Goodsell Gazette

Carleton College *February 21, 2020*

Northfield, MN 55057 *The newsletter for the Carleton mathematics and statistics community* *Vol. 38, No. 09*

Comps Talks

Come support your classmates and friends at their comps talks next week! Independent comps talks will take place in CMC 206 from 3:30 to 6:30 pm on Tuesday, February 25, and 3:30 to 5:30 pm on Thursday, February 27. Take a look at what they'll be speaking about below, then be sure to stop by and support them while they show what they've learned; you're likely to learn a thing or two as well!

Tuesday, February 25 — CMC 206

Title: Central Groupoids
Speaker: Will Knospe
Time: 3:30 PM – 4:00 PM

Abstract: Does there exist a nontrivial algebraic system satisfying the property (x * y) * (y * z) = y? Intriguingly, not only do such objects exist, but in fact have a number of interesting qualities, including necessarily containing a square number of elements. Introduced by Trevor Evans in 1967, Central Groupoids are a remarkably simple structure that nevertheless lend themselves to analysis through a wide array of branches of mathematics. We will explore Central Groupoids through the lenses of graphs, matrices, combinatorics and algebra in order to produce a number of interesting results about these objects.

Title: Queueing Theory: The M/M/1 Queue
Speaker: Peter Keel
Time: 4:00 PM – 4:30 PM

Abstract: Queueing Theory, as its name states, is the study of queues or lines. The discipline was founded in the early 1900's by Agner Krarup Erlang to serve the purpose of optimizing the field of telecommunications. However, nowadays Queueing theory is very prevalent in many different fields of operations research and is used by many companies and organizations to assess run-time as well as profit optimization. As an example, an owner of a grocery store may use Queueing Theory in order to make optimal hiring decisions for their checkout lines and to make decisions regarding how many checkout lines to include in a given store. In my presentation, I will start by introducing quantities that are of interest in Queueing Theory such as average waiting time and average system size. Next, I will provide a heuristic proof for ``Little's Theorem", an equation that relates waiting time in a system to the size of that

system. I will then introduce the M/M/1 queue, multiple derivations for its steady state probabilities, and then give derivations for multiple performance measures for the system. Last, I will give other examples of queues that are more relatable to applications in society.

Title: Bayesian Adaptive Clinical Trials for Rare Diseases
Speaker: Alyssa Akiyama
Time: 4:30 PM – 5:00 PM

Abstract: The current standard for clinical trials is the randomized controlled trial in which patients are randomized to either the experimental or control treatment in a fixed proportion. This design performs well when maximizing statistical power thus benefiting future patients. On the other hand, when conducting clinical trials for rare diseases, patient benefit should be maximized as a substantial portion of patients with the disease may be in the trial. I will be exploring different response adaptive designs including a comparison of randomized play-the-winner rule, optimal dynamic programming, randomized dynamic programming, and constrained random dynamic programming to the fixed randomized design. I will examine the power, type 1 error rate, patient benefit, average bias, and mean squared error for each design.

Title: Kolmogorov Complexity and Notions of Randomness
Speaker: Nathaniel Sauerberg
Time: 5:00 PM – 5:30 PM

Abstract: Why is it that the string 1001011100 seems more random than the string 0000000000? After all, the probability of attaining either string from 10 coin flips is the same. Kolmogorov Complexity allows us to formalize this intuition. It gives a definition of the amount of information stored in a mathematical object based on incompressibility, or equivalently, how much information is needed to recover the object from scratch. We will see some basic results in this field and build some intuition for the subject. Then, we will apply our new theory to quantify the 'randomness' of infinite bitstrings and see how our definition compares to those based on statistical tests and betting.

Title: Money Talks: Disincentivizing Lying In Voting
Speaker: Narun Krishnamurthi Raman
Time: 5:30 PM – 6:00 PM

Abstract: Many of our conversations on campus this year will be about who we want as the president in 2020. Underpinning all of these discussions is a voting system established in 1787 that is deeply flawed. However, nearly 200 years later Alan Gibbard and Mark Satterthwaite showed that, unfortunately, any ordinal electoral voting system with 3 or more candidates is doomed to fail unless a single voter has dictatorial power. I present in this talk ways in which voting systems have been manipulated and how adding money into our voting processes may not be as bad as it sounds.

Title: Dirichlet's Theorem on Primes in Arithmetic Progressions
Speaker: Sebastian Kimberk
Time: 6:00 PM – 6:30 PM

Abstract: Dirichlet's theorem states that for any two positive coprime integers h and k, there are infinitely many primes in the arithmetic progression nk + h for n = 0, 1, 2, ... In my talk I'll be laying the groundwork for understanding the (very cool!) elementary proof of this result--bringing together concepts from abstract

algebra, real analysis, and number theory--and showing how it ultimately depends on the non-vanishing of L(1, Ï‡) for non-principal Dirichlet characters.

Thursday, February 27 — CMC 206

Title: Does The Number of People who Drowned in a Pool Per Year Depend on The Number of Films Nick Cage has Starred In?: On Causal Inference
Speaker: Chiraag Gohel
Time: 3:30 PM – 4:00 PM

Abstract: Want to learn how to prove everything with observational data and a bayesian network? That's not happening, but my presentation seeks to explore the mathematical concepts guiding causal inference. Aiming to answer causal rather than associative questions, studies in the health, social, and population sciences often attempt to model treatment effects and interventions using observational data. We'll explore causal questions, and the methods which scientists and statisticians alike have created to "prove" causation; taking a dive into graphical models, propensity score matching, and Bayesian additive regression trees. For those capitalistically inclined, we'll also cover some of the ways in which causal inference is employed by ~the industry~.

Title: Topology of Tensor Fields
Speaker: Tyler Chang
Time: 4:00 PM – 4:30 PM

Abstract: Tensors are multilinear maps that have wide-ranging applications in computer graphics, physics, and neuroscience. Second-order tensors can be represented as linear transformations; a tensor field assigns a tensor to each point in a space. This talk will introduce the concept of tensors, focusing on second-order tensor field topologies in 2D and 3D real space. The talk will outline ways to characterize and compute degenerate points in tensor fields, briefly considering applications to diffusion tensor imaging in neuroscience.

Title: Optimization Under Uncertainty: The Scenario Approach and Guaranteed Error Machines
Speaker: Elliot Pickens
Time: 4:30 PM – 5:00 PM

Abstract: Navigating uncertainty is never easy, and when it rears its head optimization becomes a particularly difficult task. Under such circumstances we cannot simply carry out an optimization regime directly. Instead we must find a way to incorporate the uncertainty into the optimization process. One approach to this problem is the "scenario approach." In my talk I will outline the basics of the "scenario approach" and dive into a few basic applications. In particular, I hope to show the link between statistical learning and the "scenario approach" through a brief explanation of guaranteed error machines. Finally if there is any time left at the end of the talk, I plan on contrasting the "scenario approach" with other well known optimization strategies.

Title: Geometric Brownian Motion: Simulating Stock Price Dynamics
Speaker: Arthur Zhang
Time: 5:00 PM – 5:30 PM

Abstract: A Geometric Brownian Motion is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion with drift. According to the Geometric Brownian Motion model, the future price of financial stocks has lognormal probability distribution, and their future value therefore can be estimated with a certain level of confidence. The first part of this presentation will cover the mathematical construction of the Geometric Brownian Motion simulation and demonstrate why Geometric Brownian Motion can be used to model stock prices. In the second part, real data will be used to simulate BMW's stock price, and we will estimate the efficiency of Geometric Brownian Motion model.

SWiMS+ Study Sesh

A reminder: SWiMS+ Study Sesh is every Tuesday, from 7-9 pm in Sayles 252!

New Statistics Course Numbering

Beginning with the coming fall term, statistics courses will have their own STAT designation, rather than the MATH designation they currently have. Our statistics courses will also have new course numbers. The content of all of these courses will remain the same; only the designation and numbers will change. Here is a table listing the old and new designations and numbers.

Old:	New:	Course Title:
MATH 215	STAT 120	Introduction to Statistics
MATH 285	STAT 220	Data Science
MATH 245	STAT 230	Applied Regression Analysis
MATH 265	MATH 240	Probability
MATH 275	STAT 250	Introduction to Statistical Inference
MATH 255	STAT 260	Introduction to Survey Sampling
MATH 280	STAT 285	Statistical Consulting
MATH 315	STAT 320	Time Series
MATH 345	STAT 330	Advanced Statistical Modeling
MATH 315	STAT 340	Bayesian Analysis

Upcoming Events

Week 8

Tues, Feb 25, 3:30-6:30pm
Independent Comps Talks - CMC 206

Thur, Feb 27, 3:30-5:30pm
Independent Comps Talks - CMC 206

Job, Internship, & Other Opportunities

Career Center Internship Funding

Have you secured a un-funded or under-funded internship for the summer? Are you needing financial assistance in order to accept your internship offer or have you accepted the offer and now wonder how you will pay for housing, transportation, etc.? The Career Center can help! We have funding from generous donors to help support you! Visit our website at https://apps.carleton.edu/career/students/internships/Fund/summer/ to learn more! Applications are reviewed on a rolling basis. The next deadline is February 24th.

Johns Hopkins University Center for Talented Youth - Mathematics Instructors and Teaching Assistants

The Johns Hopkins University Center for Talented Youth (CTY) is seeking instructors and teaching assistants for our summer programs. CTY offers challenging academic programs for highly talented elementary, middle, and high school students from across the country and around the world. Positions are available at residential and day sites at colleges, universities, and schools on the East and West coasts, as well as internationally in Hong Kong. Find more information about courses, locations, dates, salary, and the application at https://cty.jhu.edu/jobs/summer/.

MathPath - Summer Camp Counselor

This is an opportunity to work at MathPath as a counselor this upcoming summer! MathPath is a residential summer program for students aged 11-14 (typically middle schoolers) who are exceptionally gifted in mathematics. Candidates for this position should be individuals who love math, interesting & accessible problems & puzzles; and love working with, spending time with, and caring for younger students (aged 11-14). For a detailed job description, please see our website: http://www.mathpath.org/Faculty&Staff/CounselorJobDescription.htm. The initial deadline for applying to this position was 2/15/2020, but we will extend the deadline to people who reference this mailing (the flyer-mailing-list sent to the math department) to 2/29/2020. If your recommenders need more time, they may submit recommendations through 3/3/2020. If you have any questions, would like more information about the position, or need to request a further deadline extension, please email Program Director April Verser at april.verser@mathpath.org.

CIBC - Hedge Fund Intern

CIBC is a leading North American financial institution with 10 million personal banking, business, public sector and institutional clients. CIBC offers a full range of advice, solutions and services in the United States, across Canada and around the world. The investment team is seeking an intern for the Hedge Fund group within our Multi-Manager Investment Program (MMIP). This position will work closely with the group's Portfolio Managers and Analysts in coverage for the internal hedge fund of funds as well as the broader hedge fund platform with $1 billion in assets. Find details on the Tunnel: https://carleton-csm.symplicity.com/students/app/jobs/detail/a98ef6bdbfe6246ce7aedee1c7b422ad.

Evolent Health - Sr Analyst, Risk Adjustment and Quality Data Governance

This position involves working with a highly-motivated team of software engineers and data scientists on

ingesting, transforming and organizing disparate streams of healthcare data from our partners and internal teams into data models for application and analytical insights. Find more information on the Tunnel: https://carleton-csm.symplicity.com/students/index.php?s=jobs&ss=jobs&mode=form&id=dc3592562bf00af1f12e65518ef976f9.

Problems of the Fortnight

To be acknowledged in the next *Gazette*, solutions to the problems below should reach me by noon on Tuesday, March 3.

1. Three young siblings have invented a (rather silly) game called Generosity. The game starts with one of the three players having a large stack of coins (or other counters) while the two other players have none (yet). For each move, one of the three players, who must have at least two coins, decides that (s)he is feeling generous and distributes *an equal number of* coins to the other two players. For example, if the game starts with the players having $10, 0, 0$ coins, after one move they might have $6, 2, 2$ or $4, 3, 3$ respectively; in the latter case, after another move they might have $5, 1, 4$. There is no particular rule as to who must distribute coins at each move; whoever is feeling generous can do so, provided (s)he has at least two coins.

   a) Suppose that players A, B, and C have been playing Generosity for a while and A has 850 coins, B has 820 coins, and C has 59 coins. Can you tell who started with all 1729 coins? How and why, or why not?
   b) Same question, but now A has 850, B has 820, and C has 58 coins (and someone started with all 1728).

2. Let $a > 0$ be a real number, and consider the four points $(0, 0), (a, 0), (a, 1)$, and $(0, 1)$ in the plane. Suppose you want to connect all these points to each other by paths so that the total length of the paths is as small as possible. For instance, one method would be to put paths along all four sides of the rectangle whose vertices are the four points, but you could improve on that by leaving out one of the four sides - you could still get from any vertex to any other vertex by following the three remaining sides. You could also make, instead, two straight diagonal paths, one from $(0, 0)$ to $(a, 1)$ and one from $(a, 0)$ to $(0, 1)$; because the diagonals intersect (at the center of the rectangle), they can be used to go from any vertex to any other vertex. But there might be still better ways to carry out this project. What is the shortest possible total length (as a function of a) of a set of paths that can be used to travel between any two of the four given points, and what does such a set of paths look like?

Alas, the trend of no student solutions extended to the problems posed February 7. Correct solutions came in from John Snyder for the first problem, and from "Auplume" for the second. Maybe the predicted weekend thaw will change things?

- Mark Krusemeyer

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