Abstracts (May 1, 2021)

Opening Address

A radical approach to mathematics

Dr. Will Traves, US Naval Academy

I'll introduce Pascal's Theorem about conics and explain how I spent six years trying to generalize the result to cubics. Along the way, we'll meet many interesting geometric concepts, including the radical axis. But the radical approach to mathematics that I advocate will be a very personal reflection on the value of community and emotion in mathematical progress.

Closing Address

Should You Believe It? Numbers in the News

Dr. Rebecca Goldin, George Mason University.

News accounts of science and scientific ideas are filled with numbers and implicit advice. They also tell a story. Do violent video games lead to violence? Can brain scans read our minds? Does chocolate make us smarter? In contexts as diverse as political surveys, criminal courts and public health, numbers play an increasingly prominent role as data becomes more accessible. Despite our need for clear rendering of numerical information, many media accounts using statistics are misleading. In this presentation, Rebecca Goldin will share some humorous as well as serious stories about statistical bloopers in the media, peppered with suggestions for better communication. Numerical reasoning can be powerful, she says, when we move past politics and morality to clarify what quantitative information actually tells us, what it does not and what it cannot.

Student Presentations (in alphabetic order of the authors' last names)

Modeling Crime with Stochastic Processes

Adedoyin Adegbuyi, Ryan Budahazy, Cody Stephenson, and Margaret Trimpin, Towson University

The premise of this project is that the occurrence of crimes of a certain type triggers the nearby occurrence of crimes of the same type shortly thereafter. This phenomenon is similar in principle to the triggering of aftershocks by the initial occurrence of an earthquake. We will be using publicly available crime data to fit the parameters of a Self-Exciting Poisson Point Process (SEPP) model, a mathematical model having the ability to quantify the crime triggering mechanism. This modeling tool will give us notions of how likely and where crimes are to occur in a given spatial region. Also, in the event that a crime does occur, how likely is a triggered crime to occur; And finally, given that a triggered crime occurs, when and where is it likely to occur.

Fixing Sets of Groups

Ummul Aymen, James Della-Giustina, Erin Stales, Jason Riley, Towson University

A graph is an ordered pair (V, E), where V is a set of vertices, and E is a set of 2-element subsets of V called edges. E gives adjacency relations on V and an automorphism (or symmetry) of a graph is a permutation of the vertices that preserves these relations. The set of all symmetries of a graph form a group (an automorphism group) under function composition. The automorphism group of a graph is the set of adjacency preserving permutations of the vertices, and this group gives a description of the graph's symmetries. We will examine a graph invariant called the fixing number which is the minimum number of vertices that when fixed, remove all non-trivial automorphisms of a graph, and discuss the fixing set, the union of all fixing numbers for every graph that share an automorphism group. Additionally, graph operations on specific families of graphs that preserve the automorphism group but change the total number of both vertices and edges will be briefly touched upon.

Optimal Recovery Methods of Three-Times Differentiable Functions

Ryan Budahazy, Towson University

We wish to interpolate a class of functions with certain known properties on an interval. A recovery method uses these known properties to produce an interpolating function. We define the error of a method to be the supremum of the errors of the interpolating functions the method produces. We seek to find methods with minimal error which are called optimal recovery methods.

The Relationship Between Race/Ethnicity and Suicide Deaths in New York Between 2003-2017

Teresa Doley, Montgomery College

Recognizing racial differences in the amount of suicide deaths is crucial to design effective suicide prevention programs. When research has been conducted, it has been found that American Indians commit suicide at a higher rate than other racial groups. This project explores whether race/ethnicity is related to number of suicide deaths in the state of New York from 2003-2017. The data were collected by observations of death certificates on record from 2003 – 2017. I used the programming language R to run statistical tests. A Kruskal-Wallis test provided evidence that the Hispanic group had experienced a significantly higher number of suicide deaths relative to the other racial groups (p-value = 0.00000005444). These results suggest that there is evidence to support a difference in suicide deaths between different racial groups in NY between 2003 - 2017. Therefore, race/ethnicity of the targeted demographic should be considered when designing suicide prevention programs.

SOA Case Study: Building a Parametric Insurance Product

Cole Evans, Drew Mason, Mary Sacco, Towson University

Given two fictitious countries – Ambernïa and Palòmïnïa – with two very different demographic groups and economic statuses, it's up to team JEMS to figure out how to create a parametric health insurance that will provide adequate coverage and incentivize good health across both countries.

Developing Parametric Insurance in Ambernïa and Palòmïnïa

Xinran Hua, Anmol Limbu, Jean-Carl Mamaril, Towson University

The presentation is for 2021 student research case study challenge. The objective of the case study is to design a parametric insurance product for two virtual neighboring countries: Palòmïnïa and Ambernïa, to cover financial losses facing health risks. The role of each participated group is an actuarial team from a consulting company hired by a multinational insurance company called NEW WORLD to assist its product development, and our team's name is APSIRE. The main content of the presentation is to introduce the parametric insurance product we designed as well as some of our R&D ideas and processes. Six parts will be covered in this presentation: Objective, Data and Data Limitations, Product Design, Implementation Plan, Risk Mitigation, Sensitivity Analysis and Conclusion. In addition to contents, we hope that more and more people can look at the parametric insurance market and realize its supporting role in health management.

Machine Learning with Tetris Breakout Room 1

Carter Montgomery, Towson University

I attempt to create a Machine Learning agent to play Tetris through reinforcement learning. I explain some of the background and mathematical techniques I used, and demonstrate the agent. Although the agent does not currently work, I discuss possible improvements.

Differential Privacy of a Randomized Learning Algorithm

Julianne Nierwinski, Towson University

Differential privacy is a rapidly developing area of machine learning. Differential privacy is a property of an algorithm where the results derived from datasets that differ by a single sample are almost indistinguishable. Companies and agencies including the Census Bureau, Apple, and Google utilize differential privacy in their algorithms to gain statistical insight into a dataset of users, while preserving the individuals' privacy. I will discuss various notions of differential privacy that can be found in literature.

Privacy and Accuracy of Machine Learning Algorithms

Avery Schweitzer, Towson University

The goal of machine learning is to learn a concept based on limited data. There is a trade-off between the accuracy of the algorithm and how well the algorithm protects the privacy of the underlying data. The sample complexity problem asks how large must our data sets be for an algorithm to be both accurate and private? I will introduce a family of concept classes based on equivalence relations and study the sample complexity problem for those classes.

Hypothesis Classes and Their Littlestone and Threshold Dimensions

Ramon Suris-Rodriguez, Towson University

Machine learning is a field of computer science and mathematics rich in both theory and applications. In particular, there is a high activity of research in machine learning algorithms that can learn without violating

an individual's privacy. This talk will define the Littlestone and Threshold dimension of a Hypothesis Class, explain their importance for privacy-preserving machine learning algorithms, and examine the Littlestone and Threshold dimension of a Cross-Cutting Partition Hypothesis Class.

Shattering Sets with Ellipses and their Generalizations

Richard Soucy, Towson University

In this presentation I will introduce the notion of Vapnik–Chervonenkis (VC) dimension. VC-dimension is a tool used when analyzing learnability of a concept class. First, I show that the concept class of axis-aligned ellipses in $\mathbb{R}^2$ has a VC-dimension of 4. Then, I generalize the result to show that the VC-dimension of the concept class of a zero-set of linear combinations of m linearly independent functions from a set S to a field $\mathbb{F}$ has an upper bound of $m - 1$.