

Abstracts (April 6, 2019)

Opening Address

A Tour of Symbolic Dynamics and an Application to Automata Theory

Dr. Kelly Yancey, Institute for Defense Analyses

Symbolic dynamics is a vibrant field of pure mathematics. However, it also overlaps nicely with automata theory from computer science and has many applications. In this talk we will take a brief tour through symbolic dynamics that includes coding orbits of the doubling map, sofic shifts, and topological entropy. We will end with an application: compute the topological entropy of a deterministic finite automata and use that to measure the distance between regular languages.

Closing Address

The Mathematics of Contemporary Games

Dr. Franklin Kenter, United States Naval Academy

In this talk, we will investigate the plethora of mathematics found in popular modern contemporary games that you can buy at the store today. Perhaps surprisingly, games do not need to be overly complex to feature intricate mathematical phenomena. While the study of games and mathematics is often associated with discrete mathematics and combinatorial game theory in games like tic-tac-toe, chess, and go; we will demonstrate that many other areas of mathematics can be found in games as well. These include the quasi-periodic functions of Guess Who?, recursion relations in basketball, information and coding theory in Hanabi, and even delayed differential equations in Dominion. In the end, it is not about how abstract the mathematics is, but rather, it is about asking the right question and applying the right tools.

Student Presentations (continued on the reverse side)

Analyzing Statistics for Towson's Men's Basketball Team

Kristian Brown, Ashley Imus, Derek Margulies, and Jennifer Weiler, Towson University

The Towson University Men's Basketball team was interested in identifying historical trends to help the coaching staff improve their win-loss record. This research project involves data collected from 2015–2018 seasons. Part of this research includes using individual player and team data to calculate players per-minute statistics and creation to turnover ratios. These calculations show areas where certain players excel and areas where their contributions could have had a negative impact on the outcome of the game. This analysis allows the coaches to quantify the contribution of a player to the success of the team in comparison to how much they hurt the team during any given game

Living on a Hyperbolic Donut

Ajeet Gary, University of Maryland, College Park

In topology, a torus (or "donut") is a simple example of a surface. We can remove a hole from the donut to make it a more interesting surface, on which all metrics (ways of measuring distance) are hyperbolic. We (for the most part) live in a Euclidian world where everything is flat, but in a hyperbolic metric the shortest distance between two points - "as the crow flies" - is actually an arc. The research project this is based off of deals with dynamics on the space (Teichmüller space) of metrics, but the talk is targeted towards a general audience where concepts in basic algebraic topology and hyperbolic geometry are touched on and visualized with demonstrations in Mathematica.

Graph Addressing

Brandon Gilbert, University of Delaware

In 1971, motivated by network routing problems at Bell Labs, Graham and Pollak developed a way to label/address the vertices of a graph G such that the distance between any two vertices x and y equals the number of positions where the address of one vertex is zero and the address of the other vertex is one.

Eigenvalues of simplicial complexes

Chunxu Ji, University of Delaware

In our research, we investigate the eigenvalues of higher dimensional Laplacians associated with graphs and their use in distinguishing nonisomorphic graphs with the same ordinary Laplacian eigenvalues.

Parameter Study of Calcium-Induced Calcium Release Linkages in Cardiomyocytes Modeled by Seven Partial Differential Equations

Gerson Kroiz, University of Maryland, Baltimore County

Cardiac arrhythmia affects millions each year in the U.S. This irregularity in the heartbeat can be caused by dysregulation of calcium in cardiomyocytes, the cardiac muscle cell. Cardiomyocytes function through the interplay between electrical excitation and mechanical contraction through calcium signaling, an overall process known as calcium-induced calcium release (CICR). A system of seven coupled nonlinear time-dependent partial differential equations (PDEs) provides a mathematical model of this mechanism and is solved numerically in parallel computing to provide simulations. In this project, we show parameter studies of the crucial parameters that directly influence the functionality of the calcium store in the sarcoplasmic reticulum, electrical excitation, and mechanical contraction. Simulations within these studies display the effect of each of the extensions over the original model consisting of three equations for calcium signaling only. Additional research in this field is a necessity for a better understanding of cardiac regulation and dysregulation.

VC-Dimension, Thicket Dimension, and Notions of Learnability

Laszlo Steinhoff, Towson University

This talk will explore the VC-dimension of a concept class and its relation to PAC-learnability, and major results stemming from these ideas. We will also develop an analogy to the online learning framework and thicket dimension, and compare the two models.