Goodsell Gazette

Carleton College *October 25, 2019*
Northfield, MN 55057 *The newsletter for the Carleton mathematics and statistics community* *Vol. 38, No. 03*

NUMS 2019

Date: Tuesday, October 29, 3:40-7:15pm
Location: 310 Regents Hall, St. Olaf

The Northfield Undergraduate Mathematics Symposium (NUMS) 2019 will be held at St. Olaf on October 29, 2019 from 3:40pm-7:15pm in Regents Hall 310. The conference will feature Carleton and St. Olaf students who will talk about their summer research experiences. In particular, Brody Lunch & Emma Qin (3:40pm-4:00pm), Aaron Li (4:30pm-4:50pm), and Marietta Geist & Abby Loe (6:25pm-6:45pm) will all be giving talks. Dinner at 5:20pm will be provided. We hope to see you there!

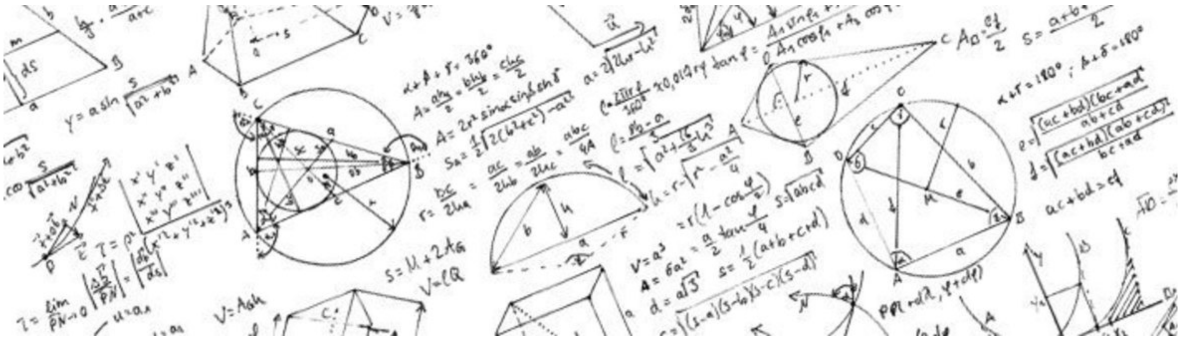
BRIDGES 2020

Building Relationships for an Inclusive and Diverse Group of Emerging Students (BRIDGES) is a conference aimed towards early graduate students and advanced undergraduate students interested in representation theory, number theory, and commutative algebra. The goal of this conference is to foster a sense of community amongst underrepresented groups in mathematics, introduce possible research areas, and expose the participants to role models and possible mentors.

The workshop will be May 20-22, 2020, and funding is available for undergraduate and graduate students, with priority given to participants with backgrounds that are traditionally underrepresented in mathematics. The deadline to apply for funding is January 31, 2020, and registration will be open through May 1, 2020. Confirmed speakers are Eloisa Grifo (UC Riverside, Commutative Algebra), Wei Ho (Michigan, Arithmetic Geometry), and Aaron Pollack (Duke, Algebraic Number Theory). You can find more information and an application form for funding on the conference website: http://www.math.utah.edu/awmchapter/conference.

What's the Math and Stats Department Teaching Next Term?

Have you checked your registration number yet? Made a list of classes you're hoping to take next year? Let the course descriptions below guide you into an adventurous new term with the Carleton Department of Mathematics and Statistics! There's something for everybody, from applied regression to advanced linear algebra -- find out more below.



Math 206: Tour of Mathematics
Instructor: Varies
Time: Fridays only, 6a
Prerequisites: None

Description: Are you considering a math or stats major, but wonder what those disciplines are all about? Maybe you're curious as to what research in mathematics or statistics even means. Are you already a major who would enjoy some fresh perspectives on the subject you love? Join us for a series of lectures on a variety of mathematical and statistical topics, with emphasis on exciting ideas, concepts, and results rather than depth in a particular area. This course is offered annually, and you are allowed to register for it twice, in consecutive years. 1 credit; attendance required. Contact Kate Hake with questions.

Math 236: Mathematical Structures
Instructor: Rafe Jones
Time: 4a
Prerequisite: Math 232 or instructor permission

This course is an introduction to the mathematician's route to certainty: mathematical proof. We'll study set theory, formal logic, and axiomatic systems, which are the solid building blocks of mathematical arguments. We'll learn about techniques for discovering (or inventing) proofs, common methods of proof, and how to write good proofs; these are the tissues that tie the building blocks together. And we'll study some fascinating problems and mathematical truths that everyone should know, such as the many sizes of infinite sets.

Math 236 is the first course in our curriculum whose primary goal is to teach you how to write proofs. Because proofs are how mathematical truth is established, it will give you the keys to a whole new mathematical world -- not to mention the necessary prerequisite for a slew of upper-level mathematics courses.

Math 241: Ordinary Differential Equations
Instructor: Rob Thompson
Time: 4a
Prerequisite: Mathematics 232 or instructor permission

Differential equations are a fundamental language used by mathematicians, scientists and engineers to understand and describe processes involving continuous change. In this course, we will study differential equations from both a practical and theoretical point of view. Our focus will be on developing differential equation models from natural laws and exploring the mathematical ideas that arise within these models.

We'll study examples like mechanical vibrations, lasers, insect outbreaks, competition and cooperation of species, language coexistence, superconducting circuits, and much more! The science will stay at an elementary level; our focus will be the mathematical ideas that arise in these models. Feel free to contact Rob (rthompson) with any questions!

Math 245: Applied Regression Analysis
Instructor: Laura Chihara
Time: 5a
Prerequisite: Math 215 (AP statistics 4/5) or Math 275

On the night of January 27, 1986, engineers at Morton Thiokol teleconferenced with engineers and managers at the Marshall Space Flight Center and Kennedy Space Center to determine whether it was too cold (31 F) to launch space shuttle Challenger. Data from previous flights seemed to suggest that temperature had an effect on the integrity of the O-ring seals on the booster rockets, but the final recommendation was to launch the Challenger on schedule. Could a statistical analysis of the pre-accident data have predicted the catastrophic failure of the shuttle? In this class, we will investigate the Challenger data and in general, learn statistical model building and model checking techniques. We will use the software package R to aid in the modeling.

Math 265: Probability
Instructor: Tom Madsen
Time: 4a
Prerequisite: Math 120 or 211

Einstein famously said, "God does not play dice with the universe." That may be, but we are all confronted by randomness and uncertainty on a daily basis. Probability gives us a set of tools for reasoning about uncertainty. Probability theory is a fundamental tool in physics, biology, meteorology, finance, computer science, political science, gambling, and many other fields. Probability is also the basis of all statistical inference. And on top of all that, it's a beautiful area of abstract mathematics in its own right. In this course, we'll use the tools of counting and calculus to develop a principled framework for quantifying uncertainty and randomness.

Math 275: Introduction to Statistical Inference
Instructor: Laura Chihara
Time: 2a
Prerequisite: Math 265

Statistics is the art and craft of studying data and understanding variability. Though mathematics (in particular, probability) governs the underlying theory, statistics is driven by applications to real problems. We will cover basic statistical inference as well as modern computational approaches, all in the context of investigating interesting questions that arise in scientific and public policy settings. We will use the software package R.

Math 280: Statistical Consulting
Instructor: Adam Loy
Time: Tuesday only, 2/3c
Prerequisite: Math 245 and instructor permission

Students will work on data analysis projects solicited from the local community. We will also cover the fundamentals of being a statistical consultant, including matters of professionalism, ethics and communication.

Math 285: Introduction to Data Science
Instructor: Katie St. Clair
Time: 1a
Prerequisite: Math 215 or Math 275

This course will cover the computational side of statistics that is not typically taught in an intro or methodology focused course like regression modeling. Most of data you encountered in your first (or second, or third, ..) stats course were contained in small, tidy .csv files with rows denoting your cases and columns containing your variables. The only messiness to these data may have been some missing values (NAs). We will start this course in data science by learning how to extract information from data in its "natural" state, which is often unstructured, messy and complex. To do this, we will learn methods for manipulating and merging data in standard and non-standard formats, data with date, time, or geolocation variables, text processing and regular expressions, and scraping the web for data. To effectively communicate the information contained in these data, we will cover data visualization methods (or, as statisticians often call it, EDA) that go beyond a basic histogram or boxplot, including methods for creating interactive graphics. We may also cover some modern computationally-intensive statistical learning methods. We will primarily use the stat software R in this course.

Math 331: Real Analysis II
Instructor: Gail Nelson
Time: 3a
Prerequisites: Math 321 or instructor permission

Now that you have mastered the ideas behind Îµ-Î´ proofs it is time to take advantage of your new skills. In this course we will look closely at the notion of integration. After a review of Riemann integration we will turn our attention towards other topics. More specifically, this course includes the Lebesgue measure, the Lebesgue integral, an introduction to general measure theory, and Banach and Hilbert spaces. Not only is this your chance to "integrate" your knowledge of functions, it is also an opportunity to better your understanding of the legal interchange of limit operations. And if you know the instructor, it shouldn't surprise you if the Cantor set makes an appearance!

The flavor of the course will be similar to a graduate-level course in analysis. If there is a possibility that you are headed for graduate school in mathematics or a related field, this course comes highly recommended.

Math 333: Combinatorial Theory
Instructor: Mark Krusemeyer
Time: 5a
Prerequisite: Math 236 or instructor permission

Does "let me count the ways" stress you out because you're not sure how you should go about that? Maybe you're not even sure, in situations (romantic or not) where your intuition is perhaps not to be trusted, whether there are any ways. And given that there are, in fact, ways, which way is the best one?

Questions of this sort come up in very different contexts - ranging from pure mathematics to the routing of garbage trucks, the study of communication networks, the matching of medical students to residencies, and the design of statistical experiments. Among the methods used to get answers are counting techniques, often involving binomial coefficients and/or generating functions (you get to have all the fun of infinite series with none, or almost none, of the bother about convergence!), proof techniques involving ideas such as the pigeonhole principle, and optimization techniques involving recursive algorithms. All sorts of interesting things will come up as we venture into this material, so do join us!

Math 342: Abstract Algebra
Instructor: Eric Egge
Time: 3a
Prerequisite: Math 236

Abstract algebra (not to be confused with elementary algebra, which you studied in high school or before) is a pillar of pure mathematics which supports a large body of work both within and outside of mathematics. Although most topics in abstract algebra were first studied for their intrinsic interest, ideas and results from the subject have also been applied in theoretical physics, in the design of error-correcting codes, in quantum chemistry, and even in the study of symmetry and artistic patterns like those in Escher's "Regular Division of the Plane" drawings. In this course, we will study groups, rings, and fields, which generalize ordinary arithmetic systems like "clock arithmetic," matrix multiplication, permutations, and the set of real numbers, in the same way that abstract vector spaces generalize Rn. Along the way we'll see how a few simple axioms can give rise to a remarkably rich theory and a zoo of fascinating examples.

Math 354: Topology
Instructor: Kate Hake
Time: 2a
Prerequisites: Math 236 or instructor permission

Imagine a surface made of thin, easily stretchable rubber. Bend, stretch, twist, and deform this surface any way you like, just don't tear it. As you deform the surface, it will change in many ways, but some aspects of the surface will stay the same. The aspect of an object that is unaffected by deformation is called the topology of the object. Often the properties that are significant are those that are preserved when we treat an object as deformable, as opposed to those that are preserved when we treat an object as rigid. They say a topologist cannot distinguish between a donut and a coffee cup, but what a topologist can do is identify and use the properties that these shapes have in common. In this class, we will look at mathematical definitions for determining when two topological spaces are essentially the same and develop techniques for distinguishing spaces. We will also see how topology impacts both real-world problems and a variety of results in other areas of mathematics.

Upcoming Events

Week 7

Tuesday Oct 29, 3:40-7:15pm
NUMS - Regents Hall 310, St. Olaf

Job & Internship Opportunities

Proto Labs, Inc.: Web Development Intern

Are you looking for the opportunity to gain real world experience while working with an innovative and industry leading organization? Would you like to help improve custom software that is used daily? As a Protolabs Web Development Intern, you will be working on business critical initiatives that build your technical knowledge and leadership capabilities. While working alongside seasoned developers and software quality engineers, you'll gain invaluable on-the-job experience, career development, and leadership opportunities while experiencing our team oriented, fun, and engaging culture. Application deadline is Nov. 15. Learn more and apply at https://carleton-csm.symplicity.com/students/index.php?s=jobs&ss=jobs&mode=form&id=bd0b13f9980b1425f5555fd3ba081e34.

Federal Reserve Bank of New York: Summer Analyst

Our Summer Analysts play an integral role in both the policy and research functions of the Research and Statistics Group. Analysts work closely with our economists, whose specialties include macroeconomics, microeconomics, banking and payment systems, capital markets, and international economics. Summer Analysts oftentimes return to the Fed as Research Analysts; others successfully pursue graduate school, private-sector and public-sector positions.

We seek candidates who are currently juniors and have records of superior scholarship and academic curiosity. Analysts usually have a strong background in economics, policy, mathematics, or computer science, though a major in one of these fields is not a necessity. Successful candidates often have previous research experience, and many are considering careers in economic research, public policy, or related fields.

In addition, we seek candidates from a wide range of backgrounds, particularly those that are typically underrepresented in economics. It is important to us that we succeed in recruiting a diverse cohort of Analysts each year. Thus we encourage many students with varying experiences and backgrounds to apply. Applications are being accepted now, on a rolling basis, at https://www.newyorkfed.org/careers/summer-programs#undergrad. It is recommended that candidates apply by November 1.

PhD Programs at Harvard Business School

Harvard Business School trains doctoral students to conduct innovative research within a broad range of academic fields, including: Accounting and Management; Business Economics; Health Policy Management; Marketing; Organizational Behavior; Strategy; and Technology and Operations Management. These are all intensive research programs aimed at placing graduates in an institution of higher learning as an Assistant Professor; the vast majority of HBS graduates place at top tier business schools.

Successful students come from a variety of academic backgrounds including computer science, economics, engineering, mathematics, psychology, sociology, and statistics, among many others. HBS seeks applicants with a pattern of strong academic performance, creativity, entrepreneurial spirit, and self-management skills who are passionate about learning and will be able to produce innovative research. HBS proudly offers full funding for all incoming students; regardless of financial need or national origin. In fact, each admitted student is automatically awarded a fellowship which includes tuition, single-person health fees, and a living stipend ($43,000 for 2019-2020 academic year) for up to 5 years of study. Students are not required to serve as research or teaching assistants in order to receive the stipend.

Explore the website (https://www.hbs.edu/doctoral/Pages/default.aspx) and contact HBS directly (doctoralprograms@hbs.edu) with questions about the details of the doctoral programs, the admissions process, and careers in business academia.

Problems of the Fortnight

To be acknowledged in the next *Gazette*, solutions to the problems below should reach me by noon on Tuesday, November 5.

1. Find

$$\lim_{N\to\infty}\lim_{n\to\infty}\sum_{k=1}^{N}\left(\frac{2019}{n}\right)^k\binom{n}{k}.$$

(As usual, $\binom{n}{k}$ denotes the binomial coefficient "n choose k".)

2. Suppose you have an unlimited supply of each of two kinds of rectangular blocks, one with dimensions $2\times5\times11$ and one with dimensions $3\times7\times13$. Can you assemble such blocks to form a single large block of size $150\times200\times5000$? If so, explain how you know it can be done; if not, explain why not. (Naturally, you are allowed to put the blocks in any orientation.)

The first problem posed October 11 was solved by Ethan Rojek, who should stop by CMC 217 some time to pick up an item from the B(ig) B(ox) O(f) P(rizes). Solutions to both problems also arrived from "Auplume" and from John Snyder; I'm hoping to post some of my own solutions soon. Meanwhile, enjoy the remaining fall colors, and good luck on the new problems!

- Mark Krusemeyer

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