6th Week Update

We are more than half way through Spring Term -- time certainly passes quickly when you're caught up in the excitement of life in the Carleton Math & Stats Department! So far this term, many students have participated in mathematics and statistics related conferences and competitions and many more are getting ready to present their findings from their comps projects. There is a lot happening in the department in the upcoming weeks: read on for information about independent comps presentations next week, to learn about job and internship opportunities, and try this issue's Problem of the Fortnight.

Independent Comps Talks

Some people haven't yet started their comps here in the Math & Stats Department. Others among us, however, are nearly done! On Tuesday, May 8th and Thursday, May 10th several department majors will be giving their comps talks in CMC 206. Take a look at what they'll be speaking about below, then be sure to stop by and support them while they demonstrate what they've learned!

Tuesday, May 8

Title: Mathematical Celestial Mechanics and The 3-Body Problem
Speaker: John Scott
Time: 5:00 p.m.

Abstract: The motion of celestial bodies has long served as an impetus for the study of mathematics. However, even early mathematicians realized that addressing orbital mechanics becomes substantially more complicated when more than two objects are involved. General solutions to these problems, known as n-body problems, elude physicists, astronomers, and mathematicians alike to this day. In this talk we will approach many-body orbital mechanics from a mathematical standpoint. In turn, we will treat the fundamental mathematics of several well-known physical principles and then several problems which allow us to constrain solutions to many-body orbits, such as Sundman's theorem, the virial theorem, and specific methods for the 3-body problem.
Title: The Rationality of Hyperbolic Discounting  
Speaker: Aman Panda  
Time: 5:30 p.m.

Abstract: The task of choosing between an immediate smaller reward over a delayed larger reward is a classic question in behavioral economics. Traditional economics accepts the exponential discounting model as means to value the present vs. the future; however, empirical data seems to fit better with a hyperbolic discounting function, which under standard assumptions can be deemed time inconsistent and hence irrational. In a stochastic world, where one-period discount rates are uncertain, hyperbolic discounting can be shown to be rational. This has numerous implications, the biggest of which is that agents attach a larger weight to events that are very distant in time.

Title: Geometric Constructions  
Speaker: Ben Clark  
Time: 6:00 p.m.

Abstract: The ancient Greeks were the first to explore ruler and compass constructions, and Euclid was the first to develop a formal theory on them. There are several famous problems that cannot be solved using compass and straightedge, such as trisection of the angle. However, we need not construct with the ruler and compass. We could also use the drafter’s dividers, the compass alone, the ruler alone, or even a tool known as the cannon, and using these tools gives us some interesting fields of constructible numbers. In this talk, I will demonstrate the capabilities of geometric constructions and show how they are an exciting way to explore math without using algebra.

Thursday, May 10

Title: Nonlinear Least Squares  
Speaker: Andrew Qi  
Time: 4:00 p.m.

Abstract: We have mostly all heard of or used linear least squares some time during our academic careers. Much like a high school science lab’s simple "line of best fit", linear least squares is about finding a the parameters of a linear model that best fit a given dataset. But what do we do if a dataset is not linear? Suppose we hypothesize the dataset to be an exponential model by visual inspection, we need an algorithm to help us find the parameters of an exponential model that best fits the given dataset. Of course, nonlinear equations can become much more complex, but the underlying principle remains the same. The process of finding a least squares fit involves numerical optimization techniques; in this talk we will specifically uncover the Gauss-Newton and Levenberg-Marquardt algorithms and see how they can be directly applied to real world datasets.

Title: Measure Theoretic Probability  
Speaker: Phineas Callahan  
Time: 4:30 p.m.

Abstract: Probability Theory provides us with a mathematical framework to analyze noisy, complex systems. As such, it serves as the mathematical foundation for many subfields of economics, finance,
physics, and statistics. My talk will serve as an introduction to measure-theoretic probability theory. Specifically, I will explain how measure theory allows us to rigorously reformulate the topics and theorems of MATH 265 (expectation, variance, distributions, etc) and MATH 365 (martingales and stochastic processes) in a simple and concise manner.

**Title:** Electrical Networks and Applications in Mathematical Theory  
**Speaker:** Tegan Wilson  
**Time:** 5:00 p.m.

**Abstract:** Electrical networks as a subset of graph problems have a wide variety of real world applications: including the design of circuits, power grids, and computer structure. In this talk, I will delve into two applications in mathematical theory: the perfect squared square problem, and the matrix tree theorem. We begin by defining and investigating electrical networks and solutions in general. We then apply these findings to mathematical theory: we will more efficiently solve the perfect squared square problem, and offer another proof of the matrix tree theorem.

**Title:** Tournament, Kings and Heirs  
**Speaker:** Vianne Gao  
**Time:** 5:30 p.m.

**Abstract:** The idea of studying chicken behavior and trying to quantify who dominates a given flock was first theorized by H. G. Landau, a Mathematical Sociologist, in 1953. People who work with farm animals knows that bringing together a flock of chickens that are not already familiar with one another often leads to trouble. A barnyard riot is likely to arise, in which every pair of chickens will determine which of the two of them is dominant over the other, primarily by pecking. Once chickens have determined their pecking order, we represent the relationships with a complete directed graph, in which the chickens are represented by vertices and the relationship between any two chickens is represented by an edge. Besides providing an entertaining backdrop to the subject of graph theory, studying pecking order has offered many insights to the structure of tournaments.

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**Tepper L. Gill Talk**

**Speaker:** Tepper L. Gill, Howard University  
**Date/Time:** Friday, May 11, 3:15-5:30 p.m.  
**Location:** Regents Hall of Science, Room 310, St. Olaf

Despite a nontraditional path to math and science, Dr. Gill has had a celebrated research and academic career, with degrees in Mathematics, Physics, and Applied Mathematics, and interests ranging from space to computational science. In addition to his significant contributions to academia, Dr. Gill also has a strong commitment to the community, and has worked to expand economic options and opportunities for minorities in science. This talk is brought to you by the Increasing Diversity and Excellence in STEM (IDEAS) Distinguished Speaker Committee. The deadline to sign up for the talk, dinner, and/or van rides is May 9, visit: https://www.broadeningthebridge.org/ideas/.
UW-Madison Actuarial Program

Are you considering a career in actuarial science? UW-Madison offers a Capstone certificate program in actuarial science that can help you prepare for an actuarial career. The certificate program is a great way to launch an actuarial career quickly. For more information: https://wsb.wisc.edu/programs-degrees/certificates/actuarial-science-capstone.

Upcoming Events

Week 7, Tuesday, May 8, 5:00 - 6:30pm
Comps Talks - CMC 206

Week 7, Thursday, May 10, 4:00 - 6:00pm
Comps Talks - CMC 206

Week 7, Friday, May 11, 3:15pm
Tepper L. Gill Talk - Regents Hall, Room 310, St. Olaf

Week 8, Tuesday, May 15, 3:30 - 6:30pm
Comps Talks - Olin 141

Job & Internship Opportunities

US Census Bureau, Mathematical Statistician
Mathematical statisticians at the Census Bureau develop statistical methodology and conduct research to solve methodological problems for census programs. Basic requirements are a degree that included 24 semester hours of mathematics and statistics, of which at least 12 semester hours were in mathematics and 6 semester hours were in statistics. For more information and to apply visit the Tunnel. The deadline is May 25.

Johns Hopkins Center for Talented Youth, Teaching Assistant
The John Hopkins University Center for Talented Youth (CTY) is seeking instructors and teaching assistants for their summer programs. CTY offers challenging academic programs for highly talented elementary, middle, and high school students from across the country and around the world. Positions are available at residential and day sites at colleges, universities, and schools on the East and West coasts. For a full list of sites, visit cty.jhu.edu/jobs/summer/sites_dates.html. Why teach for CTY? Share your passion for mathematics with highly motivated and talented students, be a part of an intellectual community, develop your teaching skills in a supportive, collegial environment, and earn a competitive salary. A limited class size (15 students), plus an instructor and assistant for each class, also ensures a low student-teacher ratio. There are two sessions: June 21 - July 14, 2018 and July 14 - August 4, 2018. For more information, visit: cty.jhu.edu/jobs/summer/positions.
Problems of the Fortnight

To be acknowledged in the next Gazette, solutions to the problems below should reach me by noon on Tuesday, May 15.

1. a) Given a triangle $ABC$ (in the plane), show that there is exactly one triangle $PQR$ such that $A$ is the midpoint of $PQ$, $B$ is the midpoint of $QR$, and $C$ is the midpoint of $RP$.
   b) Now suppose we have, instead, a quadrilateral (four-sided polygon) $ABCD$. Under what conditions (if any) does there exist a quadrilateral $PQRS$ such that $A$ is the midpoint of $PQ$, $B$ is the midpoint of $QR$, $C$ is the midpoint of $RS$, and $D$ is the midpoint of $SP$? If such a quadrilateral $PQRS$ exists, is it unique?

2. Consider the $2018 \times 2018$ matrix $A = \begin{pmatrix} 0 & e^{-1} & e^{-2} & \cdots & e^{-2017} \\ e & 0 & e^{-1} & \cdots & e^{-2016} \\ e^2 & e & 0 & \cdots & e^{-2015} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ e^{2017} & e^{2016} & e^{2015} & \cdots & 0 \end{pmatrix}$

whose $i, j$ entry is 0 if $i = j$ and $e^{i-j}$ if $i \neq j$. Find $\det(A)$.

For the problems posed April 20, so far one solution each has come in: from “Auplume” for the first problem, and from Will Hardt for the second. I will stop by CMC 217 some time to collect a B.B.O.P. item. Meanwhile, apologies for not posting any of my own solutions yet this term; things are busy enough that it may stay that way for a while yet ...

- Mark Krusemeyer