MAA

MATHEMATICAL ASSOCIATION OF AMERICA

PRESENTS

PIC MATH 2020 STUDENT SHOWCASE

PRESENTED VIRTUALLY

July 31, 2020 & August 1, 2020
12:30pm - 2:00pm ET

SCHEDULE OF EVENTS

Friday, July 31

12:30pm	Introduction: PIC Math Leadership
12:35pm	Onondaga Community College
12:40pm	Youngstown State University
12:45pm	Kutztown University
12:50pm	Rowan University
1:00pm	Industry Speaker: Raymond T. Perkins
1:30pm	Ouachita Baptist University
1:35pm	University of Northern Colorado
1:40pm	The Catholic University of America
1:45pm	New York University
1:50pm	Idaho State University
1:55pm	Closing: PIC Math Leadership

MAA.ORG/PIC-MATH

SCHEDULE OF EVENTS

Saturday, August 1

12:30pm	Introduction: PIC Math Leadership
12:35pm	University of Guam
12:40pm	Dixie State University
12:45pm	Bates College
12:50pm	Centre College
12:55pm	Frostburg State University
1:00pm	Industry Speaker: Gwen Spencer
1:30pm	Whittier College
1:35pm	California State University, Channel Islands
1:40pm	Lone Star College-North Harris
1:45pm	Wentworth Institute of Technology
1:50pm	Carleton College
1:55pm	Closing: PIC Math Leadership

MAA.ORG/PIC-MATH

PROJECT ABSTRACTS

In order of presentation

Onondaga Community College

Investigating Recidivism into Poverty for JOBSPlus! of the Department of Social Services in Onondaga County (New York)

Faculty Advisor: Patty Zabel

Student Presenters: Eric Frank, Lewes Kunda, Greg Reeves, and Ian Allen

The Department of Social Services in Onondaga County (New York) has been experiencing an issue with recidivism in their applicants, meaning that citizens are returning to the program after their income has reached the threshold to receive temporary assistance. The DSS provides additional assistance for 30 days after a case has closed due to excess income; however, they have determined that this 30-day window is not sufficient, as applicants frequently return. These citizens assimilate into a "cycle of poverty", which typically remains unbroken by subsequent generations. The goal that DSS and JOBSPlus! presented to our team was to find a more appropriate window of time to provide additional assistance, which will aim to reduce (or even eliminate) the amount of times applicants reapply to the program.

Youngstown State University

Mahoning County LandBank Impact Measurement Project

Faculty Advisor: Thomas Wakefield

Student Presenters: Madison McDonald, Jonathan Snyder, and Keith Sikora

The Mahoning County Land Bank is a nonprofit corporation that focuses on community improvement within the county. Their overall goal is to see a reduction in crime rates and create a more stable housing market within the different intervention areas. Through the partnership with local government and large variety of nonprofit groups, and community members, the Land Bank has completed a variety of demolitions and other types of interventions on vacant houses or lots. After intervention, the corporation wants to see a clear, positive impact on the different areas and communities. Through a preparation for industrial careers in mathematics (PIC Math) course at Youngstown State University, the Land Bank recruited a group of students to assist them in reporting positive impacts. In order to examine the impact, research was conducted over ten different neighborhoods, five control groups and five intervention areas. For each location property values and transfers, crime rates, number of demolitions, elasticity of demand, and the number of property sales over time were examined. Some major results of the project included identifying a positive, linear relationship between demolitions per structure and the difference in crime per capita from 2014 to 2019 and elasticity of demand for home ownership. The research conducted for this year provides data that shows the overall goal of the organization is being reached more and more. Every year Land Bank continues to operate and intervene in these areas, more and more data becomes available to show their positive impact.

Kutztown University

Estimating the Cost of Inflow and Infiltration at the Borough of Kutztown Wastewater Treatment Plant

Faculty Advisor: Eric Landquist

Student Presenters: Vanessa Maybruck, and Robert Goold

Inflow and infiltration (I&I) consists of groundwater and rainwater that enters the sanitary sewer system via direct or indirect connections to the sewer line (i.e. through illegal connections or damaged pipes). I&I is a major financial and environmental issue for wastewater treatment plants because it increases costs by processing non-wastewater and increases overflow risks, which pose a public health hazard. This study focuses on the Borough of Kutztown, PA Wastewater Treatment Plant and its efforts to reduce I&I in the Kutztown area. (continued on next page)

PROJECT ABSTRACTS

(continued from previous page) The goals of this project are to assess the severity of the I&I problem at several different pump stations, approximate the percentage of total I&I that is being processed by the plant, and determine total possible savings if I&I were eliminated. By comparing precipitation and pump discharge at the pump stations of interest, we determined that there is a strong positive correlation between them at two of the pump stations, as compared to the control pump station, which we assumed had no I&I. Furthermore, we found that 77.7% of the wastewater flow that the plant processes is actually I&I, and the plant spends roughly $1.15 million treating I&I every year. This presents a strong case for the need to implement I&I control strategies in Kutztown, which presents one direction for future work. Our priority, however, will be refining our model and applying further analysis to the pump station systems to determine the best ways to approach the I&I problem in Kutztown.

Rowan University

Identifying Road Anomalies Using YOLO

Faculty Advisor: Thanh Nquyen
Student Presenters: Matthew Gartland, Ciara Sikking, and Nicholas Sokoya

We consider the problem of detecting road distresses from visual images captured obtained from a camera attached to a car bumper. This project aims to categorize images of roads into good or bad road images. Furthermore, if an anomaly is identified on a road surface, it will be labeled as a crack, pothole, marking, or patch. Our method is based on a Convolutional Neuron Network model named YOLO for image classification. Our method can categorize potholes, patches, and cracks quite well.

Ouachita Baptist University

Flash X-Ray Machine Diagnostics

Faculty Advisor: Jeffery Sykes
Student Presenters: Lauren Dunaway, Sarah Freeze, Caleb Harmon, and Bryan Honeck

Researchers at the Nevada National Security Site (NNSS) employ the Cygnus flash X-ray machines in experiments to study nuclear weapons materials. The authors worked with Dr. Marylesa Howard of NNSS to analyze data from numerous Cygnus diagnostics with the goal of helping NNSS to more quickly identify bad shots and, eventually, to predict when a bad shot is about to occur. The team was able to identify quantitative characteristics of several diagnostics that could be used to identify a bad shot.

University of Northern Colorado

The Effect of Zoning on Traffic

Faculty Advisor: Virgil Pierce
Student Presenters: Maxwell Solko, Jeremy Taylor, and Olivia Nikkari

Our initial task was to explore the connections between traffic flow and zoning, specifically how zoning changes affect traffic in the surrounding area. We wanted to explore how a zoning change affects traffic on an adjacent road network and the existing road network. Additionally, we hoped to gain an understanding of the zoning changes necessary to make alternative forms of transportation more appealing, as would be useful for a municipality hoping to encourage public transportation and bicycle use. We interpreted these three questions as questions about how to optimize traffic flow through zoning classifications, which became the primary focus of our research.

PROJECT ABSTRACTS

The Catholic University of America

Optimizing Waste Collection In Howard County using Mathematical Modeling Techniques

Faculty Advisor: Prasad Senesi

Student Presenters: Beth Pacious and Sarthak Regmi

Route optimization is a common problem in business and industry. Our research team considered the problem of optimizing the routes taken by trash trucks in a local county. Whereas the problem of finding a route of minimal distance is familiar, we considered the more challenging problem of optimizing a route with respect to the work done by a truck,which is a function not only of distance but also of accrued weight as more trash sites are visited. This variation on the standard route optimization problem posed some remarkable challenges for us. In this report on our research project, we will discuss data collection, mathematical theory, strategies, algorithms, and future directions.

New York University

An Automatic Task Assignment System for Bus Fare Evasion Monitoring

Faculty Advisor: Vindya Bhat

Student Presenters: Yiming Huang, William Zhang, and Thierry Zhao

The New York City Transit ("NYCT") runs a fare evasion monitoring program that manually assigns a daily schedule to checkers on the bus and subway system. The goal of this project is to automate and optimize this process by delivering a monthly schedule for the NYCT bus checkers via optimizing task coverage and considering various constraints. The scope of this project is split between task gathering and task assignment. Task gathering focuses on the valid tasks that can be completed by a checker within a day and such is resolved by constructing a graph simulating a checker's trajectory and using a variation of the traveling salesman problem algorithm. Task assignment deals with the scheduling process regarding the pool of valid daily tasks and is approached through two methods, one focusing on constrained randomness and another one using meth-heuristics genetic algorithm. In the end, the completed model through the constrained randomness method was able to achieve 88% sample coverage while the genetic algorithm method achieved 25% sample coverage and still requires additional optimization.

Idaho State University

Skills Taxonomy

Faculty Advisor: Xiaoxia Xie

Student Presenters: Present Karmacharya, and Dongyou Yu

The project is to classify occupations based on skill requirements provided in online job advertisements. It has the potential to allow measurement of a person's career progression within a skill domain, to recommend jobs based on a person's skills, and to mitigate occupational misclassification. They believe that the main contributions are a methodology for grouping jobs into occupations based on skills.

University of Guam

An Analysis of the Fujita Pump Station

Faculty Advisors: Leslie Aquino, JaeYong Choi

Student Presenters: Allison Padaong, Mary Gold Raz, Jacob Richards, and Jonathan Bondoc

PROJECT ABSTRACTS

Dixie State University

Trail Density Prediction Model for Zion National Park

Faculty Advisor: Vinodh Chellamuthu

Student Presenters: Douglas Baer, Heather Smith, and Nicholas Warner

Every day, thousands of people come to Zion National Park to enjoy its world famous hiking trails and stunning views. Park administration needs a means to predict how many hikers will be on a trail the next day, by the hour. This will help them better plan for the future, allocate resources, and provide visitors with insight on trail activity levels. Many factors influence an individual's decision to hike a trail at a particular time. Thus, predicting the number of hikers on a trail at a given hour of the next day is a complex problem. Utilizing simulated data from past years' park visitation and trail activity, and Kapoor and Bedi's (2013) weather predicting Sliding Window Algorithm, we developed an algorithm to make trail activity predictions as described. Our algorithm's predictions will enhance Zion National Park's planning capabilities and improve visitors' experiences at the park.

Bates College

Expanding outreach for a Maine mental health services provider

Faculty Advisor: Adriana Salerno

Student Presenters: Jason Canaday and Claire Ruhlman

Tri-County Mental Health Services is interested in expanding outreach across its Maine constituency. Based on demographic data compiled from one operational year, TCMHS has requested a predictive model to identify areas of potential new customer base. In doing so, TCMHS will gain greater understanding of its current impact and target areas of possible growth. Our goal is to create an accurate model based on the data TCMHS has provided. Due to the sensitive nature of this information, TCMHS has disidentified all data (in accordance with HIPAA) in order to protect clientele. Thus, our challenge is to construct a realistic needs assessment using a combination of internal and external data. Ideally, in following our recommendations, TCMHS will better be able to accomplish its mission of serving the greater Maine community.

Centre College

Aging Bourbon

Faculty Advisor: Michael Lamar

Student Presenters: Ana Gabriela Mira, James Pack, Cameron Cahill, and Jack Shannon

We seek to model the costs associated with aging bourbon beyond the minimum of four years. By accurately modeling these costs, we can determine profitability at different price points for different ages of bourbon. Similarly, given a market demand profile, we can optimize the allocation of the bourbon for various ages to maximize profit.

Frostburg State University

Redistricting Mineral County EMS Box Areas

Faculty Advisor: Justin Dunmyre

Student Presenters: Bailey Brewer, Jay Collins, Andrew Kastner, and Will Macomber

The map of Mineral County in West Virginia is partitioned into regions called box areas. These box areas indicate which of the 9 ambulance companies will respond to an emergency. The box areas that are currently in use were created more than 20 years ago by the heads of the companies. The box areas were created based only on their judgement, as they did not have access to sophisticated data at the time. The goal of this project is to use existing geospatial data to redraw the box areas so as to improve response times and, accordingly, save lives.

PROJECT ABSTRACTS

Whittier College

Clustering COVID-19 Lung Scans

Faculty Advisor: Fred Park

Student Presenters: Jacob Householder, Andrew Householder, and John Paul Gomez-Reed

With the recent outbreak of COVID-19, creating a means to stop the spread and eventually develop a vaccine are the most important and challenging tasks that the scientific community is facing right now. The first step towards these goals is to correctly identify a patient that is infected with the virus. Our group is applying a technique to identify COVID-19 infected patients using unsupervised machine learning. This is an important topic as COVID-19 is a novel disease that is currently being studied in detail and our methodology has the potential to reveal important hidden differences between it and other lung targeting illnesses. This could then in turn, allow doctors to react appropriately to each patient. Our proposed method utilizes, Principal Component Analysis (PCA), t-distributed Stochastic Neighbor Embedding (t-SNE), and the recently developed Robust Continuous Clustering algorithm (RCC). We display the performance of RCC in identifying COVID-19 patients and its ability to compete with other algorithms, namely K-Means++ (KM++). This not only opens new possible applications of RCC, it could potentially aid in the creation of a new tool for COVID-19 identification.

California State University, Channel Islands

Comparisons of Reduced Order Models Using Principal Component Analysis, Non-Negative Matrix Factorization and Tensor Decomposition to Analyze Radiation Transport

Faculty Advisor: Alona Kryshchenko

Student Presenters: Avery Brunk, Adam Capdeville, Peter Madsen, Christopher Salas, and Hunter Bilby

Radiation transport is the study of how particles like neutrons, photons, electrons, and α-particles (Helium nuclei) move through a scene and interact with matter. These different particles get emitted in the real world by machines like linear accelerators or pulse-power X-ray sources and by radioactive materials. In order to study radiation, it is necessary to be able to measure it, and there are many kinds of radiation detectors used in applications from high energy physics to nuclear emergency response. One of the biggest challenges in radiation detection is identifying the source of radiation from a measured radiation spectrum. We were provided with a data set containing radiation spectra produced by Monte Carlo simulation for Cesium-137, Cobalt-60 and Technetium-99m by Dr. Aaron Luttman from the Pacific Northwest National Laboratory and analyzed it with reduced order modeling (ROM) which is a common technique used when working on the Monte Carlo simulation of radiation transport. Reduced order modeling allows for quicker and more explainable results of the simulation, as well as capturing the dynamics of the data. Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF) and Canonical Polyadic Tensor Decomposition (CPT) are the specific types of reduced order modeling we used. These methods decompose the data into features which will explain various behaviors that are present in the data. The main goal is to not only run and explain the PCA, NMF and CPT for each of the elements listed above, but also to mathematically define the differences of the three methods.

PROJECT ABSTRACTS

Lone Star College-North Harris

The Effect of Fan Promotions on Major League Baseball Attendance

Faculty Advisor: Jennifer Travis

Student Presenters: Colton Baker, Jonathan Nam, and Karen Santiago

Major League Baseball (MLB) teams offer frequent fan promotions at their home games, to increase brand presence, fan enthusiasm, and game attendance. The purpose of this study was to analyze the effect of fan promotions on attendance and provide recommendations for the most effective promotions. The research study was undertaken on behalf of the Houston Astros, who provided the research team with the data set used for the analysis. The data set included all 2431 games played by the 30 MLB teams in 2018. Our team classified the promotions into a set of 18 categories for giveaways and 16 categories for theme/event promotions. Initial analysis showed that attendance was highly dependent on home team and day of the week. We used a median-based robust z-score to identify highly-attended games for each home team and day of the week. We then compared the relative frequencies of promotions in these highly-attended games to the remaining games. This analysis was repeated after removing several opponent teams that were overrepresented among the highly-attended games. Promotions associated with high attendance included hats, jerseys, and T-shirts. Our team concluded that promotions are secondary factors when it comes to attendance, in particular when compared with home team, opponent team, day of week, and whether it is a home opener game.

Wentworth Institute of Technology

IntelyCare Churn Analysis

Faculty Advisor: Semere Gebresilasie

Student Presenters: Julianna Bernardi and Ryan Maresca

IntelyCare is a platform that schedules nursing shifts for healthcare facilities. Nurses choose shifts based on recommendations within their area, and facilities can request and hire nurses through similar recommendations. Although IntelyCare has a high hiring rate, it only has a 45% retention rate among its users. We aim to 1) define engagement, 2) determine feature importance for predicting disengagement, and 3) accurately assess the risk of a nurse becoming disengaged as well as implement learning algorithms to predict disengagement. We utilize the following models: logistic regression, the survival function, cox-proportional hazard model, decision trees, and survival random forests. The accuracy of these models are validated using appropriate statistical techniques.

Carleton College

Optimizing Manufacturing at 3M

Faculty Advisor: Rob Thompson

Student Presenters: Luanqi Chen and William Thompson

How can we use mathematics to make a manufacturing process more efficient? We consulted on this question with employees at 3M, a company you probably know for products such as Command Strips, Scotch tape, and Post-it notes. In this talk, we will outline the manufacturing problem our industry partners in the 3M Films Division posed for us, and the methods we used to approach it. We will explain the factors that influence a manufacturing schedule and how we translated these factors into mathematical language. By taking into account cost constraints and fluctuations in demand, we embarked on a computational modeling process of balancing efficiency with expense, which resulted in a mathematical model and a Python simulation that we hope 3M will build off of and use.

MAA

MATHEMATICAL ASSOCIATION OF AMERICA

THANK YOU TO OUR FUNDERS

Support for this Mathematical Association of America program is provided by the National Science Foundation (DMS-1722275) and the National Security Agency.

PIC MATH LEADERSHIP TEAM

Michael Dorff

Suzanne Weekes

Darren Narayan

MAA PROGRAMS STAFF

Rachel Levy

Kiera Edwards

Grace Murrin