Prospective Major and Minor Information Session

Are you considering a math major or minor, or a statistics major? On Thursday, February 10, we'll host an information session where you can learn a little more about our department and mingle with professors and fellow students.

What: Prospective Majors and Minor Info Session  
When: Thursday, February 10, 4 - 5 PM  
Where: CMC 306

Research Opportunities with Carleton Faculty this Summer!

Carleton faculty Adam Loy and Rob Thompson are looking for student researchers for Summer 2022. See below for project descriptions and contact Adam or Rob with any questions.

To apply, visit forms.gle/KasGzJ3fosrr7etc9. The application deadline is Feb 15 at midnight.

Let's Write an R Package! (Adam Loy)

2 or 3 students (pending funding), June 13–August 5 (8 weeks)

Mode: in-person is preferred

Gauge R & R studies are used by engineers and physical scientists to assess the uncertainty associated with a measurement system. Understanding the uncertainty in a measurement system is important because this knowledge allows researchers to quantify the quality of the measurements they are receiving from a device. For example, Houf and Berman (1988) discuss a gauge R & R study to understand the variability of the instruments used to measure the thermal performance of semiconductor power modules. The study consisted of three randomly selected operators each making three measurements on ten randomly selected power modules. In this study, variability in the thermal measurements can be due to two sources: (1) the manufacturing process, and (2) the measurement instrument. The goal of this gauge R & R study was to determine whether the variability from the measurement instrument is small relative to the manufacturing process, as is desired in a quality measurement system.

In R, the qualityTools and SixSigma packages provide the primary means to fit gauge R&R models; however, neither package provides a complete modeling framework. The goal of this project is to create
an R package that implements a (more) complete modeling framework for gauge R&R models in R, following the tidymodels philosophy.

During this summer project you will:

- Learn about different estimation procedures for Gauge R&R models. Specifically, we'll consider an ANOVA-based method as well as a Bayesian method.
- Think about how to visualize different sources of variability.
- Learn a lot about R programming and how R packages are constructed.
- Write a help files and a vignette (technical report) that will help users start using your R package.

Prerequisites: This project is open to students who have completed Stat 220 and Stat 250. Ideally, one student would have completed Stat 340.

### JAGS and Stan and Greta, Oh My! Navigating the Opinionated Waters of Bayesian Computation (Adam Loy)

1 student (pending funding), June 13–August 5 (8 weeks)

Mode: in-person or remote

Computation is a fundamental element of Bayesian statistics, allowing us to fit complex models where we can’t find closed-form solutions for the posterior distribution. While there is broad agreement about how fundamental computation is to the Bayesian paradigm in undergraduate statistics education (see Volume 28, Issue 3 of the Journal of Statistics and Data Science Education), it’s unclear what framework should be used in the classroom. In this project, we’ll review different ways MCMC can be implemented in R, comparing and contrasting the flexibility, extensibility, and required cognitive load. Specifically, we will compare how common Bayesian models can be fit using the following MCMC programs:

- Just Another Gibbs Sampler (JAGS) via runjags and rjags
- Stan via rstan and brms
- greta
- NIMBLE

During this summer project you will:

- Implement a variety of Bayesian models using each MCMC program.
- Reflect on the usability, flexibility, and extensibility of each program.
- Write an article (and webpage) comparing these programs that statistics educators can use when deciding how to structure their Bayesian statistics course (including Stat 340 this fall!)

Prerequisites: This project is open to students who have completed Stat 220, but Stat 340 is strongly recommended so that the models make more sense.

### AMAAZEing Mathematics: Computational Methods for Studying Broken Bones (Rob Thompson)

2-3 students (pending funding), 10 weeks (likely June 13 – August 19)

Mode: in-person is preferred

You are interning for the famous (fictional) archeologists Prof. Sydney Fox and Prof. Henry Jones, Jr., and you come upon a mysterious discovery…an ancient pile of broken animal bones deep in a cave. The professors want to know: who broke these bones? Was it an early human, smashing them with stone tools to get at the precious marrow, or bone crunching predators who long ago made their home in the
cave? Or maybe one of the other interns stepped on them accidentally?

This story is more than fiction, of course. Archeologists often look for evidence in the remnants of the past – like old bones – to better our understanding of human activity. This evidence is growing increasingly quantitative, incorporating more sophisticated tools from applied mathematics, statistics, and computer science. For this project we'll help develop some of these new tools by joining a consortium of researchers known as AMAAZE (https://amaaze.umn.edu). In particular, these researchers need better methods for understanding the stories that broken bones can tell: stories of early human and animal activity and interaction.

We will focus on the development and testing of methods in computational geometry for analyzing 3d scans of broken bones. Key tasks include the automated detection of the faces of the break, measurement of break angles, and methods for comparing break faces and reassembling fragmented bones. We will work with a data set consisting of 3d scans of elk bones, broken both by modern recreations of ancient human tools and by spotted hyenas (Scruffy and Nyota) from the Milwaukee zoo.

Minimal prerequisites are linear algebra, and some experience in computing (e.g. introductory computer science or statistics). During this project we will use some assortment of MATLAB, Python, and MeshLab for computing. Feel free to contact Rob Thompson to talk more about the project!

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**Summer 2022 Research Funding and Post-Baccalaureate Fellowship Opportunities**

Questions about any of these opportunities? Contact Amy Csizmar Dalal (adalal@carleton.edu) or Rob Thompson (rthompson@carleton.edu).

**Summer Science Fellowships**

Application Deadline: Friday, February 4, 2022, 5:00 PM

**What:** The goal of the Summer Science Fellowship is to broaden participation of historically underrepresented groups (based on gender, race, ethnicity, socioeconomic background, or disability) in the sciences and math. Carleton Summer Science Fellows have the opportunity to work in a research lab either at Carleton or at another institution for two summers (with guaranteed funding) with a stipend of $500/week for full time work for up to 10 weeks. Summer Science Fellows participate in group meetings and activities both before and after the summer research experience and are expected to enroll in the 1 credit Science Fellows Research Colloquium both in the spring before and the fall following their research experience.

**Who:** First- or second-year Carleton students with a strong excitement and interest in graduate study in fields of biology, chemistry, computer science, geology, math/stats, physics, or psychology. By the end of the 2021-2022 academic year, students must have completed at least one introductory science course with a lab, or students interested in Computer Science, Math, and/or Stats must have completed at least one course in those fields. Students who identify as members of the following groups are especially encouraged to apply:

- Students from groups traditionally underrepresented in science and math fields
- Students from low-income backgrounds
- Students who attended under-resourced high schools
- Students who are in the first-generation in their family to attend college
More details are available in the application form, found here: [www.carleton.edu/math-science/research/summer-fellows/](http://www.carleton.edu/math-science/research/summer-fellows/).

**Student Research at Another Institution (Kolenkow-Reitz Fellowship)**

Application Deadline: Tuesday, March 29, 2022, 5:00 PM

**What:** The Kolenkow-Reitz fellowship provides research support for Carleton students working with non-Carleton science and math faculty at another institution during the summer. These research opportunities are intended to encourage Carleton students’ development as scientists and their exploration of mathematics and the sciences as a possible career. Awards fund student stipends ($500/week for full time work) for up to 10 weeks during summer break. Additional expenses up to $500 can be requested to help defray travel or research supply expenses. Note that students must work full time in order to qualify.

**Who:** Carleton students are eligible to apply for this funding. Before applying, students should have already contacted and discussed the nature and timing of their project with the person they are planning to work with as well as a faculty member at Carleton who can vouch for the project and its alignment with their professional development goals. Because the intent of the fellowship is exploration in STEM fields, priority is given to students who have completed coursework related to the proposed research, but who have not yet had a significant funded research experience (7 or more weeks). Please note that students previously supported through the Kolenkow-Reitz Fund (winter break or summer) are less likely to receive funding, but are still eligible to apply. The Career Center also offers internship funding that can, in some cases, be applied to research experiences in STEM.

More details are available in the application form, found here: [www.carleton.edu/math-science/research/studentresearchaway/](http://www.carleton.edu/math-science/research/studentresearchaway/).

**Paglia Post-Bac Research Fellowship**

Application Deadline: Friday, February 25, 2022, 5:00 PM

**What:** The goal of this fellowship is to enable graduating seniors with a strong interest in a career in scientific research to experience working life in a lab/research group at a U.S. Research One (R1) institution for a period of one year (for international students) or two years (for US citizens or permanent residents). Fellows will have access to the intellectual life of the university as well as infrastructural and other support for research under a PI. The expectation is that networking and other opportunities available in the R1 environment will inform and strengthen the fellow’s commitment to a career in research and help them secure letters of recommendation for an eventual application to a PhD program. Carleton will select up to three fellows for this opportunity each year.

**Who:** Graduating seniors with a major in a discipline represented on Carleton’s STEM Board (Biology, Chemistry, Cognitive Science, Computer Science, Environmental Studies, Geology, Mathematics and Statistics, Physics and Astronomy, and Psychology) are eligible to apply. Students who wish to pursue the MD and enter clinical practice should not apply, but those students interested in an MD/PhD track are welcome to do so. International students will be eligible for a one-year opportunity, during which they can be employed as part of their OPT (optional practical training) F-1 visa extension, as available. Students with US citizenship or permanent residency will be eligible for a two-year opportunity.

More details, including the application form, are available here: [www.carleton.edu/fellowships/carleton-fellowships/research/paglia/](http://www.carleton.edu/fellowships/carleton-fellowships/research/paglia/).
Job, Internship, & Other Opportunities

Program for Research in Markets & Organizations - Harvard Business School

This is a 10-week program for undergraduates who wish to work closely with Harvard Business School faculty on research projects on topics ranging from business strategy to social media, and from innovation management to private equity.

Summer 2022 will be the twelfth year for this research experience program, which has been designed to stimulate community and creativity among a small group of motivated undergraduates. PRIMO will tentatively run from Monday, June 6, 2022 through Thursday, August 11, 2022. PRIMO fellows will be offered Harvard campus housing, a partial board plan, and a modest research stipend.

Applications to the PRIMO program for Summer 2022 are now open until February 15 at 11:00 a.m. CST. Applicants are required to submit their current transcript, an academic recommendation letter, a resume, and three short essays. For detailed instructions, please see hbs.edu/doctoral/primo/Pages/apply.aspx.

Information sessions will be held Wednesday, Feb. 2 at 3:00 p.m. EST and Wednesday, Feb. 9 at 6:00 p.m EST; register at hbs.edu/doctoral/primo/Pages/key-dates.aspx.

Opportunity Insights Predoctoral Fellowship - Harvard University

Raj Chetty (Harvard), John Friedman (Brown), and Nathaniel Hendren (Harvard) are looking to hire several students to work with their research group, Opportunity Insights.

The position is two years long and ideally begins around July 1st, 2022. The fellowship is based at Harvard University under the direction of Professors Chetty and Hendren and at Brown University under the direction of Professor John Friedman. It will include a variety of tasks that provide preparation for graduate school, such as analyzing data, developing statistical models, creating presentations, and editing research papers. In addition to working with faculty as research assistants, the pre-doctoral fellows frequently co-author papers with other students or faculty members. Most previous fellows have gone on to top Ph.D. programs in economics or related fields.

Further details and application instructions are available at opportunityinsights.org/joinourteam/.
Problems of the Fortnight

To be acknowledged in the next Gazette, solutions to these problems should reach me by noon on Tuesday, February 8 - in other words, before, during, or right after midterm break.

1. a) Given a plane and a sphere (in 3-space) that don’t intersect each other, describe the set of all points $P$ for which the distance from $P$ to the plane equals the distance from $P$ to the sphere. (The answer should be in geometric terms, although you might use various methods to find it.)

   b) What happens if the plane and the sphere are tangent? And what happens if the plane intersects the sphere in more than one point (in which case they intersect in a circle)?

2. a) Find the minimal area of a triangular region that contains the entire ellipse $3x^2 + 5y^2 = 17$.

   b) How many such triangular regions (containing the ellipse, of minimal area) are there?

Both problems posed January 14 were solved by Sebastian Vander Ploeg Fallon, who should check in with Sue Jandro about collecting a B.B.O.P. item. Good luck on the new problems; I promise that the number 2022 won’t make an appearance this time. And stay warm, healthy, and safe!

- Mark Krusemeyer