TALKS

Hannah Graff (Creighton University)
Wreath Product Character Table Values (Talk)
For a finite group G with integer-valued character table and a prime p, we show that almost every entry in the character table of $G \wr S_N$ is divisible by p as $N \to \infty$. This result generalizes the work of Peluse and Soundararajan on the character table of S_N.

Scott Hootman-Ng (University of Nebraska-Lincoln)
An Introduction to Nonlocal Modeling (Talk)
In this talk we will introduce and discuss a relatively new framework introduced by Stewart Silling in 2000 called nonlocal modeling. The original motivation was to study fracture in elastic materials, but it has grown to be a framework that has been used to model things like: population swarming, image processing, general fracture and damage (called Peridynamics in the literature), sand piling and corrosion. The main idea is that in some modeling contexts, the solution function may inherently be discontinuous or not differentiable, so classical PDE may not be ideal. To deal with this, we replace the PDE (local equations) with integral operators that "add up" interactions between nearby points (nonlocal equations) and can handle non-differentiable and discontinuous functions. We'll also discuss the subtleties that need to be addressed if these models are used and the type of questions mathematicians are interested in related to these models.

Sam McCoy (Simpson College)
Predicting Vulnerable Functions Using Abstract Syntax Trees and Graph Neural Networks (Talk)
There have been past use of machine learning to classify if a function contains a vulnerability, with an emphasis on natural language processing. However, this research is focused on classifying if a code snippet contains a vulnerability by creating an abstract syntax tree and a C/C++ parser library within python to identify the program structure. By parsing the created abstract syntax tree into nodes and connections between nodes to create a graph, then training and testing the code snippets' classification using a graphical neural network based on those nodes' connections. The hope is that this method will have reduced training time without a significant loss in accuracy compared to other methods of code classification.

Lawrence Seminario-Romero (University of Nebraska-Lincoln)
Plant compensatory growth in plant-herbivore interactions (Talk)
Herbivory is often perceived as having a negative effect towards the growth of plants, but there are some plant species that actually benefit from getting eaten. These plants have a phenotypic trait known as "compensatory growth" which can be described as an accelerated growth in plant biomass as a response to damage caused by herbivory. Very few mathematical models that describe plant-herbivore interactions have accounted for plant compensatory growth. In this talk, we will present and analyze a system of nonlinear ordinary differential equations used to model the interactions between a plant with compensatory growth and an herbivore. The analysis consists of nondimensionalization, as well as determining the existence, uniqueness and stability of steady-state equilibria. We also present numerical estimates obtained from MATLAB to determine coexistence conditions between a plant with compensatory growth and an herbivore.

POSTERS

Christina Dietrich, Jeffrey Roberts, and Jason White (Simpson College)
Data Augmentation for Tabular Data Sets (Poster)
Often times after performing case studies, insufficient data is collected to create accurate predictive models. For this reason, data augmentation has become an increasingly popular research area. The goal of data augmentation is to create new data points without collecting any new data since it can be a costly and time-consuming process. We are developing new methods of augmenting tabular data. To demonstrate the data augmenting capabilities of our methods, we apply them to various data sets. By inflating the data while maintaining the intrinsic patterns, the new synthetic data set helps to get better predictions.

Jace Howard, Parker Lee, and Joseph Sams (Simpson College)
Data Engineering Databases of Biology Experiments (Poster)
Data engineering involves managing different sources of data, which need to be combined in various ways for

data analysis. In the context of PowerPollen, a company with multiple datasets in three different formats, this research aims to develop an automated system that can import these data sets into a database and enable their integration. The study utilizes VBA and SQL, as well as the Microsoft Excel extension, QueryStorm, as tools to accomplish this goal with Microsoft Access in mind as a long-term database workspace for the company. The project is significant because data engineering is a rapidly expanding field, and having an automated system to manage large amounts of data is essential for efficient and accurate decision-making.

Kayla Jensen, Jeffrey Roberts (Simpson College)
Automated Computation of Pollen Germination (Poster)
Pollen germination assays can be used to find pollen viability, but processing these assays by hand can be time consuming for skilled workers. Automating this process by using a convolutional neural network will save both time and money. We utilized PyTorch to implement the YOLO algorithm for object detection. We've created a model that can take an image of pollen germination assay and calculate a germination percentage, the ratio between tubes and the sum of all grains. This model will be implemented by the company PowerPollen to increase efficiency of their analysis.

Nicole Lacey (Drake University)
Exploring SIR To Represent Extraneous Parameters (Poster)
In this project, we study techniques for mitigating the spread of Streptococcus Pharyngitis. We develop a logistic and compartmental SIR model for the spread of strep in two freshman dorms at Drake University. To simulate the spread of the strep and collect data, we utilize dorm floor maps with scattered beans representing the movement of susceptible students in residence halls. Two experiments are conducted, one with no restrictions - allowing the disease to spread freely among students, and another with extra measures taken including air filters, designated bathrooms for sick students, and increased cleaning schedules.

Kenneth Norris, Katelyn Smith, and Allison Young (Affiliation)
Access to Care for Individuals with Down Syndrome (Poster)
This project focuses on analyzing digital healthcare decisions made by families of individuals with Down syndrome. Currently, there are 71 Down syndrome specialty clinics across the country in 34 different states. It is estimated that 5 - 20% of eligible patients are enrolled in specialty clinics (King, Remington, & Berger, 2022). To enable better access to specialty clinics, the Down Syndrome Program and Lab of Computer Science at Massachusetts General Hospital (MGH) launched a virtual asynchronous clinic called Down Syndrome Clinic to You (DSC2U). An international survey was conducted in the US and Mexico to understand the frustrations and concerns of caregivers of individuals with Down syndrome to gain perspective on how both physical and virtual clinics can be improved to better serve the DS community.

Aras Yilmaz (Cornell College)
Optimal Strategies for Game Play on $n \times n$ Boards (Poster)
Game theory is such a fun way to discover mathematics and work on hard problems that are stated simply. So, let's play a game, on an $n \times n$ board, starting in the lower right corner. I'll be player one, you be player two. I can only move vertically, you can only move horizontally. You must play in the same row as my last move, I must play in the same column as your last move, and any move on the backward diagonal is not allowed. Lastly, any square cannot be visited more than once. The loser is the person who cannot make another move. If we both play optimally, who wins for each $n \geq 3$? In this presentation, we will discuss who wins up to $n = 5$, and optimal strategies for Player 1 on an $n \times n$ board up to $n = 5$. Generalizing the strategy proves to be challenging for higher n, but there are patterns that give insight into winning on larger game boards. Moreover, we want to connect to the mathematics behind the game in terms of group theory, and discuss game play in terms of group elements and operations.