



# Goodsell Gazette

Carleton College  
Northfield, MN 55057

The newsletter for the Carleton mathematics and statistics community

October 29, 2021

Vol. 40, No. 4



---

## Comps Talks

Come support your friends and classmates in their comps talks next week! Individual talks will take place Tuesday, November 2 and Thursday, November 4, both in CMC 206 starting at 3:30 pm. 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; you're likely to learn something new yourself as well!

---

### Tuesday, November 2 — CMC 206

**Title:** The State Space Model: Estimating the Hidden Series

**Speaker:** Yucheng Yang

**Time:** 3:30 - 4:00

**Abstract:** In time series analysis, measuring the trajectory of processes over time is a central objective. Usually, we would take the observed data directly to estimate the true series. However, the state space model considers the possibility of the existence of an underlying unobserved state series behind our observations. Specifically, the model assumes that the observations are biased/partial representations of the hidden state series. Some applications of the state space model could be seen in ecological studies where we collect data of multiple subpopulations to study the overall trend of the entire population or in engineering fields where we study the energy transfer process within a dynamic system. With state space models, we are able to accommodate a wide variety of model structures, allow time-varying coefficients, and obtain stable estimates of the series even with irregularly spaced missing data. In this talk, we will look at a specific example of using the state space model to understand the change in shared bike usage of downtown Los Angeles.

**Title:** Strategic Voting and You

**Speaker:** Ethan Rojek

**Time:** 4:00 - 4:30

**Abstract:** Voting theory is a mathematical discipline which is integral to the structure of our democratic systems. Despite this, many people know relatively little about the subject. To amend this, we will briefly

discuss Arrow's Theorem to prime our readers with some integral concepts to voting theory. Then, we will discuss strategic voting in depth. In specific, we will show Satterthwaite's proof of the Gibbard-Satterthwaite theorem, then following this, we will discuss Green and Laffont's work on revelatory mechanisms and what they mean for strategic voting.

**Title:** Differential Geometry of Mechanical Systems

**Speaker:** Yuanhao Zou

**Time:** 4:30 - 5:00

**Abstract:** Mathematicians and physicists have developed different mathematical tools to model concepts and laws in classical mechanics. My research focuses on the differential geometry approach to model complicated mechanical systems. In particular, I examine concepts in linear algebra and differential geometry - such as bilinear maps, tensors, tangent bundles, Riemannian manifolds, and geodesics - that allow us to conceptualize fundamental concepts in elementary mechanics from a geometric perspective. My discussion will begin with an introduction to these mathematical concepts I examined. Then, I will make connections between ideas in differential geometry and basic concepts in mechanics including position, angular velocity, kinetic energy, and forces. The discussion will conclude with connections made between the Newton-Euler equations in physics and the Euler-Lagrange equations in the calculus of variations.

**Title:** The Rationality of Economic Discounting

**Speaker:** Paul Hinton

**Time:** 5:00 - 5:30

**Abstract:** How do we decide to consume goods that have immediate benefits but also future consequences? How can we explain a person's decision to procrastinate? Economists use assumptions about behavior to determine if an economic agent acts rationally. A paper by J. Doyne Farmer and John Geanakoplos proposes a new model in which decision makers are rational. We will look at the math behind economic discounting and explore why traditional discounting models fall short of either rationality or empirical validation. In addition, we will see how the discounting model changes when we introduce uncertain information about the future.

---

## Thursday, November 4 — CMC 206

**Title:** Clustering Methods and the NFL Salary Cap

**Speaker:** Beau Nelson

**Time:** 3:30 - 4:00

**Abstract:** From market research to image processing, supervised and unsupervised, learning algorithms are supplying easy to understand analysis to big data. In this project, three different clustering methods will be considered: k-means, hierarchical, and model based clustering. These three methods present a flexibility in cluster creation that can be applied to a wide range of functions. This project will focus on the NFL's salary hierarchy and search for more efficient ways to assemble winning teams. Additionally, this talk will grapple with the ethical dilemma teams face when balancing the compensation of their athletes while chasing a super bowl ring. The NFL has been challenged with using predictive statistical analysis

because of its vast complexity. However, this project will illustrate how isolating a small part of the game, in order to obtain more applicable analysis, can give a team the winning edge.

**Title:** Construction and Coefficients of a Cyclotomic Polynomial

**Speaker:** Conner Taylor

**Time:** 4:00 - 4:30

**Abstract:** The factors of polynomials of the form  $x^n-1$ , called cyclotomic polynomials, have various properties that can be observed just from looking over a list of the first few, and most of which actually hold for all  $n$ . Additionally, many of them are easily proven just by creating a rigorous definition for the cyclotomic polynomial that allows for easily constructing one for any particular  $n$ . The first half of the talk focuses on this definition, and the relationship between complex numbers and roots of unity, and the construction of a cyclotomic polynomial and the construction of a polynomial of the form  $x^n-1$  out of cyclotomic polynomials. However, one easily-observable conjecture that does fail relates to the coefficients of a cyclotomic polynomial. The latter half of the talk focuses on the first failure of this conjecture, and how this relates to the number of prime divisors for  $n$ .

**Title:** Compressed Sensing: Overcoming the Nyquist-Shannon Theorem through Random Sampling

**Speaker:** Jan Williams

**Time:** 4:30 - 5:00

**Abstract:** The Nyquist-Shannon Sampling Theorem is a central result in the field of signal processing that describes conditions under which a continuous signal can be reconstructed by discrete sampling. In general, the conditions described are both necessary and sufficient. However, if we add the requirement that the signal has a sparse representation in some basis, we can reconstruct the signal with far fewer samples than required by the Nyquist-Shannon Theorem. This process is known as compressed sensing and leverages the fact that the Manhattan norm promotes sparsity to find the sparsest solution to an underdetermined, linear system. In turn, this solution allows for the reconstruction of the continuous signal. We explain how to formulate and solve a compressed sensing problem and when we can expect successful recovery of a signal.

---

## **Job, Internship, & Other Opportunities**

### **Predoctoral Research Fellows Program - Stanford Institute for Economic Policy Research**

We seek highly skilled and motivated individuals from diverse backgrounds and perspectives to join our full-time Predoctoral Research Fellows Program for a one- to two-year appointment.

Find details and apply by November 12 at [siepr.stanford.edu/programs/apply-predoctoral-research-fellow-program](https://siepr.stanford.edu/programs/apply-predoctoral-research-fellow-program).

### **Investment Research Summer Internship - DGV Solutions**

We are seeking highly motivated students to join our team for full-time, paid, 8-10 week summer 2022 internships. An internship at DGV Solutions offers real world experience at a premier investment management firm. This is a unique opportunity to grow your knowledge and skills through direct exposure

to senior investment professionals in a dynamic work environment. At the conclusion of the internship, you will have an opportunity to present the investment idea you have developed, throughout the summer, to the entire firm.

Apply by November 19 at [carleton.joinhandshake.com/jobs/5428886](http://carleton.joinhandshake.com/jobs/5428886).

### **Global Macro Summer Internship - Franklin Templeton**

At this internship, conduct detailed macro-economic, sovereign credit, and political analysis as well as monitoring current market developments for a selected country, and work closely with a small team comprised of other Analysts, Traders, and Portfolio Managers.

Find more information and apply by October 31 at [carleton.joinhandshake.com/jobs/5477125](http://carleton.joinhandshake.com/jobs/5477125).

---

## **Upcoming Events**

### **Week 8**

Tuesday November 2, 3:30 - 5:30pm  
Individual Comps Talks — CMC 206

Thursday November 4, 3:30 - 5:00pm  
Individual Comps Talks — CMC 206

---

## **Problems of the Fortnight**

Since this is a special edition of the Goodsell Gazette, there are no problems of the fortnight. Check this space next week for more problems, solutions, and Mark's secrets of the universe.



**Editors:** *Owen Biesel, Antonia Ritter*

**Problems of the Fortnight:** *Mark Krusemeyer*

**Web & Subscriptions:** *Sue Jandro*

