QUEEN'S MATHEMATICAL
COMMUNICATOR
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Department of Mathematics and Statistics
Queen's University, Kingston, Ontario, Canada K7L 3N6

WELCOME FROM THE HEAD, TROY DAY

Welcome everyone to the latest edition of the communicator. It has been a very busy year, with several important successes and changes to our department.

I am very happy to report that **Ivan Dimitrov** and **Bahman Gharesifard** were both promoted to Full Professor this year. Our colleague and cross-appointee to Mathematics and Statistics, **Mark Green** was named the Scholar in Residence at the Natural Sciences and Engineering Research Council of Canada (NSERC), and three of our colleagues, **Alan Ableson**, **Ping Li**, and **Chuck Molson**, were singled out this year for their dedication and championing of the well-being and mental health of our students. We also had success on the research funding front with **Jamie Mingo** receiving a substantial increase in research funding from NSERC and **Maria Teresa Chiri** having outstanding success as a first-time applicant to NSERC.

Our students have celebrated several remarkable achievements. **Hudson Chen** was awarded the Medal in Mathematics and Statistics, **Spencer Hill** the Medal in Mathematics and Engineering, **Ryan Simpson** the Annie Bentley Lillie Prize in Mathematics, and **John Alajaji** the Irene Macrae Scholarship in Mathematics and Statistics. Two of our students also received awards for their contributions to the Engineering Society: **Thomas Mulvihill** with the Peter Carty Memorial Award, and **Aidan Shimizu** with the J.S. Donnelly Award. Last but far from least, **Jingjing Mao** was the recipient of the Chair for Women in Engineering Research Award.

There have also been important changes in personnel. We had three new Coleman Postdoctoral Fellows join our department this year: **Christopher Kennedy**, **Sunil Naik**, and **Khoa Nguyen**. Welcome to them all! One of our staff members, **Israte Afroze**, went on parental leave this year after giving birth to Mehrad Khan Rahman, We welcomed **Angela Yao** to our department as our new financial assistant. She has taken over for Israte while she is on leave. We also welcomed back **Priya Rajan** from her parental leave. Finally, **Abdol-Reza Mansouri** has taken over responsibility as our graduate program chair as **Mike Roth** has now finished his term in this role.

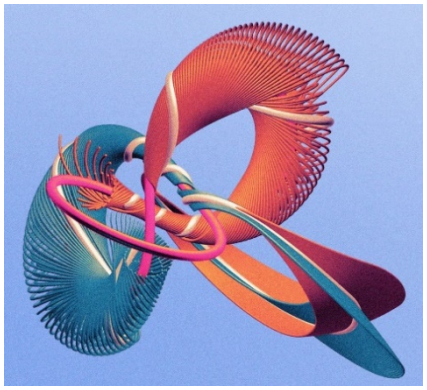
We suffered the loss of our friend and colleague Bob Erdahl in December (see the story in this issue). A beautiful and well-attended celebration of his life was held at the Kingston Yacht Club in July.

There are many budgetary challenges facing the university. Although this will require making some difficult decisions it is also an opportunity to look carefully at our programs and to revise them in ways that are not only more efficient but more attractive to students and more effective at achieving our educational goals. We have already begun this challenging revision process and I look forward to providing a detailed update down the road.

Our department also has some exciting activities planned for the coming year. Thanks to the hard work of our colleagues **Bahman Gharesifard**, **Felicia Magpantay**, and **Giusy Mazzone**, Queen's University will be hosting the Canadian Applied and Industrial Mathematics Society's Annual Meeting in June 2024. This is a major conference that brings together researchers from all areas of applied mathematics to share their latest research results. Coupled with this event, our department is also planning to host a set of summer school courses for early graduate students. Our intention is that this summer school program will become a regularly offered event at Queen's. I look forward to providing a more detailed update on these events next time as well.

DEPARTMENT NEWS

THOMAS BARTHELMÉ: A TOPOLOGICAL INVARIANT OF ANOSOV FLOWS



Think of a flow on a space as a rule that, given a particle in some ambient space and a time t, will give you the new position of that particle after time t. Mathematically, a flow can be defined via an (ordinary) differential equation: a particle will follow the solutions of the differential equation at a certain speed. From the point of view of a flow, these solutions are the *orbits* of the flow.

In dynamical systems, the goal is not to find exact solutions, but instead to understand the long-term properties of the flow. One such property that mathematicians sought to characterize early on was the notion of *chaos,* which has been popularized as the butterfly effect: an arbitrarily small change in the initial position may lead to radically different orbits. The mechanism behind chaos is *hyperbolicity,* for each point, the ambient space splits into three directions: the direction of the flow, a direction in which orbits differ exponentially fast in the future and a direction in which they differ exponentially fast in the past.

Thanks to some groundbreaking work that started in the 1960s with mathematicians such as D. Anosov, A. Katok and Y. Sinai in Russia or S. Smale and his school in the US (and many others), we now know that hyperbolicity is also the mechanism behind an apparently contradictory behavior. If instead of considering small changes in initial position, we decide to change the rule defining the flow a little bit (i.e., modify a tiny bit the coefficients of the differential equation), then the global behavior of the new flow is the "same" as that of the old flow. This property is called *structural stability.*

Here's an example of a completely different sort, showing that these properties are not to be expected in general: Consider the family of linear flows on a 2-torus $T = R^2/Z^2$, where all orbits follow a line of slope θ, no matter what θ is if you pick two points close by on the torus and follow their orbits, they stay parallel for ever, the opposite of chaotic. However, globally two such flows may have very different behaviors: a linear flow with rational slope will have all its orbits periodic (they close up after some time), while for an irrational slope, each orbit will be dense (they visit the whole torus).

What Anosov did in the early 60s, was to extract a definition of hyperbolicity from properties that certain classical dynamical systems enjoyed, and establish structural stability from there. Anosov flows were born: These are the "simplest" flows exhibiting both these local chaos and global stability properties, as they are hyperbolic everywhere. They have served as toy models to explore and understand properties of hyperbolic systems and their generalizations ever since.

Mathematicians love to classify: given a certain class of objects with certain properties, can one write down a complete list of all such objects? Classifications may be too complicated to be practically useful, however the tools needed to obtain such classifications usually lead to a better understanding and may also be of use elsewhere.

So dynamicists wondered about the classification of Anosov flows. Structural stability tells us that we do not need to worry about small changes, they all lead to essentially the same flow, but what about big changes? How can we tell that two Anosov flows are "the same" (the mathematical concept for "the same" is that of *orbit equivalence*: there exists a homeomorphism of the ambient space sending all the orbits of one flow to the orbits of the other).

When Anosov defined Anosov flows, there were essentially two family of examples, but starting in the 1980s, more and more examples have been obtained, and (at least in dimension 3) we now have a huge zoo of examples of distinct flows exhibiting all sorts of different behaviors. So, for mathematicians to have a chance of classifying these flows, they need as simple a way as possible of deciding if two flows are distinct or not (this is called a *complete invariant*).

In some recent work Thomas Barthelmé, Kathryn Mann and Steven Frankel managed to find such a complete invariant for (most) Anosov flows. Roughly speaking, their theorem state that, for two Anosov flows to be orbit equivalent, it is enough to know whether the periodic orbits of the flow are freely homotopic. That is, if, individually, each periodic orbit of one flow can be continuously deformed into a periodic orbit of the other flow then the two flows are "the same".

Thomas Barthelmé is an Associate professor in the Department of Mathematics and Statistics at Queen's. A fascinating article about this work has appeared in Quanta magazine. The pictures are taken from this article.

IVAN DIMITROV
PROMOTED TO FULL PROFESSOR

I believe that students learn best when they see a class as a process of discovery rather than a collection of results.

“This promotion is both an honour and an opportunity for reflection on the profession and my place in it. Looking at the two seemingly opposite parts of my job: teaching and research—I realize how well they complement each other and how much I benefit from both. There is nothing more satisfying than watching our students grow and mature from young eager and a bit naive minds into mature critical thinkers. Witnessing this process over and over again helps me approach new research topics because I know that learning is difficult but, ultimately, very satisfying. Often, I spend the morning helping a first-year student through the maze of definitions, examples, and proofs only to face the same kind of challenge in the afternoon when working on my own research. I enjoy teaching various courses to diverse sets of students. In fact, I try to avoid teaching the same course more than twice in a row to avoid making my lectures too smooth and polished. And it seems to me that students appreciate being active participants in the discovery rather than consumers of a ready-made product.

“In research I enjoy problems that aim to understand and classify various algebraic structures, mostly related to Lie algebras, groups, and related geometric and combinatorial objects. It is very satisfying to be able to come up with a unifying framework for seemingly diverse structures which allows for a new point of view on well-studied constructions. I also have a particular liking for classification problems - it feels nice when I can catalog all algebras with such and such a property or all representations that behave in a particular way, etc. In developing my research interests and style, I have learnt from many formal and informal advisors throughout my academic life - as an undergraduate and then a graduate student and a postdoctoral fellow. This process continues to this day - every research collaboration is a learning experience from which I emerge with more knowledge about mathematics and about doing mathematics. I have been especially lucky to find great colleagues and collaborators at Queen’s. Some of the most enjoyable research projects in my career have been with other members of the algebra group, including postdoctoral fellows who bring fresh ideas and energy into the group. I am especially proud of the numerous successful USRA projects in which collaborations with colleagues and undergraduate students have resulted in beautiful papers.

“I realize also how lucky I am to be part of a great department in which colleagues are always ready to help and the support staff ensures that everything runs so smoothly that my job feels more like a hobby. Among my colleagues I have found many friends with whom I share interests outside of mathematics and academia.”

Troy Day, Ivan, and Mike Roth at the Mathematics and Engineering Graduation Reception Fall 2022

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BAHMAN GHARESIFARD PROMOTED TO FULL PROFESSOR

“I am honored by this promotion and thankful to everyone who has supported me in reaching this stage. It is a privilege to walk into classrooms hoping to make a mark on fresh minds that allow us to preach what we think is the way. The most joyful part of my career has been interacting with my graduate students, both before and after graduation. My main objective has been to cultivate critical thinking skills in them, and to help them appreciate the beauty of mathematics. I would like to express my gratitude to every one of them for embarking on a journey of exploring the unknown, often in areas where I had no prior expertise, and for teaching me valuable lessons along the way. I have found the supervisory responsibilities to be the most challenging aspect of my job, but also the most rewarding.

If I were to offer a suggestion to my junior colleagues, it would be to step outside of your comfort zone.

“My journey in research began with geometric control theory and mechanics, and it evolved during my stays at UC San Diego and the University of Illinois to encompass optimization theory, game theory, and the study of network systems. Throughout my academic career at Queen's, the University of Stuttgart, and UCLA, I have worked on various topics including system theory, optimal transportation theory, stochastic processes, optimal control theory and variational calculus, Lie theory, and more recently, theoretical areas of machine learning, universal approximation theory of neural networks, and reinforcement learning. I enjoy delving into new areas, regardless of the subject matter. This is one of the privileges of being an applied mathematician—we are not confined to any particular subject inmathematics.

“I am grateful to my colleagues at Queen's who have always welcomed my naive questions and included me in seminars, despite my limited knowledge. Additionally, I would like to extend my thanks to my mentors. In particular, my advisor Tamer Basar at the University of Illinois at Urbana-Champaign has had a lasting impact on me in terms of understanding what matters in an academic career in the long run beside research. My career has also been greatly influenced by Roger Brockett at Harvard, who unfortunately passed away recently. I am grateful for the serendipitous events that allowed me to be a student in his master class, even though he was never my official advisor.”

Bahman at the American Control Conference in June 2023 in San Diego with some of his students.
Annika Fuernsinn, PhD student (Garesifard) Jeremy Coulson BScEng 2015 and MASc 2017, Daniel Adu MSc 2017 and PhD 2022.

ALAN ABLESON, PING LI, AND CHUCK MOLSON CHAMPIONS FOR MENTAL HEALTH, SPRING 2023

https://www.queensu.ca/campuswellnessproject/campus-participation/champions-mental-health

Alan Ableson
Alan is a Professor in the Department of Mechanical Engineering and is cross-appointed with Mathematics and Statistics. He is a specialist in our first-year Engineering Mathematics courses, calculus and linear algebra.

“Professor Ableson is truly the kindest professor I've had this year in my first year at Queen's. You can tell during lectures that he cares about his students and makes a conscious effort towards ensuring everyone's understanding of the material. He talks to us about our exams, asks how our exams went and you can tell he really values our opinion of them. He makes engineering enjoyable, and I look forward to his classes every day! He radiates positivity and has a true passion for his work, which inspires those around him. This has a huge impact on mental health when everyone is struggling through midterms and finals and he improves everyone's day for an hour during lectures.”

Ping Li
Ping teaches a wide range of first-year courses in both Arts&Science and Engineering, as well as offering MATH 384, the intro course in our Actuarial stream. Currently she coordinates MATH 121, our 1200+ applied calculus course.

“Professor Ping Li is very supportive of student wellbeing; she consistently provides assistance and office hours to drop by and discuss anything course-related or general help. She is easy to talk to and is always there to answer student emails and concerns. She acknowledges the stress that most students experience during a difficult full-year course, so she provides multiple opportunities to be examined and provides the option to drop your lowest score on quizzes and webwork. This form of flexibility relieves the pressure and promotes student care and wellbeing! She is always there to clarify answers and will walk you through problems or difficult concepts.”

Chuck Molson
“I grew up in Kingston and began my Queen’s education in 1967 with woeful academic results (including a zero in calculus) at least partially due to well-concealed depression. So I took a break and travelled in Europe and across North Africa. When I returned to the university in 1969, I had the good fortune of having a Queen’s girlfriend who was an excellent student, and I found myself spending evenings in the Douglas Library with her. I repeated the introductory calculus course, splendidly taught by Ralphe Clench, an adjunct professor and eccentric who taught only one section in addition to his actual job in the Registrar’s Office. My calculus grade increased from 0% to 90%, and that helped steer me toward becoming a math major.

“That was followed by a B.Ed. and a summer job at St. Lawrence College which turned into a thirty-year career, teaching algebra, calculus, business math, and ultimately specializing in statistics. I returned to Queen’s 1979, for a master’s degree in statistical consulting, and in 2003, I had the wonderful luck of being appointed as an adjunct lecturer at Queen’s teaching intro statistics. I have now taught STAT 263 more than fifty times and try to improve the course every time around. In total that’s more than 20,000 students, ranging from marginally better than I was in 1967 to academic stars. I doubt if any of those students learned as much from me as I have learned from them.”

MARK GREEN
SCHOLAR IN RESIDENCE FOR NSERC

This article is adapted from the Queen's Gazette article, Wednesday June 21, 2023

The Natural Sciences and Engineering Research Council of Canada (NSERC) has announced the appointment of Mark Rahswahérha Green as the new Scholar in Residence. This is a two-year advisory position where Dr. Green will provide an Indigenous research perspective on NSERC's programs, policies, and processes.

Mark has been part of the Department of Civil Engineering for over 30 years, and he is cross appointed to the Department of Mathematics and Statistics. A current theme of his research is to investigate how to prepare bridges and other concrete structures to withstand extreme conditions, like fires.

He is also a champion of inclusivity and Indigenization, working with Indigenous communities across Ontario to implement sustainable engineering projects.

He also served as Queen's Provost from 2020 to 2022.

Mark sits with the Turtle Clan in the Kenhtè:ke Longhouse in Tyendinaga and has played a crucial role in initiatives such as Queen's University's Truth and Reconciliation Commission Task Force and Queen's Indigenous Futures in Engineering, which promotes engineering education for Indigenous students.

"Indigenous perspectives have so much to offer Canadian scientific research, and I'm excited about the opportunity to strengthen these relationships. I am looking forward to working with NSERC to help create partnerships with Indigenous communities for mutual benefit."

Read the NSERC story to learn more.

THE L. LORNE CAMPBELL LECTURE
MOON DUCHIN: HOW SOCIETIES CHOOSE

On Dec 7 2022, Professor Moon Duchin of Tufts University delivered the annual L. Lorne Campbell Lecture. Her topic question was: how can we measure a healthy democracy?

There are infinitely many election systems -- how voters fill out a ballot and then how we combine ballots to decide the outcome -- and they all have different properties and tendencies. Professor Duchin provided some philosophical and mathematical perspectives on finding fairness in representative democracy.

Dr. Duchin is a mathematics professor at Tufts University and founder of the Metric Geometry and Gerrymandering group, a nonpartisan research group coordinating and publicizing research on geometry, computing, and their application to the redistricting process in the US. Her mathematical research concerns geometric topology, geometric group theory, Teichmuller theory, and the geometry of politics. Dr. Duchin is a fellow of the American Mathematical Society. She gave a 2016 Mathematical Association of America distinguished lecture, was awarded a Guggenheim fellowship in 2018, and in 2018-2019 was a fellow at the Radcliffe Institute for Advanced Study at Harvard.

Dr. Duchin at the board in the Jeffery Lounge with a number of graduate students.

L to R: Becca Carter, Prof Catherine Pfaff, Dr. Duchin and Luke Steverango.

A. VIBERT DOUGLAS
THE DEAN OF WOMEN, EULER AND ADELAIDE

by Peter Taylor

Recently someone sent me a question about A. Vibert Douglas who was the Dean of Women from 1939-59. Yes, there was a Dean of women in those days, but not a Dean of Men. That was a time when women occupied a special place in the student hierarchy; for example there were different rules for women and men. Curfews: women had to be "in" by a certain time each evening, although these rules were less restrictive for upper-year students. Dress Code: slacks were permitted in class only on Saturday. And yes, there were Saturday classes.

Dean Douglas was a professor in the Mathematics Department, and the one teaching item that we have on record is that she gave courses in astronomy. In those days there was no astronomy group in the Physics Department and astronomy got linked with Math.

I do have one interesting "Dean Douglas" story, one that I got from John Coleman. Our second oldest residence is Adelaide Hall, opened in 1952, and Dean Douglas arranged for a remarkable mathematical formula of Leonhard Euler (1707 – 1783) to be etched in stone above the main entrance so all the "young ladies" who passed through the door would be reminded of the beauty and power of mathematics. This is

$$e^{i\pi} = -1$$

Here, *e* is the *e* of exponential growth and it is named after Euler. The number π is well known, and *i* is the square root of –1. This remarkable formula combines and relates the 4 most important numbers in mathematics. See the middle panel at the top of the picture on the right.

The nice thing about this story is that it really speaks to Dr. Douglas's values—she always tried to encourage women to learn math and sciences and to open up the disciplines of engineering and medicine to them as well.

TYLER MEADOWS
POSTDOCTORAL FELLOW

Tyler is one of our Coleman Postdoctoral Fellows. He arrived in September 2021 and this is his last year with us. During this time he has taught two of our key advanced biomathematics courses, BIOM 300 and MATH 339, our popular course in Game Theory. It is interesting that Game Theory has changed a lot since its early development in the 50's which arose out of strategic thinking during the second world war. The point is that your payoff depends not only on your own strategy but of the strategy of the other guy, and that switches our attention onto how the two strategies coevolve in response to one another. Given this our focus is on finding a set of strategies that is "evolutionarily stable" rather than being simply optimal.

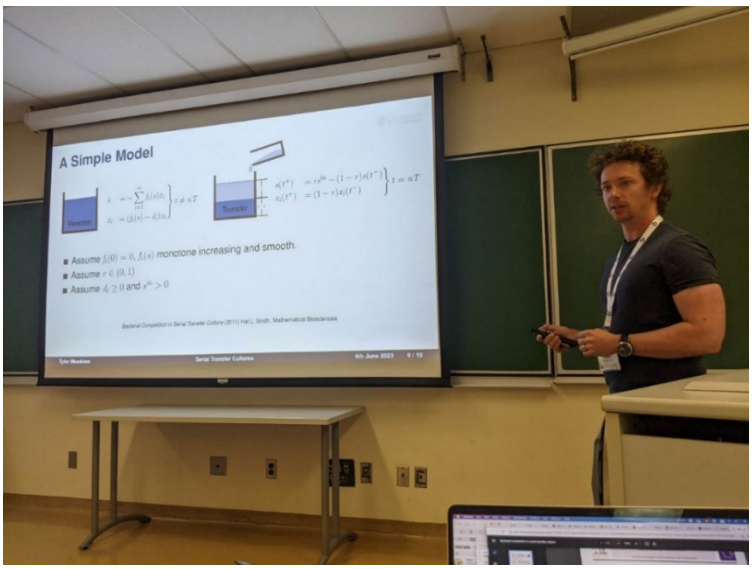
But we should get back to Tyler and let him tell *his* story.

"I started my academic career studying Oenology and Viticulture (Wine & Grapes) at Brock University, with the intention of making beer for a living after school. Like most undergraduate programs, the first year was very general, and I quickly learned that I liked my physics and math courses much more than the ones directly related to my program.

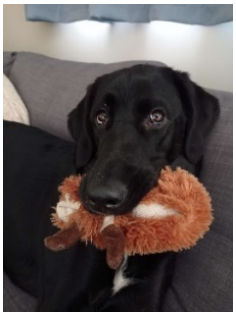
"About 2 months into my undergraduate, I switched majors to physics. Following my undergrad, I enrolled in a master's program in mathematical physics at McMaster University studying the mathematical properties of high temperature superconductors using the calculus of variations. During my masters I took a course on bifurcation theory, which helped me realize that I actually like dynamical systems a lot more than PDE. I switched gears for my PhD program and began studying mathematical biology. My PhD thesis was on several models of fermentation processes used in industry, some of which are closely related to wine and beer production. In a way, I've ended up back where I started.

"The day after I graduated in 2019, I drove across the continent to start a two-year post-doc at the University of Idaho studying microbial diversity and the human microbiome. A few months into this postdoc, the pandemic started, and the research group I was working with shifted gears to help with the state's pandemic response. As a result, I learned a lot about incorporating real data into mathematical models, and realized that it's much harder than it sounds. After living in the United States for two years away from my family during the pandemic, I decided I wanted to come back to Canada and began this position at Queen's.

"Since moving to Kingston, I have gotten married to my wonderful wife, Jen who is a high school math teacher at a local private school. We bought a house together last spring and have been living there with our puppy Peanut, who we also adopted last year. Peanut is part black lab, part Bernese mountain dog, part poodle, and part great pyrenes. However, if you saw her and didn't know all that, you would think she's just a tall black lab."



Tyler presenting at the Summer Meeting of the CMS June 2023.



STUDENT AWARDS

HUDSON CHEN
MEDAL IN MATHEMATICS AND STATISTICS

The medal is awarded annually by the University to the graduating candidate who has demonstrated academic excellence in an honours degree who is deemed by a Department to have achieved the highest standing in a Plan offered by that Department. Departments within the Faculty of Arts and Science will consider students in a major, joint honours or specialization Plan offered by that Department.

This year's winner is Hudson Chen.

"I am Hudson, who is in love with the high returns and vagaries of the stock market. I have dived into the sea of mathematics and statistics to succeed in this field.

"At Queen's, I learned solid foundation knowledge and conducted relative research. Here, I want to express my thankfulness to Professor Brian Ling and Yanglei Song. They gave me chances to put mathematical theories into practice by giving me exciting projects. Outside of school, they are good friends who share dreams about my future. Besides them, I also owe much of my academic success to the support and encouragement of the department!

"In August 2023, I began a study of financial engineering at Cornell University. My objective there is to utilize the knowledge from Queen's and extend it to finance.

"I hope to carve a place for myself and my company on Wall Street. If you are interested in my experience or goals, contact me!"

JOHN ALAJAJI
THE IRENE MACRAE MATH & STATS SCHOLARSHIP

Established in April 1986 by Margaret Crain in memory of Irene MacAllister MacRae, Arts 1914, who was vice-president of the Mathematical Club while at Queen's. Awarded on the basis of academic excellence to a student graduating with a BA (Honours) degree or a BSc (Honours) degree with an academic plan in Mathematics or Statistics.

“As someone intrigued by mathematics and its applications in computer science, I found the degree in Computing and Mathematics (COMA) ideal for me. I enjoyed taking courses from both disciplines, being exposed to mathematical abstract reasoning as well as acquiring the more applied skills of computing. What was also nice about this degree was that it allowed me to interact with students majoring in both disciplines, giving us two homes on campus: the CASLab facility in Goodwin Hall and the Math Help Center in Jeffery Hall. I spent most of my time on campus in the Math Help Center, which was a great place to study and meet new people. I will look back fondly on the long hours spent with classmates working on homework there.

“I also enjoyed using Jeffery Hall’s undergraduate lounge, where I worked on my NSERC summer research after 3rd year. I was fortunate to be supervised by Professor Greg Smith and Professor Mike Roth on an algebraic geometry project investigating the structure and properties of Hilbert schemes.

“I also had a chance to conduct NSERC summer research after my 2nd year through the School of Computing under Professor Kai Salomaa in the field of Automata Theory. In this project, I focused on characterizing the average size increase of converting a random regular expression to its corresponding minimal deterministic finite automaton. Both projects introduced me to challenging problems and gave me a taste of what academic research is truly like.

“These were great learning experiences and swayed my decision to stay at Queen’s this fall for a Masters under Professor Salomaa.

“Finally, throughout my time at Queen’s, I greatly enjoyed cycling and playing volleyball, board games, and soccer, including noon hour soccer with Queen’s students, staff and faculty.”

SPENCER HILL
UNIVERSITY MEDAL IN MATHEMATICS AND ENGINEERING

Awarded to a student who has the highest Grade Point Average for all courses of third and fourth year.

“Ever since childhood I have been obsessed with math, to the point of driving those around me crazy discussing the latest tidbit of information I had read. I was extremely fortunate to find a community of similarly inclined people in the Mathematics and Engineering program at Queen’s. The program’s mathematical richness and practical engineering knowledge gave me an experience I could not have gotten at any other school or engineering discipline.

“During my time here, I enjoyed a wide variety of courses taught by our amazing faculty, in particular those on Stochastic Control (Dr. Yüksel), Stochastic Differential Equations (Dr. Mansouri), and Information Theory (Dr. Alajaji). I also completed a fascinating thesis project on Image Compression using Artificial Neural Network under the supervision of Dr. Linder. I am excited to explore these subjects and more in self-study and further education in the not-to-distant future. Outside of the classroom, I gained experience through leading QMIND, conducting summer research, and many intramural teams (although it would be a stretch to say I gained any mathematical experience from those!).

“This fall, I am beginning work as a consultant for Stroud International. Here, I hope to apply the problem-solving skills Apple Math taught me to problems outside of the domain of applied mathematics.

“Outside of school and work, I enjoy hiking, canoeing, playing piano, and running; all of which I am looking forward to having more time to do in the fall.”

Photos: Spencer in Portugal, awake and asleep.

RYAN SIMPSON
THE ANNIE BENTLEY LILLIE PRIZE IN MATHEMATICS

Awarded to a graduating student in Mathematics and Engineering who has the highest average on courses in Mathematics in the final year.

Ryan Simpson with Giusy Mazzone

"Taking apple math has one of the best choices I've made. I always enjoyed math classes growing up and in first year, but I wouldn't say I was passionate about it until I started in apple math. I chose apple math mostly because I was interested in robotics and AI, and also because I love to be challenged and am admittedly quite competitive. After my first year of apple math I found myself to be more passionate about studying mathematics.

"After third year I was fortunate to have the opportunity to research under Professor Serdar Yüksel, and I absolutely loved it. The experience made me look at the field in a new light; it gave me confidence that math was something I could actually contribute to, rather than just studying. One of my favourite accomplishments came from this summer, as I was able to co-author a paper on the subject of decentralized stochastic control, and I presented this paper at the American Control Conference in San Diego last June.

"Receiving this award means a lot to me, knowing the work that went into it. My final year at Queens was busy, difficult, and rewarding. I started working part-time during school as an AI engineer for a startup focused on the mining industry, completed my first half-marathon in Philadelphia, and kept up my other hobbies like hockey and basketball. I am now working full-time for that same startup. I am loving the position so far as I get to make use of so much of the concepts I learned in the apple math program, and I find working at a startup to be both stimulating and rewarding. I have a great deal of freedom to implement my ideas and try out novel technical approaches to problems, and since we are still building the product, I get to see all of my work in the final design."

At a half marathon in Philadelphia with fellow Queen's students (L to R) Daniel Lambert, Chadd Benteau, and Ben Normandeau.

AIDAN SHIMIZU
J.S. DONNELLY AWARD

The J.S. Donnelly Award acknowledges the continuing interest and dedication of the individual in and toward the general welfare, prosperity and reputation of the Engineering Society. This award is open to all members of the Engineering Society who currently are not members of the executive.

“When I came to Queen’s I really wasn’t sure if I had made the right decision choosing engineering. However, as someone who was more interested in project management and using logic to solve complex problems, I found a home in Apple Math. I chose it because in my opinion, it offered the most diverse outcomes.

“I still am unsure what my final career path will be, whether it’s biomechanical engineering, data analytics, financial consulting, law, or medicine. Regardless, I know I want to work with people, which is why I decided to get involved in the Engineering Society. I’ve held many roles throughout my time here, starting as a First Year Project Coordinator, and going on to take on more roles such as the Director of External Relations, and in my 4th year, Apple Math President. Going into my 5th and (hopefully) final year, I have taken on the position of Engineering Society President, where I get to oversee over 200 employees, 800 volunteers and a budget of $2.4 million. Armed with this experience, and the tremendous knowledge I’m gaining from my Apple Math classes, I can’t wait to get out into the world and put myself to the test.”

L to R: Kalena McCloskey, Apple Math Sci’ 25; Simon Yung, Mechanical Sci’ 25; Dylan Ellingson, UWaterloo Engineering Society President, and finally, Aidan.

Aiden, Kalena and Simon all successively held the position of Director of External Relations for the Engineering Society in 21-22, 22-23, and 23-24.

THOMAS MULVIHILL
PETER CARTY MEMORIAL AWARD

The winner of the Peter Carty Memorial Award is the Engineering student who has contributed the most to the spirit and good reputation of the Queen's Engineering Society.

Thomas (on the left) is receiving the award from Benny Day Sci '23 (Eng Phys)

"Hey everyone! My name's Thomas Mulvihill, and I'm a Sci '23 graduating from Apple Math in April '24. On top of my Bachelor in Applied Science, I am taking the Certificate in Business to enrich my business knowledge and hopefully apply it in the real world someday! Working with the Engineering Society has given me the opportunity to interact with so many amazing people and to try out a ton of different experiences.

"I am incredibly thankful for everyone I've had the pleasure of working with over these past four years, from upper years mentoring me into becoming a better leader and better person, to working with incoming classes and trying to create a memorable experience. Although I am receiving this award for my involvement in this past year's Engineering Society's activities, it's thanks to the many opportunities along the way that I've continued to dedicate myself and my time to these different causes.

"I've had the honour of working as a member of the FREC Committee, on the First Year Team, as the Head Manager of the Tea Room, and this past year as Director of First Year. Throughout all these roles, my main focus has always been the people I've had the opportunity to interact with. Whether I was managing my own team, or running activities for a larger audience, I always felt like I was having an impact on others and hopefully improving their day, even in the slightest.

"In the future, I'd love to continue working for other people and to try and have a positive impact on the world! Once again, thank you to everyone who I have worked with, who has given me guidance along the way, who has supported me directly or indirectly, and to Benny Day for this nomination."

Thomas viewing the famous Grease Pole last fall.

STUDENT NEWS

JINGJING MAO
C4WiE RESEARCH AWARD

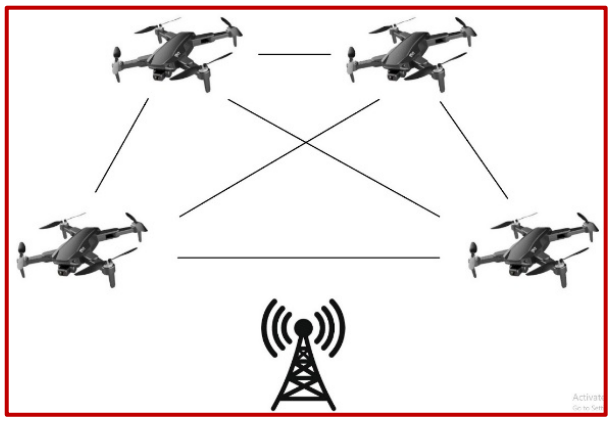
This past summer, Jingjing Mao, one of our Mathematical physics students, was successful in obtaining a research award from The Queen's Chair for Women in Engineering (C4WiE) to support her summer project. Her supervisor was Kexue Zhang.

Here is Jingjing:
"I'm a mathematical physics graduate. I will start doing my Ph.D. at the University of Toronto this fall. My dream job is to be a professional researcher, or a professor if possible. In my free time, I enjoy watching anime, spending time with nature, and being exposed to art. Whenever I visit a new city in Canada, I try to visit its art museum.

"I'm humbled to receive the C4WiE Summer Undergraduate Research Award. It feels exciting to be recognized and supported. Through this award, I was introduced to other female students in engineering research and got to know their projects outside mathematics, which is fun. I appreciate the recognition from the math department (who probably nominated me) and the research opportunity they offered. I also appreciate WIE (Women in Engineering) for not only this award but also for supporting women researchers and building an inclusive community.

"Now about my work: We are trying to generalize input-to-state stability (ISS) to nonlinear systems in a way that would includes all types of stabilities such as Lyapunov stability, partial stability, orbit stability, and stability of the invariant set. Furthermore, we will study similarities and differences in the stability analysis between continuous-time and discrete-time systems.

"As an example, we could look at the control of a number of drones for which a change in the trajectory of one will affect the trajectory of others. This can be represented using a system of ordinary differential equations. Suppose we want to trace the trajectory of drone number 2, but there are some external factors (e.g. air turbulence) that perturb the trajectory of drone number 1. The theory I'm studying is called "input-to-state stability" is able to guarantee that if the perturbations are small enough, the motion of drone 2 will stay within certain bounds.



"I want to say a big thank you to my advisor Professor Zhang and my colleague Michael Cronin. I enjoy working with them. Professor Zhang is really supportive and patient. He creates a friendly research environment for us where all our thoughts and questions are valued. "

APSC 200: The Evolving Design of an Engineering course.

Every Summer over the past few years, a couple of mathematics and engineering students are hired through our Summer Work Experience Program (SWEP) to work on and up-grade a second-year engineering course, APSC 200.

The goals of this course are to give second-year engineering students the experience of designing a multi-robot system using one of two different algorithms (consensus or clustering). Some examples of applications of such systems include transportation systems, smart power grids, environmental monitoring, disaster recovery, and ocean sampling but the chosen application is ultimately left up to each group of students to define. The nature of these multi-robot systems leads to high dimensional outputs and so can be challenging to generate informative plots of the system's response.

The SWEP students working on the design of the course are tasked with the development of a set of ground robots that execute the movements dictated by the computer simulation. During 2017, the SWEP students built three Robots from elementary components (circuits, controllers, gear boxes etc.) In 2018, they provided these robots with a more robust hardware, integrated the software in a more efficient manner, and developed project material that delivered a graphical interface to use for implementation. During 2019 and 2022 students developed a localization method to further improve the robustness of the hardware and used MATLAB to improve the software.

The current system supports three robots which communicate with a Raspberry Pi server and use an overhead camera for localization. The number of robots must be increased before the system can be integrated into APSC 200 so that students can experience less trivial communication topologies. This year, the SWEP students were tasked with upgrading the preexisting robots and/or fabricating more robots. The students were successful in fabricating one more robot and upgrading the software.

So now there are four: 😊😊😊😊

Fourth-year AppleMath students Henry Wilson (L) and Ben van Eeden (R), playing with their new Robot.

The DSC—Departmental Student Council
Sophie Moors and Izzy Page, DSC Co-Chairs

The 2022/23 academic year kicked off with a welcome lunch for all Mathematics and Statistics students. We gathered outside of Jeffrey Hall and treated the students to a pizza lunch. We had a huge turnout, the pizza was gone within an hour. Students lingered throughout the afternoon meeting new and reconnecting with old friends.

We also had the pleasure of hosting a number of other in-person socials including our much anticipated trivia night. The Fall trivia night was a great success, with a turnout of over 50 students from the Mathematics & Statistics Department. Given the success of this event, we organized another trivia night in the Winter semester, which drew an even larger group of students.

Industry night provided an invaluable opportunity for students to hear from professionals who have graduated from Mathematics and Statistics programs. We chose to host this event over Zoom, in order to feature a diverse range of professionals. We were honoured to have Queen's very own Professor Cellarosi share his experience, as well as other professionals including actuaries and lottery mathematicians. In an effort to appeal to the Con-Ed students, in Mathematics and Statistics, a high school teacher also discussed their career path. The feedback we received from this event was extremely positive. Many students appreciated hearing about the various career options that may be available after graduation.

Sophie Moors (top) and Izzy Page, DSC co-chairs.

Of course we cannot reflect on the 2022-2023 academic year without mentioning Pi Day. This year on March 14 (03 14) we partnered with FryPi, a small business located in Stirling Ontario, and sold their delicious handheld pies in Jeffrey Hall. This event exceeded our expectations. There was so much demand that we were sold out of pies within an hour. The funds raised from our Pi Day sale will be used to organize more social events for the department during the 2023/24 academic year.

We would like to take this time to thank all the professors who not only purchased pies, but also contributed to the student council. As a small department, we truly value your support, as many of these social events would not be possible without your assistance.

Kristina Radkevich and Zoe Dicker

Thank you to all the students and staff of the Mathematics and Statistics Department for your enthusiasm and participation during the 2022/23 academic year. The journey was a blast.

Sophie Moors, DSC co-chair.

Kayla Peckham and Nicole Shipton

ALUMNI

Doug Bates wins the 2023 ASA Statistical Computing and Graphics Award

The Joint Statistical Computing and Statistical Graphics Sections of the American Statistical Association (ASA) have announced that Dr. Douglas Bates is the winner of the 2023 ASA Statistical Computing and Graphics Award. https://community.amstat.org/jointscsg-section/awards/computing-graphics-award.

The award was presented at the 2023 Joint Statistical Meetings held in Toronto in August. The citation reads:

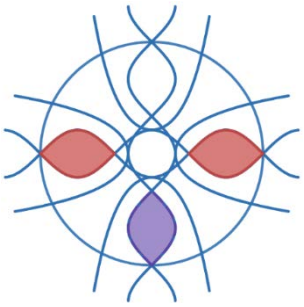
"For his fundamental contributions to statistical computing infrastructure, developments of S, R, Julia, and mixed-effects models, and their applications in statistical research and practice."

Doug is currently an Emeritus Professor in the Department of Statistics at the University of Wisconsin-Madison. He received his Ph.D. in Statistics from Queen's in 1978 with supervisor Don Watts. After being on the faculty of Mathematics at University of Alberta, he joined the University of Wisconsin-Madison in 1980, where he chaired the Department from 1991 to 1994. Throughout his career, he has published two books and over 40 papers. He became a Fellow of the American Statistical Association in 1992.

Doug contributed significantly to the early development of the S and R languages. He is a founding member of the R Development Core Team. He is well-known for his impressive contribution to the development and implementation of mixed-effects models. He is one of the major developers of the three widely used packages for mixed-effects models: "nlme" (for S and R), "lme4" (for R) and "MixedModels" (for Julia).

Doug writes:
I enclose a photo taken at the "R á Québec" conference at Laval University in 2019. I am holding a framed CD containing R-1.0.0, released on Feb 29, 2000. (R is an Open Source language and system for statistical computing and graphics. It is widely used in data science.) We created a signed, numbered set of CD's to commemorate the 1.0.0 release.

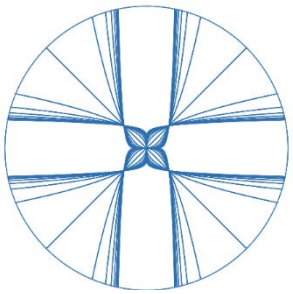
MATH QUEST—August 2023
OUR GIRLS' SUMMER MATH CAMP

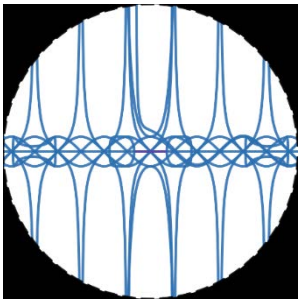


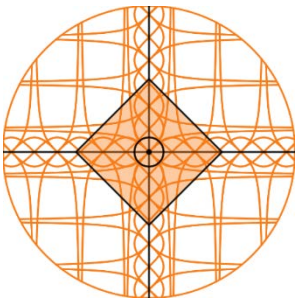
Once again, Math Quest, our August Girls' Math Camp, hosted a wonderful bunch of students all the way from grades 8 to 11.

One amusing novelty this year was the purchase of a "button-making" machine. The idea is the students do a bit of simple coding to take a standard graph and play with different kinds of symmetry to make a button design. More here!

And then they took the buttons home!







ROBERT ERDAHL
IN MEMORIAM

Last December we lost Bob Erdahl, a long-time friend and colleague. Bob arrived at Queen's in the late 60's and served the Department and the university in many capacities including a time as Head from 2000 to 2004. His daughters Sophie and Leah describe him as both spirited and disciplined, prone to great focus and diversion, a man who investigated fundamental questions in his field and pursued simple joys in life.

At Woodrow Wilson High School in Washington in the early 50s, Bob developed a passion for music, playing the clarinet and then alto sax and bassoon and played in the Catholic University Youth Orchestra. His love for jazz developed in the nightclubs downtown where Bob first encountered *The Birth of Cool*. It was a decade of cultural change and one of progress. In 1954, his was among the first schools in the country to desegregate.

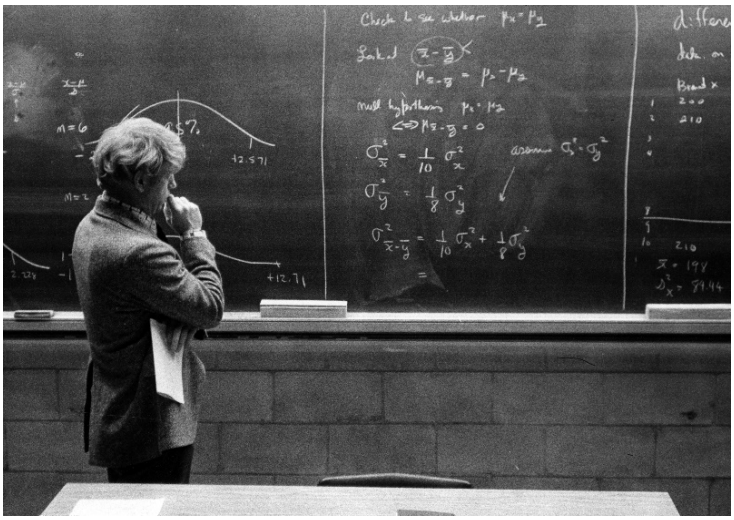
He was an undergraduate at Bucknell where he was captain of the swim team and held a pool record in butterfly. He started his studies in engineering and then switched into chemistry. It wasn't until he was a graduate student at Princeton in the 1960's, that Bob encountered mathematics and, as he often put it "I converted." John Nash was among his many distinguished teachers. In a farmhouse close to campus, he lived with his buddies Stewart Smith (who would become Head of Princeton Physics) and Anthony Russo (who would be prosecuted with Daniel Ellsberg during the Pentagon Papers Trial). He received his Ph.D. in Quantum Theory in 1966, and then answered the call of the Mathematics Department at Queen's.

Here he became a keen squash player, and was well known for his competitive nature in the Flying Dutchman races on Lake Ontario. In 1974 he purchased a modest lot which over the next decades he cultivated into "Shady Acres." His life, in its various aspects—math, gardening, a new family, friends, strangers and strange friends—all came together and flourished.

By the infamous fire pit at Shady Acres (1993)

Sailing with his two daughters, Sophie (L) and Leah (R)

Bob always had a project on the go and as often as not it was about the well-being and prosperity of the department.



He organized international conferences including *The Coleman Symposium*; he co-founded the M.Sc. Mathematics and Engineering program; for seven years he was Chair of Graduate Studies; from 2000 to 2004 he was Department Head and generally regarded as exceptional for his imaginative leadership and dogged persistence.

From 1979 to 1991, Bob was secretary of a Cold War diplomacy program. The scientific exchange sent researchers between Steklov Institute for Advanced Mathematics (Moscow and St. Petersburg) and Queen's University with participation from other Canadian universities as well.

One of his main projects was the establishment of the *Coleman Postdoctoral Fellowships*. His plan was to work with advancement to locate and connect with alumni whose lives had been changed (yes that's not too strong a word) through their encounters with John Coleman. That involved many trips, often to Toronto, to meet and greet and raise a glass. I had the good fortune to be part of a number of these visits and hear what these former students had to say about John. I will say, parenthetically, that John also had a huge influence on me, both as an undergraduate at Queen's and as a young member of faculty.

The Fellowship program was a great success. We are able to carry some 6-9 postdoctoral fellows for three-year terms, and they make a huge contribution to both the teaching and research life of the Department.

A second major project for Bob was to ensure that Queen's became a *full member of The Fields Institute*. For this to be financially possible, other units in the university, particularly the Faculties, needed to buy in and Bob, at his persuasive best, worked tirelessly towards this objective. We are now one of nine Principal Sponsoring Universities of Fields. That connection enriches both our research and teaching lives, not only in Ontario, but increasingly world-wide.

Bob retired into his research. His vegetable garden, transformed into a community project with the help of very fine friends, yielded several seasons of outstanding dinner parties, and is still maintained. He continued to publish, though regrettably his results on the *Voronoi Conjecture* were not resolved in writing before time fell short.

Bob will be remembered for his generous sense of friendship which extended into so many different communities, and for the value he placed on team effort. Now the efforts continue, except the world has lost a great participator. Bob will be dearly missed.

Another account of Bob's life and contributions has recently appeared in the Gazette:

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