

# Abstracts

## Opening Address

### **The Mathematics of Google**

*Dr. Hal Schenck, Department of Mathematics, University of Iowa*

How does Google sort through the roughly thirteen billion webpages to find relevant sites? It turns out that the answer involves the mathematics of linear algebra, which, roughly speaking, involves solving systems of linear equations. Such systems are ubiquitous in science and engineering. In this whirlwind talk, we'll learn about Gaussian elimination, linear transformations and change of basis, eigenvalues and eigenvectors. All of this leads to the crown jewel: the page rank algorithm developed by Page and Brin (while they were graduate students at Stanford!). If you have not yet had a class in linear algebra, fear not – all the tools needed will be developed in the talk!

## Student Presentations (Morning)

### **How UAVs Affect Escalation In Game Theory**

*Kathryn Dura, University of Pennsylvania*

UAVs (more commonly known as drones) are an emerging technology in warfare and therefore there are no international norms guiding their use or responses to their use. Their unique attributes differ enough from manned aircraft to warrant an investigation into how players will react to them in an incomplete information crisis bargaining model. This two-player model uses an extensive game format and Bayesian updating to simulate a real-life scenario. The models payoffs are based on the platform costs, the cost of human capital, and reputation costs. The results indicate that player two, the defensive player, will always attack any platform regardless of a plane or a UAV while player one, the aggressor, will send a UAV when resolved but do nothing when unresolved. The resulting equilibria are then tested qualitatively by using real life events as case studies such as Pakistan-India drone escalation and Israel-Hezbollah drone escalation.

### **Odd Coverings of Subsets of the Integers**

*Kristina Marotta, Cedar Crest College*

Let  $S$  be a set of integers. A covering system of  $S$  is a finite collection of congruences such that every integer in the set satisfies at least one of the congruences in the collection. An odd covering of  $S$  is a covering system such that all moduli are distinct, odd, and greater than 1. The existence of an odd covering of the entire set of integers is a long standing question in Number Theory. In this talk we investigate the existence of an odd covering of certain subsets of the integers.

### **Mathematical Modeling of Plankton Behavior: Photosynthesis**

*Claire Lubash, University of Delaware*

The goal of this research is to create a three-dimensional model of the motion and aggregation patterns of *Heterosigma Akashiwo*, a species of plankton known to cause algal blooms with detrimental ecological impacts. In order to eventually mitigate these blooms, we want to understand how plankton signal each other via photosynthesis and chemical signaling. To obtain raw data and gain insight for our model, experiments were conducted to determine what variables affected the photosystems and behaviors of the plankton. From our model and experimental data, we see the number of plankton aggregations decaying exponentially with time, and the ecology eventually forming a rotating quasi-equilibrium. We have constructed a number of reduced computational and analytical models focusing on how plankton aggregate through chemotaxis and phototaxis. In the future, we hope to create more realistic models and further our understanding of the variables affecting aggregation patterns and the eventual quasi-equilibrium it attains.

### **Graph Edge Coloring**

*Chunxu Ji, University of Delaware*

In this note, we study graph edge coloring on strongly regular graphs. The main tools are Vizing theorem and spectral graph theory. We start with analyzing the chromatic index of a very special strongly regular graph – Petersen graph. We then prove a property that the chromatic index of a regular graph with even order preserves if an arbitrary vertex and all the edges induced by it are removed from the original graph. Moreover, spectral theory is applied when we compare graph edge coloring problems with matching problems.

## Afternoon Plenary Address

### **Circles and Numbers**

*Dr. Alex Kontorovich, Rutgers University*

People have long been fascinated by the beauty of iterated symmetry. We will discuss a long list of mathematicians and scientists who have delved into questions at the intersection of geometry, number theory, and chaotic dynamics.

### **Baltimore Humane Society AML Project**

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

This AML project is sponsored by the Baltimore Humane Society (BHS). We were asked to improve data collection methods for the BHS in efforts to better understand donors and solicit larger yearly donations. Our goal is also to explain how current donor practices and possible changes in these practices affect lives of Maryland residents. This project involves the analysis of large data sets (at least 20,000). Mathematical and statistical methodology were applied to explain how and why various factors affect their donations. We have used techniques such as geocoding and US census data analysis to advise the BHS who to ask for greater donations. This talk is a status update on the current progress in this project.

### **Rendezvous Search on the Edges of Platonic Solids**

*Elanor West, Johns Hopkins University*

The classic Rendezvous Search problem involves two players moving along the same line at random until they meet. We were inspired by the Astronaut Problem rendition in which two players are placed on a sphere and move around until they meet. We have simplified the model to discrete units of time and to take place along the edges of platonic solids. We assume the search ends when the two players can see each other. We have compared the mean times to end on all five solids under an unbiased random strategy, and have altered assumptions and strategies in various versions to see how certain changes affect the mean time to end. We have explored the possibility of waiting on any given turn under both biased and unbiased random strategies. We have also explored non-random, multi-step strategies with up to seven steps. These calculations all involve using first-order Markov chain decompositions. We are working to confirm patterns that we have found in our results.

### **Multi-Site Reaction Rate Constant Evaluation**

*Lucas Onisk, University of Delaware*

Scientists interested in biomolecular interaction analysis often flow a stream of ligands through a fluid-filled volume over which receptors are bound. This procedure coupled with current instrumentation allows researchers to measure reaction rate constants of multiple simultaneous reactions. New interests now lie in determining multiple rate constants associated with coupled reactions from a single coalesced signal. Current instrumentation however, cannot ascribe rate constants to specific reacting species from a single signal. In this work, we present use of MATLAB code which is optimized to take real experimental data, break it down into two experimental phases, and elucidate both the size of the reacting system as well as its rate constants. We present two similar algorithms which achieve these goals, and explore effects of introduced data error on code reliability. This work is expected to be robust enough to discern the differences in systems whose data appears alike to the user.