



Goodsell Gazette

Carleton College

November 2, 2018

Northfield, MN 55057

The newsletter for the Carleton mathematics and statistics community

Vol. 37, No. 05



As If We Don't Have Enough Problems Already...

The annual NCS problem-solving contest will take place this year on Saturday, November 10, from 9 a.m. to noon. Participants will work in teams of up to three on ten problems, which are usually at a wide range of difficulty levels. Although there will likely be more than seventy teams competing from around the region (there may even be some in Canada), our part of the contest will take place here on campus. Before the contest, there will be bagels, cream cheese, and coffee from Tandem Bagels. If you are interested in participating, please let Rafe Jones know who will be on your team by Thursday, November 8. If you want to participate but don't have a team, let Rafe know that too (the sooner, the better!) and he might be able to help you find others with whom you could form a team.

Summer Science Fellows Program

Date/Time: Monday, November 5, 7:00 p.m.

Location: Leighton 304

The goal of the Summer Science Fellowship is to broaden participation of historically underrepresented groups (including gender, ethnicity, socioeconomic background, and disabilities) in the sciences/math. Carleton Summer Science Fellows will have the opportunity to work in a research lab either at Carleton or at another institution for two summers with a summer stipend of \$4600. Summer Science Fellows will be expected to enroll in the 1 credit Science Fellows Research Colloquium in the spring before and the fall following their research experience. There is an informational session happening Monday, November 5th in Leighton 304. Only first and second year students are eligible.

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 Thursday, November 8th, four department majors will be giving their comps talks in CMC 206. Take a look at what they'll be speaking about just below, then be sure to stop by and support them while they demonstrate what they've learned!

Thursday, November 8

Title: Graph Colorings

Speaker: Harry Zhang

Time: 3:30 p.m.

Abstract: In 1850, Thomas Kirkman asked the following combinatorics puzzle in a mathematics magazine - "[f]ifteen young ladies in a school walk out three abreast for seven days in succession: it is required to arrange them daily, so that no two shall walk twice abreast. This puzzle, later known as the Kirkman's schoolgirl problem, can be solved as an edge coloring problem. In this talk, I am going to introduce and explore the chromatic numbers of a graph and the recursive calculation of chromatic polynomials to find a solution to the Kirkman's schoolgirl problem.

Title: LASSO

Speaker: Gege Zhang

Time: 4:00 p.m.

Abstract: Many of us are familiar with the concept of least squares. However, the least squares estimates might not always be the best method. On one hand, models based on least squares often have low bias but large variance. On the other hand, given a large number of predictors, we would like to efficiently identify a small subset of covariates that exhibit the strongest effect. Lasso (least absolute shrinkage and selection operator) is an alternative regression analysis method that enables us to overcome the challenges above. In this talk, I will explain the purpose of the lasso and the mathematical theories and assumptions behind it. I will also compare it with ridge regression, which is a technique that predates the lasso. Additionally, I will introduce the glmnet package in R that allows us to fit the lasso or ridge regression for generalized linear models.

Title: Mobius Maps and Anamorphosis

Speaker: Jeremy Hills

Time: 4:30 p.m.

Abstract: Anamorphosis is a method that was used and studied from the 15th century to the present day. Painters in the 15th-16th centuries studied it to get a better understanding of perspective while in modern times people use it for many reasons; from IMAX using it to project moving images onto a hemispheric dome from a flat film frame and roadway messages using it to have drivers read messages easier, to crime shows like *Numb3rs* using it to identify and catch criminals. We will look at what happens to lines and circles under Mobius Transformations and how these transformations can be used to visualize how a domain is mapped by a complex-valued function.

Title: Quandles and the Alexander Polynomial as Knot Invariants

Speaker: Perry Strong

Time: 5:00 p.m.

Abstract: Knot theory has a wide range of influences on other subjects such as quantum computing and biochemistry. In essence, the study of knot theory is a study of knot invariants. A knot invariant is a value,

in a very loose sense, that can be linked to a knot and which is the same for all equivalent knots. The strength of a knot invariant is based on how well it can tell two different types of knot apart. The goal is to create a knot invariant that is both very powerful and easy to compute.

One of the strongest knot invariants is the fundamental quandle, which can tell any two different knots apart, not respecting orientation. The only problem is that the quandle is an infinitely long set, but we can use it to arrive at other easier to compute invariants. My research focused on one such example, the Alexander polynomial, which is an invariant that applies a polynomial to each knot. This invariant has been around for almost a century, but it is both one of the strongest invariants and has had further use in more modern invariants such as floer homology. I will explain the mathematics behind the Alexander polynomial, how to calculate the polynomial, and the shortcomings of this invariant. Finally, I will briefly discuss more modern invariants that deal with these shortcomings.

Upcoming Events

Week 9, Thursday, November 8, 3:30 - 5:30 p.m.
COMPS Talks - CMC 206

Job & Internship Opportunities

Southern Teachers Agency

Are you interested in a career in education? Well, Southern Teachers has already begun recruiting your brightest and best seniors to teach the next generation! Private schools are looking for candidates who have a strong background in math and are able to share their passion with students; they usually do NOT need a teaching license or education major. Southern Teachers is the premier teacher placement agency for private schools in the South. Hundreds of schools around the South will list about 3,000 jobs with us for the next school year. The field is open to academic majors of all kinds, not just graduates with degrees in education. Our services are completely free to candidates! For more information, visit: https://southernteachers.com/new-candidate?utm_source=department%20email.

Data Science Fellowship

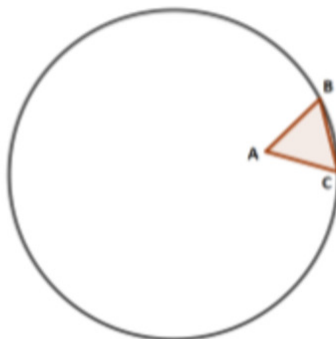
The Institute for Defense Analyses (IDA) is a not-for-profit corporation that operates three Federally Funded Research Centers (FFRDCs). IDA's Systems and Analyses Center is located in Alexandria, Virginia and is comprised of eight research divisions providing objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conducts related research on other national challenges. The IDA Data Science Fellowship provides recent graduates a unique opportunity to develop and apply data science skills to important issues in national security. Data Science Fellows will investigate the ways newly available 'big data' methodologies contribute to national security and gain experience developing advanced data science tools. They will use their critical thinking and analytic skills to work on challenging real-world national security issues. In a collaborative team environment, perform data manipulation and statistical, econometric, predictive, descriptive, and other quantitative analyses to answer national security-related research questions. Fellows should expect to learn while creatively contributing to interdisciplinary project teams. For more information and to apply, visit: The Tunnel.

Problems of the Fortnight

There is good news for motivated problem-solvers! I now have access to the legendary Big Box O' Prizes. This means that going forward, if you are a Carleton student who submits a correct solution to one of the Problems of the Fortnight, you may come by my office to claim your choice of real, physical, corporeal reward from the B.B.O.P. In addition, students who submitted correct solutions to previous problems from this fall may reach inside the B.B.O.P. as well—you know who you are.

To be acknowledged in the next issue of the *Gazette*, please send your solutions to me by noon on Tuesday, November 13.

Thog the two-dimensional caveman was kidnapped by aliens and relocated to outer space. He now lives on the interior surface of a two-dimensional Dyson sphere (that is to say, a circle) of radius 1 AU. The aliens allowed him to bring his great stone wheel with him, which is an equilateral triangle of side length x where $0 < x \leq 1$ AU. See diagram below.



Thog spends all his days rolling the wheel counterclockwise around the surface of the Dyson sphere. First the wheel rotates around point B, until point A touches the sphere. Then the wheel rotates around point A, until point C touches the sphere, and so on. For these problems, you may assume Thog pushes the wheel forever, so he circumnavigates the Dyson sphere infinitely many times.

Let $W(x)$ denote the total area of the region within the circle swept out by the wheel during this process.

- (1) For which values of x does the wheel occupy re-occupy its precise original location after a single full revolution about the sphere? At these values, what is $W(x)$?
- (2) Prove that $W(x)$ is *not* an increasing function of x —that is, there exist $0 < x < y \leq 1$ with $W(x) > W(y)$.

Congratulations to the indomitable “Auplume” who once again solved both of last fortnight’s problems. Please get to work, Carleton students, the B.B.O.P. is overflowing with claimable booty.

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-Mike Cohen



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