



# Goodsell Gazette

Carleton College

Northfield, MN 55057

The newsletter for the Carleton mathematics and statistics community

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## Comps Talks

Welcome to the Math and Stats Group Comps Presentations for Spring 2020! This term students have recorded comps presentations that are viewable by a prerecorded video. The videos will be available for viewing after 2:00 pm on Friday, May 15 on our website, [www.carleton.edu/math/major/comps/math-and-stats-comps-presentations-spring-2020/](http://www.carleton.edu/math/major/comps/math-and-stats-comps-presentations-spring-2020/).

Students from each comps group will be hosting a Q&A session by Zoom on May 19 and 21 at the times listed below. Please watch your email for a Zoom invitation for viewing. We hope you all enjoy the comps presentations.

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## Tuesday, May 19

**Title:** Bootstrap Confidence Intervals for OLS Regression

**Speakers:** Andrew Lin, Nobuaki Masaki, Colin Pi, Matt Thill, and Yihuang Wu

**Time:** 4:00pm

**Abstract:** Classical  $t$  confidence intervals for the slope and intercept in OLS regression may not capture true parameters at the intended frequency in the presence of heteroscedasticity or outliers. For our project, we first looked at techniques such as resampling cases and residuals to obtain bootstrap distributions for estimated regression slopes and intercepts. Then, we explored the BCa confidence interval in addition to the bootstrap percentile confidence interval used to make inferences about the slope and intercept from bootstrap distributions. Using simulation, we compared across samples drawn from various populations the coverage of 95% confidence intervals for the slope and intercept obtained from the techniques we explored to test their performance and see whether they were robust to model violations such as heteroscedasticity.

**Title:** A Dynamic Exploration of the Mandelbrot Set

**Speakers:** Ozzy Houck, Dylan Kempton, Milena Silva, and David White

**Time:** 4:20pm

**Abstract:** The Mandelbrot set is one of the most famous (and beautiful) objects in mathematics. This immensely complicated set has its roots in a simple question: what happens when you repeatedly apply a complex quadratic polynomial to a complex number? We use tools from complex dynamics and analysis,

including the Schwarz Lemma, the Attracting Periodic Orbits Lemma, and the Fatou-Julia Lemma, in order to describe the Mandelbrot set. Along the way, we cover fun topics such as periodic cycles, basins of attraction, and filled Julia sets. We show that even small changes in our choice of starting point can have dramatic effects on the dynamical outcome of the system, and that even simple problems can give rise to beautiful complexity.

**Title:** Wiring the Universe

**Speakers:** Emma Qin, Will Schwarzer, Elizabeth Zhu, and Peter Sparks

**Time:** 4:40pm

**Abstract:** In this interdisciplinary project, we show how wiring diagrams, a concept from applied category theory, can be used to produce models in a diverse range of subjects. We discuss examples ranging from truth tables in electrical circuits to propositional logic and from problems in geology to economic models.

## Thursday, May 21

**Title:** A Hazardous Analysis: Using Survival Methods to Understand Factors Affecting the Age of First Drug Use

**Speakers:** Natalie Maurice, Tanvi Mehta, Matteo Pellizzer, and Lewis White

**Time:** 4:00pm

**Abstract:** Understanding and modeling the time it takes for a specific event to take place is a valuable statistical tool. In situations where complete information of the time variable is missing due to the observation period ending before the event takes place or other such instances, survival analysis provides methods to analyze this data, making use of all of the available information. One interesting application for this theory is the time until individuals first try certain drugs. In this project, Cox proportional hazard models and Weibull accelerated failure time models were used to analyze how different demographic factors such as gender, race, education level, economic status, perceived risk of the substance, and age of first use of other substances affect the age at first use of marijuana, cocaine, and heroin. Largely, these two models had similar results for each of the three substances, and diagnostics suggest that the assumptions of both are reasonable. Impacts of these six factors on the hazard of trying a substance varied between the three substances. Further work could look into the varying effects of age over time, other demographic characteristics, and additional substances to see how consistent these results remain.

**Title:** Am I Ready to Learn "Real" Math Now? A Presentation About Northfield's First Math Circle

**Speakers:** Jackie Chan, Tenzin Kunsang, Elisa Loy, Fares Soufan, and Taylor Yeracaris

**Time:** 4:20pm

**Abstract:** Do school students need to wait until college-level mathematics or statistics before they can experience the true joy of mathematical discovery? By starting a Math Circle in the Northfield Middle School, we answered this question with a resounding "NO." Our Math Circle, which we ran weekly during the Fall and Winter terms, gave students a chance to approach math as mathematicians do: creatively and freely making mistakes, making discoveries, and asking new questions, all on their own terms. By letting students take the lead, we let them be the owners of their own mathematics, and helped them to experience the joy of mathematical exploration. Along the way, we exposed them to several of our favorite math topics, most of which are outside the usual public school curriculum; these included combinatorics, graph theory, probability, and cryptography. In our comps talk, we will discuss the mathematics,

motivations, methods, and “yes” madness of our Middle School Math Circles. Come on by!

**Title:** Homological Algebra

**Speakers:** Oscar Smith and Siang Wongrattanapiboon

**Time:** 4:40pm

**Abstract:** Homological algebra is the study of how to associate sequences of algebraic objects such as abelian groups and modules to topological objects in a general algebraic setting. Homological algebra began to be studied as a branch of topology in the 1800s, and became an independent subject at the end of the 19th century, chiefly by Poincare and Hilbert. One motivation for this subject is the study of chain complexes, a useful concept in several areas of mathematics including abstract algebra and differential geometry. In this talk, we will introduce R-modules, exact sequences, categories, and functors, and show how they can allow us to extract information contained in chain complexes. Along the way, we will also demonstrate a (super cool!) method of mathematical proof called diagram chasing.

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## **Budapest Semesters in Mathematics - Summer Research**

BSM would like to invite you - as former/current/future BSM students - to consider spending the summer doing what you love most: math, and even more specifically math research, under the auspices of BSM. Because of the COVID-19 pandemic, BSM had to cancel its summer semester. However, while the program cannot have a regular, transcript providing semester, they are happy to give you the opportunity (free of charge) to submerge yourself in an area of math you like and gain invaluable experience. In addition, students who successfully complete the summer research program will get a certificate of completion for the program. Read more about the initiative and see the list of research problems at [www.bsmath.hu/20summer](http://www.bsmath.hu/20summer).

Submit an application and some work on qualifying problems by June 2, 2020. Contact [office@bsmath.hu](mailto:office@bsmath.hu) with any questions.

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## **Budapest Semesters in Mathematics Education - Online!**

Budapest Semesters in Mathematics Education (BSME) is a study abroad program in Budapest, Hungary, designed for those interested in the learning and teaching of secondary mathematics. BSME participants explore the Hungarian pedagogy, in which a strong emphasis is placed on problem solving, mathematical creativity, and communication.

BSME will run an online program for the Summer 2020 session. Given the strong demand for teachers to learn about online instruction in the current climate, the session will have a dual focus on the Hungarian pedagogy and online instruction. BSME courses are taught in English by Hungarian teacher scholars. The courses are designed so that credits are transferable to American colleges and universities.

The application for the Summer 2020 session is due on June 1. It is reviewed on a rolling basis, so apply

early! More information, including the online application, can be found at [www.bsmeducation.com](http://www.bsmeducation.com). If you have any questions, please do not hesitate to contact our office at [bsme@bsmeducation.com](mailto:bsme@bsmeducation.com).

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

### **National Security Agency - Mathematics Internships**

The NSA has several opportunities for undergraduate and graduate students majoring in mathematics or statistics. Applications for summer 2021 are now open for the Directors Summer Program, Cryptanalysis and Signals Analysis Summer Program, and Graduate Mathematics Program. These 12 week paid internships provide students with the opportunity to work directly with NSA Mathematicians on mission-critical problems and experience the excitement of the NSA mathematics community. Find details at <https://www.intelligencecareers.gov/nsa/nsastudents.html>.

While next summer is a ways away, we do encourage early applications as every participant must obtain a security clearance. Completed applications must be submitted no later than Oct. 15, 2020. Please note that U.S. citizenship is required.

Applications can be found via [www.intelligencecareers.gov/nsa](http://www.intelligencecareers.gov/nsa).

### **SciTech Internship Program - STEM Interns**

SciTechsperience is an internship program that connects college students studying science, technology, engineering and math (STEM) disciplines to paid internships in small to mid-sized Minnesota companies. Companies are reimbursed for 50% of the wages paid to their intern, so there is a strong incentive for employers to hire students through the SciTechsperience program. This year at least 375 students will find internships through SciTechsperience. The program is state-funded and there is no cost to participate. Find more information at <https://scitechmn.org/>.

### **Federated Mutual Insurance Company - Actuarial Intern**

Internships are a great way to hone your skills in a professional setting. You'll be exposed to a variety of meaningful projects that may include performing company level experience and rate level studies, collecting and organizing data to create reports, calculating impact of assumption changes on current book of business, and assisting with rating filings and other regulatory reporting. You'll collaborate with team members daily. Your colleagues want you to learn and succeed, and you'll benefit from their coaching and feedback. Even better, your contributions will be valued and rewarded - as you will be an important member of our team.

This is a full-time summer internship for the summer of 2021. Seeking juniors or seniors majoring in Actuarial Science, Math, or Statistics. Find details and apply at [carleton-csm.symplicity.com/students/index.php?s=jobs&ss=jobs&mode=form&id=48ffca68eca7ec7dc9f525a0f8845674](http://carleton-csm.symplicity.com/students/index.php?s=jobs&ss=jobs&mode=form&id=48ffca68eca7ec7dc9f525a0f8845674).

### **D.E. Shaw & Co - Quantitative Analyst**

Quants at the D. E. Shaw group apply mathematical techniques and write software to develop, analyze, and implement statistical models for our computerized financial trading strategies. They utilize their

creativity and innovation to create novel approaches to trade profitably in markets around the globe. Successful candidates have traditionally been exceptionally talented students at the top of their respective statistics, math, physics, engineering, and computer science programs. Find details at <https://carleton-csm.symplicity.com/students/index.php?s=jobs&ss=jobs&mode=form&id=c6c60ccb64b4e14d39708cc0ab4ef007> or apply by May 31 at [www.deshaw.com/recruit/jobs/OC/CarletonCollege](http://www.deshaw.com/recruit/jobs/OC/CarletonCollege).

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## Problems of the Fortnight

To be acknowledged in the next *Gazette*, solutions to the problems below should reach me by noon on Tuesday, May 26.

1. Consider positive integers  $n$  such that  $361n + 1$  is a perfect square. (For example,  $n = 359$  is such an integer, because  $361 \cdot 359 + 1 = (360 + 1)(360 - 1) + 1 = 360^2$ .) Are there infinitely many such integers? If so, what is the 2020th such positive integer  $n$ ? If not, what is the largest one?
2. Consider an isosceles triangle with side lengths  $AB = 2, AC = BC = 5$ . Let  $\gamma = \angle ACB$  be the angle at  $C$ , and let  $X$  be the point on the side  $AB$  such that  $\angle ACX = \frac{3}{8}\gamma$ . Find the distance  $AX$ , giving the answer as a quotient of expressions involving only integers and square roots of integers. (In particular, the answer shouldn't involve any trigonometry, and should be exact.)

Soon after I submitted the copy for the last *Gazette*, a correct solution to the first problem posed April 17 came in from Walker Miller-Breetz at Northeastern University. As for the problems posed May 1, John Snyder solved them both and "Auplume" solved the first one. Sadly, no Carleton students have been submitting solutions. Of course, many of you probably have more pressing concerns, and I wish you all the best in dealing with them and also for your own health. Take care of yourselves!

- Mark Krusemeyer

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