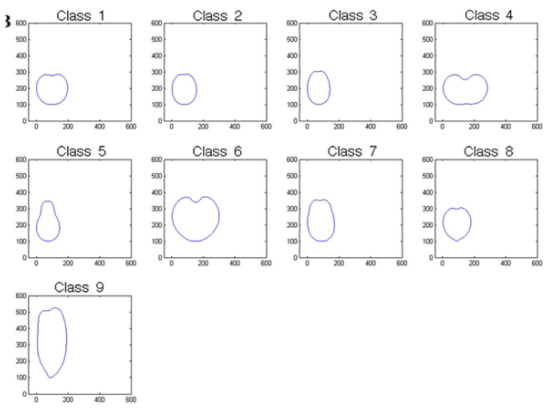


Fig. 1

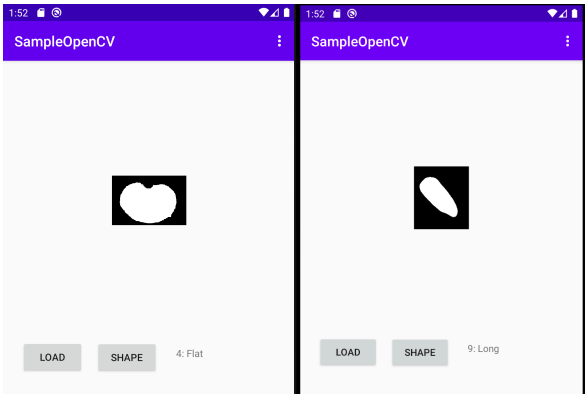


Fig. 2

FACULTY

Jillian Morrison, Assistant Professor of Statistical & Data Sciences

TEACHING

Calculus I
Probability
Introduction to Data Sciences
Independent Study Advisor
****

Dr. Morrison joined the department as our second tenure-track faculty member in Statistical & Data Sciences. A native of Belize, she completed her Ph.D. in Statistics at Washington State University shortly before coming to Wooster. In her first year at Wooster, Dr. Morrison developed the Intro to Data Science course, which will be an entry point for students interested in exploring the SDS major. Her research interests include assessment of teaching and learning, and she is writing a statistics textbook. Dr. Morrison was also a 2019-20 Project NExT fellow.

Colby Long, Assistant Professor of Mathematics

TEACHING

Transition to Advanced Mathematics
Multivariate Calculus
Applied Data Science
4 Senior Independent Study advisees
****

After a postdoc in the Mathematical Biosciences Institute at Ohio State University and an internship at Nationwide Insurance, Dr. Long joined the department as a tenure-track mathematician. During the 2019-2020 academic year, Dr. Long was a Project NeXT fellow and participated in a number of teaching workshops at the Joint Mathematics Meetings in Denver, CO. He also continued research collaborations in phylogenetics and algebraic statistics and presented work virtually at Algebraic Statistics 2020 in Honolulu, Hawaii.

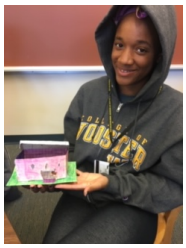
FACULTY

Ronda Kirsch, Math Center Coordinator and Instructor

TEACHING

Calculus 1A
Calculus 1B
****

Ronda participated in the Youngstown Early Intervention Program (YEIP) which meets on campus for 2 weeks during the summer. She also attended an Inquiry Based Learning conference in Portland.



Students participating in the YEIP Program

Robert Kelvey, Visiting Assistant Professor of Mathematics

TEACHING

Calculus 1
Abstract Algebra
Transition to Advanced Mathematics
Real Analysis
3 Senior Independent Study advisees
****
Dr. Kelvey finished work with the Ohio Collaborative in Fall '19.
https://ohiolink.oercommons.org/courseware/20

Dr. Kelvey gave a co-talk at the Joint Math Meetings in Denver in January '20 with colleague Dr. Jennifer Bowen, titled "*Project-based abstract algebra using Office Hours with a Geometric Group Theorist,*" based off of a course taught by Dr. Kelvey & Dr. Bowen in Spring of '18.

Rob also made progress on a project with collaborator Zachary Gates, a Visiting Assistant Professor at Wabash College, involving the study of certain games on Cayley graphs. Progress was made all throughout '19-'20 school year and will be seeking publication soon!

FACULTY

Nathan Sommer, Assistant Professor of Computer Science

TEACHING

Imperative Problem Solving
Data Structures Lab
Theory of Computation
Software Engineering–Databases
Senior Independent Study advisor

****

This spring, Dr. Sommer completed his Ph.D. in computer science at The University of Cincinnati. He has developed curriculum for a "flipped" version of Imperative Problem Solving, the second course in the introductory CS sequence and plays a key role in preparing students for Senior I.S. through the software engineering courses and in AMRE. Dr. Sommer currently has research work in progress related to AI-driven music and CS education.

Nathan Fox, Visiting Assistant Professor of Mathematics & Computer Science

TEACHING

Calculus II
Data Structures Lab
Problem Seminar
Linear Algebra
Senior Independent Study advisor

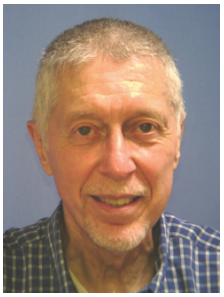
****

Seven students took The William Lowell Putnam Exam, advised by Dr. Fox.

Nathan will be headed to Buffalo, New York in the Fall of 2020 to start his new tenure-track position at Canisius College.

"Despite being excited for the opportunities ahead of me, it was not an easy decision for me to leave Wooster. My time here has been everything I could have asked of a first job out of graduate school and more. And this is thanks to all of you. I will greatly miss the level of camaraderie and support in this department, and I'll miss each of you. This department is on an exciting path, and I'm sad I won't be here as we continue along that path."

FACULTY/STAFF



James Hartman, Professor of Mathematics

Calculus I Calculus II

****

Jim officially retired from the College at the end of the 2018-2019 academic year after 38 years at The College of Wooster. However, in the Fall of 2019 he taught one section of Calculus I and in Spring 2020, taught two sections of Calculus II as an adjunct instructor. In September of 2019 a problem solution submitted to The College Math Journal was published. Jim continued work with the College Board in AP Calculus by being a question leader in the grading of the AP Calculus exam in Kansas City for 12 days at the beginning of June. In addition, he was co-director and consultant for a 4-day AP Summer Institute at Wooster in June and an instructor for a one-week AP Summer Institute in Shang Hai, China in August of 2019. In October of 2019, he was a consultant for a one-day AP Workshop at Alverno College. Finally, in June of 2020 he served as an online question leader for the online Covid-19 format AP Calculus exam given in May.

Mary Jo Kreuzman, Math Instructor

Transition to Advanced Mathematics

Mircea Ionescu, CS Instructor

Principles Comp Organization

Kyle Terakedis, Math Instructor

Business Calculus

Tom Montelione, CS Instructor

Scientific Computing

Dave Risser, Math Instructor

Math in Contemporary Society

Dawn Parker, Administrative Coordinator

Taylor Hall

FACULTY

John Ramsay, Professor of Mathematics

TEACHING

Operations Research
First Year Seminar
Senior Independent Study advisor
****

John was recently named the winner of the 2020 Ohio PKAL STEM Educator Award which "recognizes excellence and innovation in the filed of STEM education at the college level." The Ohio chapter of Project Kaleidoscope (a subsidiary of the Association of American Colleges & Universities) noted that John's, "*…continued involvement since the inception of Wooster's Applied Methods Research Experience summer program in 1994 demonstrates the effectiveness of relationships with corporate partners exposing students to 21st century skills such as collaboration and communication*."

After 33 years in the department and 26 years as the founding director of the AMRE program, Dr. Ramsay will be (semi)-retiring this summer. He will still be around Taylor, helping lead AMRE and teaching a class or two, but will also get to spend more time with his grandchildren.

FACULTY

In Memory of :

Denise Byrnes,

Associate Professor of Computer Science

A trailblazer in Wooster's computer science academic program who was devoted to her students, Denise Byrnes served as a faculty member for 29 years. She inspired countless students in her courses and her passion for virtual reality gaming is evident in the long list of IS theses she advised on animating emotion, 3-D virtual worlds, and human-technology interactions. Denise led the Computer Science major skillfully for many years, expanding the major curriculum and attracting new faculty and students. She designed the successful introductory course, "Multimedia and Scientific Computing". For many summers, she served as an expert AMRE advisor to students and local industry clients. She was planning to retire at the end of the '20-'21 year and will be greatly missed by the Mathematical and Computational Science Department and other colleagues.

Dr. Byrnes' most significant impact was the indelible mark she left on so many Wooster students, who fondly remember the care, interest, and love she showed in them. Recent student comments describe her as "a kind and welcoming person that made her field into something both fascinating and accessible," a "beautiful soul," and "witty, sensible, and always honest." For her teaching philosophy, Denise shared:"The computer science discipline is driven by rapid advances in computing technology. It is difficult to catch one's breath when your field is moving at a break neck pace and its application is extended to yet another discipline. This is exactly why I fell in love with the field; the necessity for continued learning and its ubiquitous application to general problem solving…I hope my excitement is contagious."

CONTESTS/ CONFERENCES

ASA DataFest Miami University

The American Statistical Association (ASA) DataFest is a celebration of data in which teams of undergraduates work around the clock to find and share meaning in a large, rich, and complex data set. DataFest was founded at UCLA in 2011 and sponsored by the American Statistical Association. The event is hosted by several of the most prestigious colleges and universities in the country with more than 2000 students taking part.

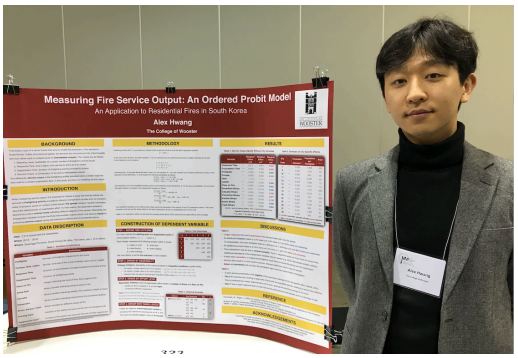
Undergraduate students do the work, but they are assisted by roving consultants who are graduate students, faculty, and industry professionals. After two days of intense data wrangling, analysis, and presentation design, each team is allowed a few minutes and no more than two slides to impress a panel of judges.

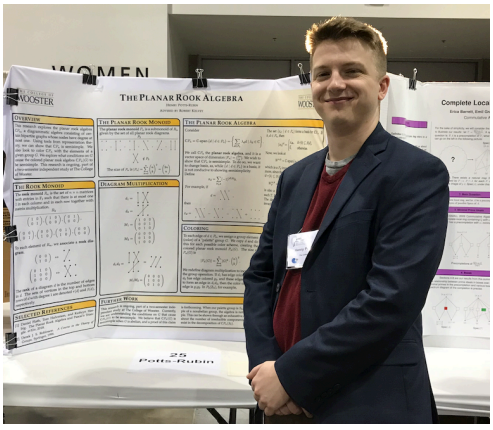
DataFest 2020 was cancelled due to the pandemic.

2019 Putnam Competition

Seven students participated in the annual William Lowell Putnam Competition, a prestigious (and extremely challenging) national contest for undergraduates in theoretical math. Nathan Fox was the faculty advisor for this group, and taught a related once-a-week seminar course in the fall, helping students prepare for the competition.

CONTESTS/ CONFERENCES





Presenting posters at the Joint Mathematics Meetings: Alex Hwang '20 (top right), Henry Potts-Rubin '20 (left), Isaac Weiss '20 (bottom right)

COMAP

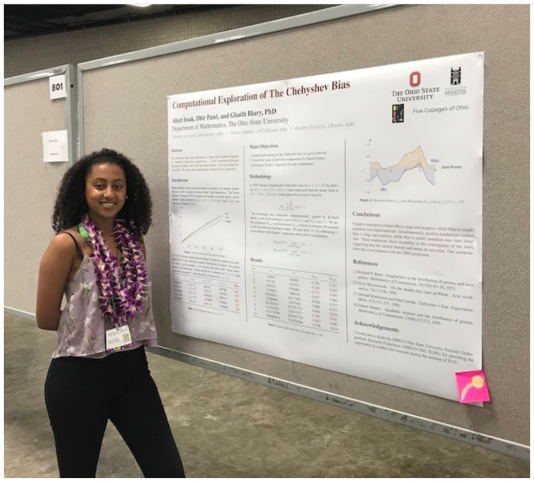
MCM: The Mathematical Contest in Modeling
ICM: The Interdisciplinary Contest in Modeling

Two teams advised by Drew Pasteur competed in the Spring.

Kien Le '22, Bang Nguyen '22, Tran Anh Vu Bui '21

Morgan Kromer '22, El Yazid Chalabi '22, Jihun Kim '22

CONTESTS/ CONFERENCES



Issak with her award-winning research poster presentation

Mathematics major and international student from Ethiopia at The College of Wooster, Alayt Issak ’21 started her junior year by meeting and networking with professionals in her field at three conferences that she attended. Each conference provided Isaak with slightly different opportunities and catered to a different area of her interests, but together all of these experiences allow Issak to return to Wooster with a greater understanding of what real-world computing looks like.

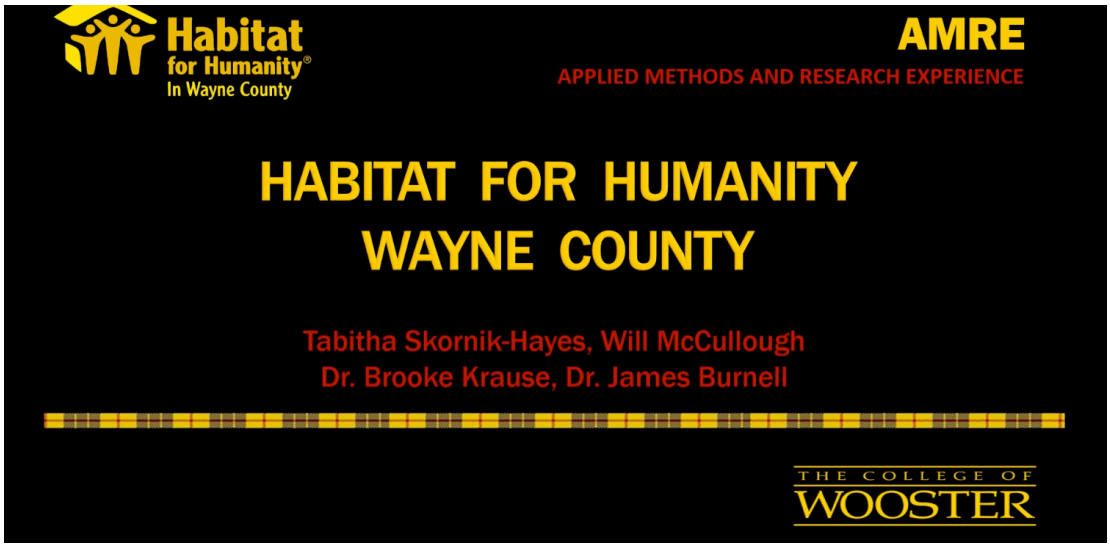
AnitaB.org is the organization that holds the Grace Hopper Celebration

Not only was Issak able to learn from hearing about other’s research, but she presented her own research along with the professionals around her at SANCAS (The National Diversity in Stem Conference), which works to empower and energize participants in the multidisciplinary paths of STEM that they are involved in. Presenting the research she did over the summer titled “Computational Exploration of The Chebyshec Bias,” Issak was recognized for her outstanding research and poster presentation.

In addition to the educational experiences the conferences’ offered, Isaak got a taste of real-world living as well. “Conferences are expensive, but they do not have to be,” said Isaak. By taking the initiative to find scholarships offered by the conferences, the cost of attending was greatly diminished for Isaak, so she was able to spend her money on other unexpected costs such as food, transportation, and souvenirs.

AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

John Ramsay, Director and Marian Frazier, Asst. Director



About HHWC

- Became a Habitat for Humanity affiliate in 1986
- 82 homes built since then
- 2 new homes built yearly

ReStore

Sells affordable, gently used building materials.

"Volunteering Virtually":

From left to right:

Research Advisors Dr. James Burnell & Dr. Brooke Krause,

AMRE Researchers Tabitha Skornik-Hayes & Will McCullough

AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

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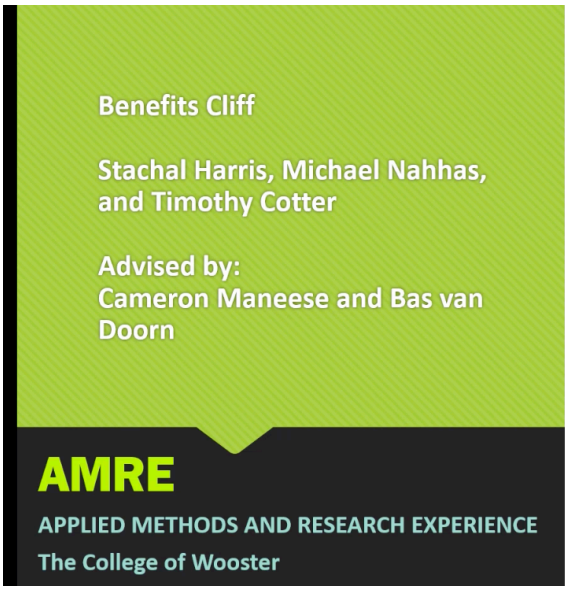


FUND FOR OUR ECONOMIC FUTURE

The goal of the AMRE Benefits Cliff II project was to research and recommend policy solutions on the local and state level to reduce the impact of a benefits cliff, as well as give an update on the current rules and eligibility for public benefits. The team collaborated with local non-profits, various state and local elected officials, and government agencies to determine challenges and solutions, especially under COVID-19. The team developed a four-pronged approach to address benefits cliffs in Ohio, which they presented to a variety of state and local agencies, organizations, and elected officials.

AMRE researchers Tim Cotter (top left) working in New York, Stachal Harris (top right) working in Arizona, & Michael Nahhas (bottom left) working in Ohio, meeting with County Commissioner Ron Amstutz (bottom right).

AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

John Ramsay, Director and Marian Frazier, Asst. Director

- STEM Success Initiative (SSI)
- Analyzing retention and persistence within STEM fields
- Determining how best to help underrepresented (UR) students
- Establishing where the SSI should put their resources for best success

Researcher Brendan worked remotely in Vermont, Sky worked in Ohio, Bang worked on campus and Ariel worked remotely in China.

AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

John Ramsay, Director and Marian Frazier, Asst. Director

Arts & Culture District

APPLIED METHODS AND RESEARCH EXPERIENCE
AMRE

Development Options for a Downtown Wooster Arts and Culture District

Brandon Charles '22, Katie Harvey '21, Andreas Xenofontos '21
Advised by Dr. Timothy Freeze, Dr. Brooke Krause

OUR PROJECT

This project aimed to produce preliminary ideas for an arts and culture district in downtown Wooster. Through conversations with members of the Wooster community and arts and culture district representatives from across the country, our team compiled a list of development opportunities that will inform the creation of plans for a designated downtown arts and culture district. The final report addressed economic impact, retail and residential opportunities, annual district programming, management oversight, and COVID-19 considerations.

OUR CLIENTS

Our five clients all operate with the overall goal of bettering the Wooster community. The Wayne Center for the Arts and the Wooster Downtown Arts Theater are working to hone the arts community. The City of Wooster, Main Street Wooster, and United Way of Holmes and Wayne Counties serve the people and businesses of the city of Wooster through programming

WHAT WE LEARNED

Working with a group of five clients with varying interests challenged us to stay organized, research deeply, and have open conversations for sharing information. Through a host of professional meetings with our clients and other parties, our team learned how to better assert ourselves and improved our presentation and communication skills. This experience prepares us to work in a professional team setting, as we enter the rest of our academic careers and professional careers.

CONCLUSIONS

As numerous cities have demonstrated by their experiences, the creation of an arts and culture district can have very positive economic effects for a community. Arts and culture events within a district inspire about both event-related and non-event-related spending that stimulates the local economy. Under the management of downtown organizations and leaders, either formally or informally structured, Wooster has the potential to fund and enact programs, such as housing redevelopment or tax incentives, that draw artists into the downtown to live and work. By drawing in residents, visitors, and businesses, these programs have proven to advance the cultural economy of the neighbourhood.

Beyond the economic benefits of bringing in deliberate spaces for the arts, construction of arts and cultural features, such as an amphitheater, sculpture garden or public art, assists in the creation of social benefits relating to mental health and a decrease in crimes of opportunity.

The impact of the COVID-19 health crisis on arts and cultural organizations will continue to be of importance as plans continue. However, with flexibility and creativity, these organizations have and will continue to find alternative ways to reach audiences solutions

ACKNOWLEDGEMENTS

This project would not have been possible without the leadership team from AMRE, who oversaw it from conception to realization. We extend our greatest thanks to our advisors, Dr. Brooke Krause and Dr. Tim Freeze, who pushed us to become better researchers, writers, and speakers. Finally, we would like to express our gratitude for this project's stakeholders and financial supporters. These visionaries have supported, not only this project, but countless efforts to make Wooster an even more brilliant place to live and work. Thank you!

THE COLLEGE OF WOOSTER · United Way · MAIN STREET WOOSTER INC · WOOSTER DOWNTOWN ARTS THEATER · WCA WAYNE CENTER FOR THE ARTS · Wooster OHIO

AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

John Ramsay, Director and Marian Frazier, Asst. Director

Wooster Tree Ring Lab Project

A dendrochronological analysis of the climate response of trees in Alaska and Wooster.

Srushti Chaudhari '22, Mazvita Chikomo '22, Wenshuo Zhao '23

Advised by Dr. Wiles

OUR PROJECT

The AMRE Tree Ring team worked with a variety of clients such as Dr. Ben Gaglioti of University of Alaska Fairbanks, Dr. Vargo a Wooster alum and a glaciologist studying in New Zealand, TRAYLS, Secrest Arboretum and many others. The focus of the program was to conduct a dendrochronological analysis of the tree ring series of Mountain Hemlock, Western Hemlock, European Larch, and White Oak trees. The team updated analyzed past climate data in Alaska and northeast Ohio to examine the climate response of these trees to various environmental factors. The team used this data to construct reports for their various clients.

CLIENTS

The City of Wooster
Wayne County Commissioners
Secrest Arboretum, Wooster, Ohio
Tatitlek Corporation, Anchorage, Alaska
TRAYLS – Hoonah, Alaska
Dr. Tim Barrow, Wollongong University, Australia
Dr. Ben Gaglioti – University of Alaska, Fairbanks
Cleveland State University



WHAT WE LEARNED

Teamwork
Research Skills
Communication
Network Connections
Creatively Thinking
Friendship
Question Solving
Learn the World



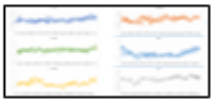
CONCLUSIONS

European Larch Project

- June-July precipitation correlation deteriorates in late 1970s due to Wooster pluvial.
- Tree growth negatively affected by high summer temperatures.

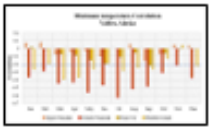
Western Hemlock Project

- Chronologies uplifted in recent years.
- Strong LIA summer response, especially for YL site.
- Better time-stable correlation with T_{mean} compared to T_{min}.
- Stronger correlation after 1950s.



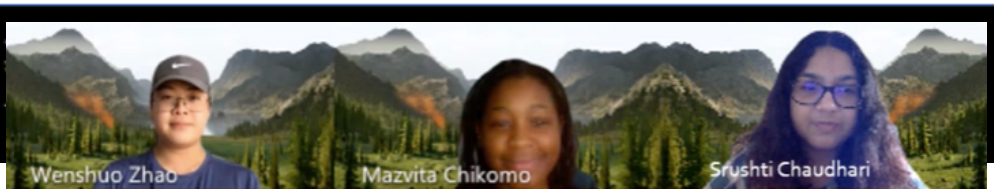
Mountain Hemlock Project

- Negative correlations with minimum temperature at four sites in Columbia Bay, Alaska caused by reduced snowpack, carbon storage imbalances
- Glacier has minimal impacts



ACKNOWLEDGEMENTS

This work is supported by the Sherman-Fairchild, Luce, and National Science Foundations. We are also grateful to Dr. Gregory C. Wiles from the College of Wooster, TRAYLS group, Earth Sciences department technician, Nick Wiesenberg from the College of Wooster, and Dr. Ben Gaglioti from the University of Alaska, Fairbanks. They made enormous contributions on sample gathering, analyzing, and academic assistance to this study.



AMRE
APPLIED METHODS & RESEARCH EXPERIENCE
2020 PROJECTS

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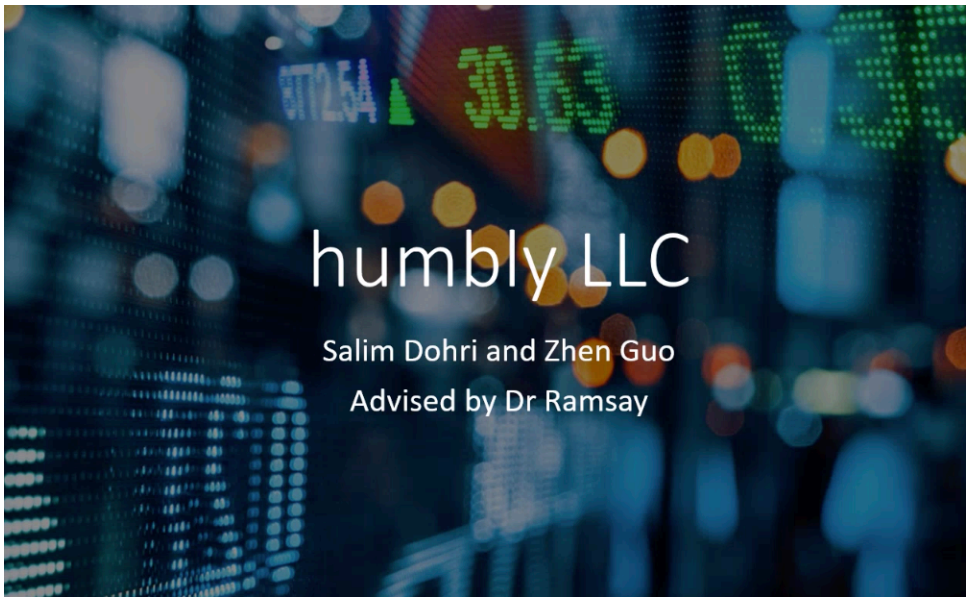
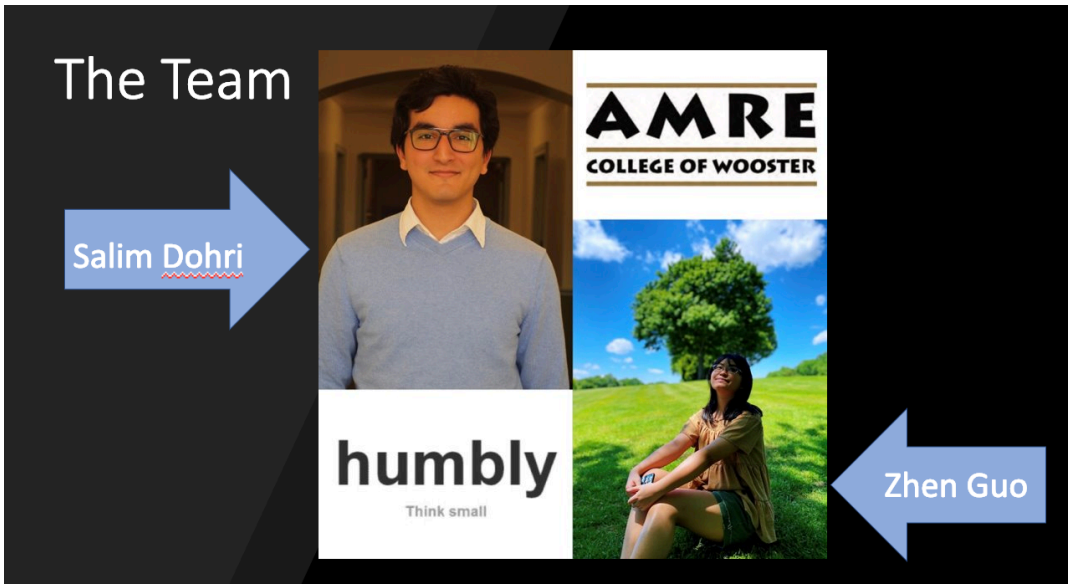


Humbly LLC is a technology company based in Philadelphia, whose primary business website domain reselling and issuance. The AMRE project for this client included two components of the business: one data analytics project, and one software engineering project. The data analytics work was to build a pricing model for humbly's domain auction business. The software engineering work was to develop a web application to do URL shortening.



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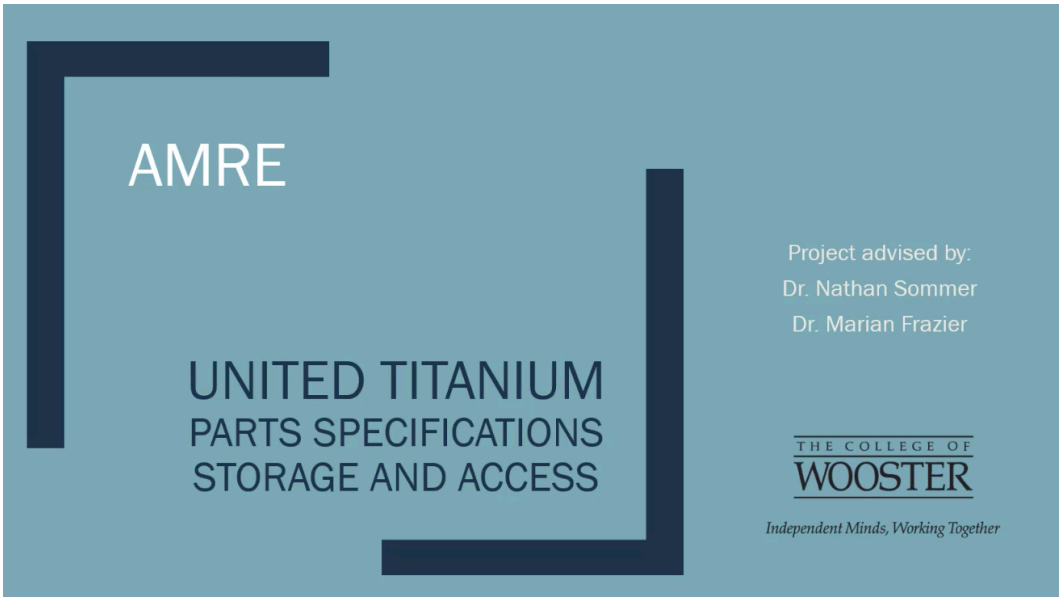
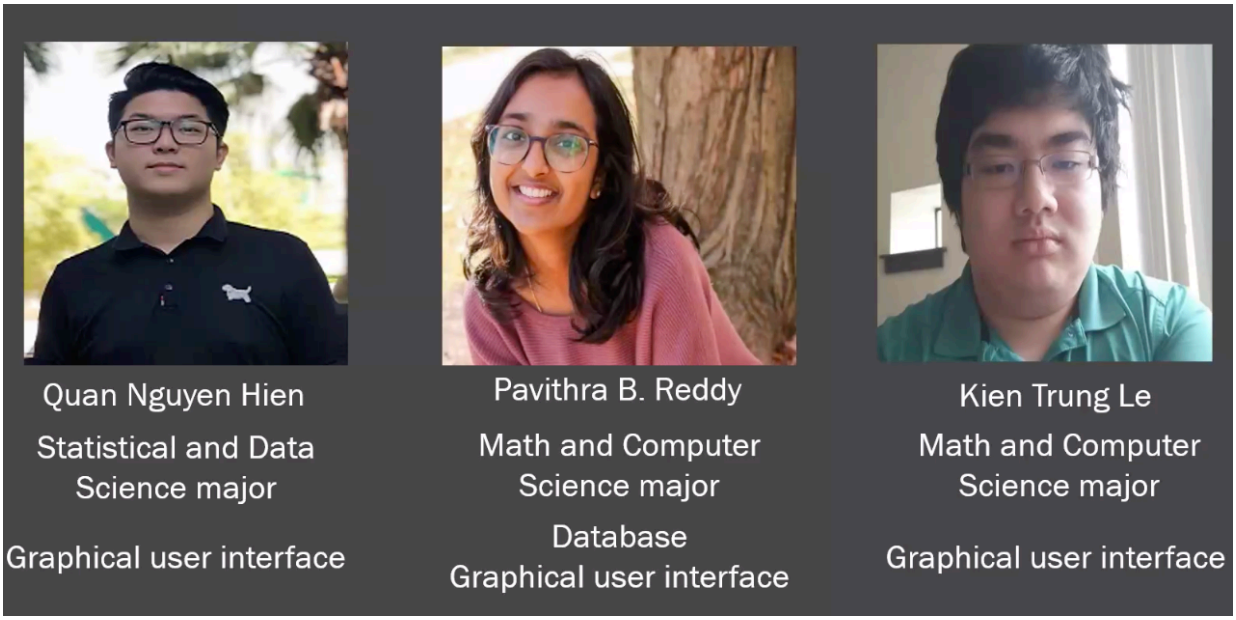


The team designed a database to store specifications for the parts manufactured at United Titanium. Further, they built a graphical application that allows employees to modify the database and retrieve relevant information from it. The database stores information about the product type, size, material, and other important details. Using the GUI, a user can insert and retrieve entries from/to the database, search for and update an existing record.



Researcher Quan worked remotely in Vietnam, Pavithra worked remotely in Florida, and Kien worked on campus.

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2020 PROJECTS

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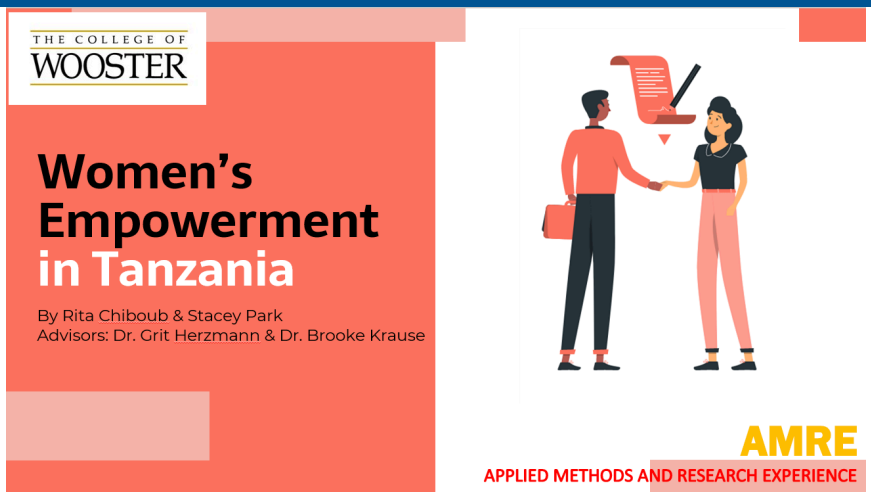
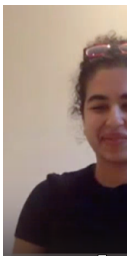
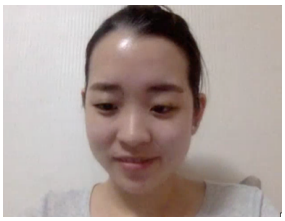


The "Women's Food Security Program for Impoverished Maasai Households" project aims to increase food security through a more diversified income through program implementation over the course of five years (2015-2020). By incorporating programs such as entrepreneurship and business skills training and women's focus groups, researchers were able to gather data on the relationship between women's empowerment and food security. The team was tasked with cleaning and conducting data checks on the quantitative data and researching information relating to program implementation in Tanzania. They also organized and conducted interviews with NGO partners to add detailed information regarding the program implementation process.





AMRE Researchers: Ghita Chiboub (left) working remotely in Canada, Stacey Park (right) working remotely in South Korea