Abstracts of Student Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
Fairmont State University
Friday, April 5th 2024

All talks are in the Engineering Technology Building (ET)

7:15 - 7:30 p.m.

Zach LaFrankie, Westminster College, ET 303

Directed Graph Burning

Graph burning is an iterative process on graphs that serves as a simplified model for the spread of a contagion or influence throughout a network. Directed graph burning is an extension of this process which adapts the use of directed edges (creating a directed graph, or digraph) to represent interactions in unilateral relationships. The directed burning number of a digraph $\vec{G}$ is denoted $b(\vec{G})$, and is the minimum number of iterations needed to burn all vertices in the graph. In this presentation we will prove that for any digraph, $b(\vec{G}) \leq \nu(\vec{G}) + 1$ if $\vec{G}$ has a perfect matching, and $b(\vec{G}) \leq |V(\vec{G})| - \nu(\vec{G})$ otherwise, where $\nu(\vec{G})$ is the matching number of the digraph.

Edison Hauptman, University of Pittsburgh, ET 306

Why Isn't There an Inverse Quotient Rule?

When learning Integral Calculus, students may have learned u-Substitution as undoing the Chain Rule and Integration by Parts as undoing the Product Rule. I will explain how a curious student could undo the Quotient Rule by developing a similar integration technique. I will use this technique to solve one of the toughest integrals in Stewart's Calculus textbook, and then I'll discuss why the Inverse Quotient Rule isn't often covered in textbooks. I will also provide a set of related exercises for any interested students. The level of this talk will be accessible to anyone who has learned u-Substitution and Integration by Parts.

Gabriel Turak, West Virginia University, ET 310

Induced Matching Partitions of Generalized Petersen Graphs

Brief introduction of graphs and Generalized Petersen Graphs $(P(n, k))$. Shows main ideas behind how $imp(P(n, k)) = 2$ iff n is even and k is odd. If time permits, will show some open problems when $imp(P(n, k)) = 3, 4$.

7:35 - 7:50 p.m.

Asia Morgenstern, Westminster College, ET 303

Leaky Power Domination: Solving the $1-$*Leaky Tree*

Power domination is an iterative graph coloring process that was first introduced as a way to model how phasor measurements units observe a network. We say that a set of initially colored vertices B is a power dominating set if we can color an entire graph by iteratively applying a colorchange rule akin to zero forcing. The power domination number $\gamma_P(G)$ is the cardinality of a smallest power dominating set. In this talk, we will introduce a variant of power domination called $\ell-$leaky power domination, which limits the color change rule from power domination in order to model faulty readings from certain locations. Finally, we will also determine the $1-$leaky power domination number of trees.

Richard Fang, Abel Wei, and Matthew Hunczak, University of Pittsburgh, ET 306
Maximizing Investment Strategy
Deciding the best way to invest assets is a very important decision, especially when it comes to pensions and preparing for retirement. In a defined benefit plan, where employers are responsible for paying out benefits to employees at retirement, many opt to use a glide path strategy to secure stable returns from their investments and minimize their payout cost. The question that arises is how can the specific allocation of assets in the glide path be decided to maximize returns and in turn lower the payout costs. Considering various asset allocations in different funding statuses with simulated return on investments, it was found that a glide path strategy can be optimized using the funded ratio or the balance of assets to liabilities. Utilizing this data has led to a tool that is capable of minimizing cumulative costs for employers and maximizing returns for investors.

Edwin Townsend, West Virginia University, ET 310
The Knowledge-GAP in Applying to Graduate School
The Undergraduate Knowledge of the Mathematics Graduate School Application Process (Knowledge-GAP) project investigates what barriers students face when applying to graduate school. To achieve this goal, we administered a national survey to mathematics majors. In this talk we will present two main results. First, using descriptive statistics, we observe that many undergraduate students did not know about certain aspects of the graduate application process. Second, using descriptive statistics and chi-squared tests, women are more likely to not have heard about the Graduate Record Examination (GRE), and so this result extends already existing literature about women performing weaker than their peers on the GRE (Bleske-Rechek & Browne, 2014; Petersen et al., 2018; Posselt et al., 2019; Verostek et al., 2021; Miller et al., 2021).

7:55 - 8:10 p.m.

Timothy Edwards, Gannon University, ET 303
Inverse Domination: Stability, Unique Minimum Dominating Sets, and Dual Domination
An open question in graph theory asks whether the inverse domination number of an isolate free graph is always less than or equal to the independence number of such a graph. We explore this conjecture, provide examples to demonstrate the complexity of this problem, and discuss graphs with a unique minimum dominating set or with maximum dual domination number. These properties appear to reduce the complexity of the inverse domination problem.

John Hohman, University of Pittsburgh, ET 306
Coffee Futures Forecasting with Transformers
Forecasting financial markets is a byzantine task relying on understanding long-term and short-term trends. Transformer models are a relatively new technique for identifying these relations being developed by Google in 2017 for Natural Language Processing (NLP) purposes. Realizing that language is a sequential ordering of information with long-term and short-term dependencies, brings the possibility to use techniques traditionally reserved to NLP to time series forecasting. This presentation will demonstrate the prospect of using transformer models to forecast complex time series data, using coffee futures as a case study.

Davis Funk, West Virginia University, ET 310
The 1-Dimensional Wave Equation on Time Scales
This talk presents a solution to an initial value problem for the 1-dimensional wave equation on time scales through the application of a Fourier Transform and its inverse via contour integrals.

8:15 - 8:30 p.m.

Chase Ake, West Liberty University, ET 303 *Mathematical Models of Fraud Detection*
Every year, fraudulent activity costs American consumers and businesses close to 9 billion dollars in damages. Consequently, fraud detection is a prominent and important field of research. We present several models of fraud detection based on empirical and theoretical analysis of text- and number-based data. Furthermore, some basic machine learning algorithms are applied to identify fraudulent financial transactions.

Peter Ridolfi, Misha Trosman, Chris Deboni, Anna Minor, University of Pittsburgh, ET 306 *Optimizing Investment Strategies of Pension Plans*
While defined benefit pension plans provide a lot of upsides to employees as the employer is entirely responsible for paying out the pension of each retiree, the question remains as to how to minimize the total cost incurred by the employer to ensure upside for them as well. The combination of legal constraints and the overall unpredictability of the market makes it very hard for employers to decide how much money to invest into their pension fund each year in such a way that they dont spend more than necessary. We propose that by simulating the behavior of the economy many times while varying the strategies used to decide how much to invest in the fund each year, we can find the best investing strategy. In this talk, we will detail the investment strategy that we found to be most optimal in terms of the total cost of the plan. Not only will these findings be used by employers to minimize the total cost of defined benefit plans, but they can also be applied to investing strategies for employees in the context of contributions for other plan structures.

Richard Williams, Marshall University, ET 310
A Contour Integral Approach to Solving Generalized Heat Equations on Time Scales
Initiated in 1988, the theory of dynamic equations on time scales unifies and extends discrete and continuous analysis. As a result, we are able to generalize processes that account for both cases or any combination thereof, provided that we restrict ourselves to nonempty subsets of the reals (a "time scale"). Since the inception of time scales, researchers have found applications in topics such as differential games, population dynamics, and economics. Here, we will study the heat equation on time scales. Expanding on the work in the literature, we will investigate the case where the time variable lies on a time scale. Using contour integrals, we will offer approaches to solving the problems that arise in this case.

8:35 - 8:50 p.m.

Caleb Thompson, Penn State University, ET 303
The"Reverse Cantor Set" and its Properties
The Cantor set is a very fascinating set, with some extremely surprising properties. This set is commonly constructed by removing the middle 1/3rd of the interval [0,1], then continuing to remove the middle third of each the consecutively smaller intervals. This results, somewhat surprisingly, in a set that is uncountable, of zero measure, compact, nowhere dense, has empty interior, contains no intervals, and has every point a cluster point. This construction makes one wonder - what if, instead of removing segments from the interval, a set was built up using by adding the midpoint of each of those intervals? In this talk, we'll explore this set (dubbed the "Reverse Cantor Set"), its topological properties as contrasted with the Cantor set, and (briefly) discuss its connections to some interesting groups.

Casey Dinan, Katelyn Donaty, Kenny Han, James Holland, Winston Osei-Bonsu, University of Pittsburgh, ET 306 *Optimization of MLB lineups*
Tasked by the Pittsburgh Pirates, we aim to leverage traditional baseball statistics within current machine learning models to optimize Major League Baseball lineups' run production. In this talk we present use of Sabermetrics, linear and genetic algorithms, and stochastic models to fulfill our objective.