

Welcome to the February Issue of the CMS Notes

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A Reflection on Open Source

Cover Article

February 2023 (Vol. 55, No. 1)

Timothy Alderson (UNBSJ)

Vice-President, Atlantic

My first encounter with open source was thirty short years ago. My, how time and technology-changes fly! As a typical financially-strapped undergraduate, I pieced together my very first personal computer, and was thrilled to have the option of using the open and (most importantly) FREE operating system, Linux.

This of course saved me money, but was also a valuable learning experience, as it required much focus and patience, through many coffee-fueled nights, accessing 'Usenet' for tips on configuring appropriate drivers etc. The community surrounding this open source stuff was amazing to me. Eventually, success! I was a firm convert to Linux, and the whole philosophy of free and open access to all that it offered. In those heady early days of the Internet, the idea of open and free access for all was a hot-button much-debated topic, as it still is to a perhaps lesser degree today.

However, once I had completed my studies and become gainfully employed, I quickly realized I was living in a Microsoft world. This was before Microsoft was broken up into smaller units/companies by U.S anti-trust laws, and before Apple had begun to compete with MS in any meaningful way.

As our campus system became more computer-based, moving beyond email and csv files to Active Directory, Learning Managements Systems (LMS), and Sharepoint etc., my administrative duties increased, and there was ever decreasing patience for non-MS files. I personally clung to a dual-boot system for some time, aiming to get back to Linux someday – but that day never came. Eventually, I installed LaTeX on Windows and left the dual-boot system behind.

To this day, I have lingering regret about this, as I viewed it as something of a 'sell-out. I'm certain millions of alternate system users felt the same way. Perhaps this is why I feel a sense of redemption whenever I am able to embrace Open Educational Resources (OER) in my job.

Open texts provide not only cost-savings to financially burdened students, but also gives Faculty the legal ability (by dint of the Creative Commons license) to supplement, re-write, rearrange, and delete content of the textbook to suit their specific course. Faculty may wish to make edits for a variety of reasons – from a desire to meet cultural, regional, or accessibility needs; to clarify or correct inaccuracies; to make examples more relevant to the class/discipline, or simply to bring text content into line with a long established lecture notes of a particular course. Of course, any such editing takes time, but for introductory courses in particular, there are many suitable options which are a perfect ready-fit for students, right out of the box.

With open texts, students have immediate access (even before classes start), and hard copies of many titles can be purchased for entirely reasonable rates. For example, the hard copy of the text I used for 'Calculus I' last term, can be home delivered for \$35.

I would add that many students are placed in a difficult moral position when asked to purchase a \$300 book when digital pirated copies are available online. Links to such resources are circulated freely, but often these files are accessed from malware-laced websites, and it is not uncommon for files to carry damaging and frustrating malicious content. There is also of course the (albeit slight) possibility that downloading these pirated materials could result in legal issues. This is perhaps not a real and serious concern for professors, but it does highlight the value of open source.

Textbook publishers have been evolving by developing software, interactive e-books, Multimedia and online homework systems to accompany their texts. Some commercial courseware-providers such as Lyryx, and WebAssign have partnered with OER. Open texts are increasingly designed to be interactive, and freely available. Graphing calculators such as Desmos.com, eMathHelp.net, and multiple mobile apps are easily linked with open texts, as are OER alternatives to mathematical software such as SAGE, Geogebra, and Scilab.

There is also OER software to support interactive homework assignments, some, such as WebWork are able to be integrated into most of the mainstream LMS such as Canvas, D2L, Moodle etc. I am by no means an OER aficionado, but I can speak to the merits of WebWork (WW), having

used it since 2012. WW has certainly come a long way since 2012, now boasting over 35,000 randomized questions in the (open) problem bank, covering a broad range of topics from pure/applied mathematics, statistics, engineering, and beyond.

I find that the immediate feedback students receive is an extremely valuable asset, making it an ideal accompaniment to hand-written assessments. It also allows for a significant reduction in the number of marking hours. The open problem-bank for example is an incredible resource, and the WW community forums provide excellent support for users, authors, and administrators alike.

I have also found WW to be a definite game-changer in my Discrete Math course, where we introduce mathematical proof. In the past, I would typically see a majority of poorly-written proofs on the first several assignments in that course.

I began supplementing the hand-written assignments with WW assignments, where students are able to drag and drop pre-written elements to create a proof (like a single column of blocks, but with extra blocks). The students were able to attempt these problems as many times as they like, with immediate feedback. The improvement in the hand-written proofs (on both assignments and tests) was frankly staggering. This made for a better experience for myself as a marker, but also for the students who did not lose marks while learning how to appropriately structure a proof for the first time. A very important win-win, and above all, an improvement in learning and understanding.

In the case that a WW question from the problem-library does not have a full solution, or perhaps the solution provided is not written to personal style, then one can be re-written in relatively short order and used, in many cases, in perpetuity.

In fact, a great way to engage interested undergraduate students who are working for a few weeks during summer work-terms, is to have them learn some Perl and LaTeX, while coding WW problems and solutions for new courses.

In our experience, students have actually had fun doing this, which elicits better work results and a more positive experience for the student and supervisor alike (especially if you hire multiple students). As an added bonus, these students are able to tag themselves as authors, and upload the problems for use by the world-wide WeBWork community! The tangible sense of accomplishment and recognition this may instill in students is quite valuable indeed.

In conclusion – even though I am composing this article on a Windows machine, I take some solace in that I am only a click or two away from a Putty terminal connected to our WW server, humming happily away on Ubuntu.

I believe that independent creative problem solving, and exploration of alternate user systems and solutions are backbones of learning.

For those that would like more information regarding some of the OER I mentioned in this article please see the embarrassingly incomplete list of links below.

- <https://openstax.org/subjects/math>
- <https://libretexts.org/>
- <https://open.bccampus.ca/>
- <https://webwork.maa.org/>

Robert Dawson (Saint Mary's University)

Editor-in-Chief, CMS Notes

Mathematics is the art of seeing the same thing in more than one way. A complex number is a field element and also a vector. A matrix is a ring element and also a linear function. A topological space, if reasonably well-behaved, can also be thought of as a ring of continuous functions, and so on. One of the skills we learn early on is when to change our glasses and look at what we're studying from another viewpoint.

In Canadian universities, the faculty members are salaried professionals. For much of the week, we write our own schedules. We have a satisfyingly large amount of control over our research. If we need to work in the evening or on a weekend, we do it because it's part of our job, not because we get paid overtime for doing it. But our positions, too, are ambiguous. Most of us are unionized – and, every few years, if contract negotiations don't go well, we may find ourselves on strike.

My union's facing that situation now: we haven't reached the last stage of negotiation yet, but a strike could be only weeks away as I write – and possibly taking place as you read this. If that happens, suddenly our regular lecturing schedules will be interrupted. Instead of going the extra mile to make sure that our students keep up with the course, we'll be in the uncomfortable position of not being able to help them. Instead of delivering carefully-crafted lectures, we'll be walking around the perimeter of the university campus, expressing ourselves via messages of a few words, printed on sheets of corrugated plastic – a surreal change.

But, when you look at it from one angle, we are just employees, in an organization that could do other things more easily if it paid us less. This adversarial system is how society establishes the value of our services: we reach our collective agreements in the same way that miners or steelworkers do because of the aspects of our employment that we have in common. It sometimes seems like an odd way to do things, but it's the system we've got.

In some countries faculty are civil servants, with salaries set by legislation. In other countries everybody has to negotiate their own salary individually, and those who don't push hard enough fall behind. Our system has its flaws, but so, I think, do the others. Whatever the system, we have to make it work – even if it means walking the picket line.

Amy Shell-Gellasch (Eastern Michigan University)

CSHPM Notes bring scholarly work on the history and philosophy of mathematics to the broader mathematics community. Authors are members of the Canadian Society for History and Philosophy of Mathematics (CSHPM). Comments and suggestions are welcome; they may be directed to either of the column's co-editors:

Amy Ackenberg-Hastings, Independent Scholar (aackerbe@verizon.net)
Hardy Grant, York University (retired) (hardygrant@yahoo.com)

While it is always great when mathematics educators can include substantive studies of primary sources in their courses—such as the projects described by the [TRIUMPHS team](#) in the [December 2018](#) issue of these *Notes* [1]—sometimes instructors may just be looking for a quick historical illustration, fact, or concept that illuminates a given day's lesson. One extensive and eye-catching resource for such glimpses of the past is the Mathematical Treasures collection found in [Convergence](#), the Mathematical Association of America's online, open-access journal devoted to the history of mathematics and its uses in teaching. The collection's over 1200 pages provide images of mathematical objects and of selected pages from mathematical manuscripts and texts housed in various libraries, museums, and private collections, all of which may be shared in your mathematics classroom. Below, I highlight some of my favorite Mathematical Treasures and explain what I think makes them engaging for students.



Figure 1. Autographed title page from De Morgan's copy of *La Methode des Fluxions*. [Convergence Mathematical Treasures](#).

In 1750, the Comte de Buffon—better known today as a naturalist—translated into French Isaac Newton's *Method of Fluxions* (written in 1671 but published posthumously in 1736) [Figure 1]. But the confluence of great figures in the histories of mathematics and science doesn't end there, as this particular copy was purchased by Augustus De Morgan in 1852. Note that he added both his autograph and information about how he found the book near the place of publication on the title page [6].

Another posthumous publication by a giant in the history of mathematics, the 1787 *Institutiones Calculus Differentialis* by Leonhard Euler, catches our attention with both its mathematical content—Euler wasted no time by bringing in differentials on the very first page—and its typographical beauty [Figure 2]. As I've written elsewhere, "I can't get enough of the wonderful engraved artwork of texts of the sixteenth through the early nineteenth centuries. Don't you love the cherubs doing geometry in the 'E'? Given that it is Euler and the letter e, I couldn't help imagining for a moment one of the little guys being Euler" [3; 7].



Historical books do not need to have made major theoretical contributions to be educational. For example, the next two Treasures help us encourage preservice teachers, liberal arts students, and others to think about how humans learn mathematics. Before mass-printed textbooks were readily available, children and teenagers typically wrote down what their teachers recited or copied from the class's single textbook in a "cyphering book." These were carefully prepared, often lavishly decorated, and preserved within a family for generations. The pages shown here were prepared by 15-year-old Mary Serjant, who was born in England in 1673 [Figure 3]. On the first page, she was working on "broken addition," and on the second she showed an example of the Rule of Three, a proportion containing three known quantities and one unknown [4].

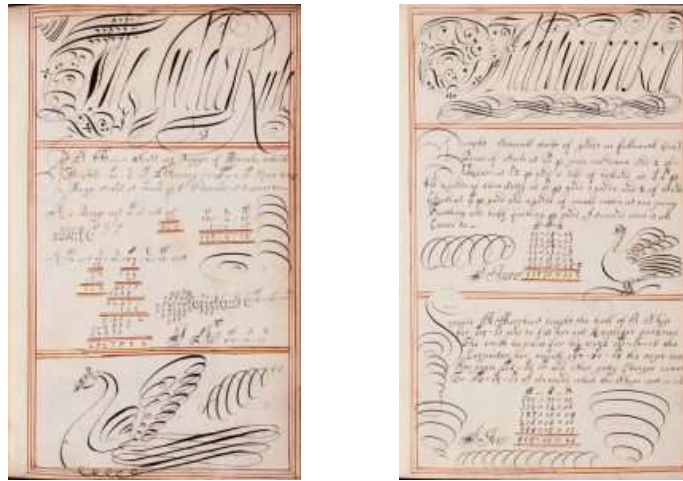


Figure 3. Two pages from Mary Serjant's 17th-century copybook. [Convergence Mathematical Treasures](#).

The cyphering-book tradition was especially associated with Christ's Hospital in London [2]. Another innovative type of teaching material from that institution is Johann Alexander's 1693 textbook, which is really a workbook with a blank page facing every page of text [5][Figure 4]. A student has attempted to solve this right-triangle problem for x . Did they find the right answer?

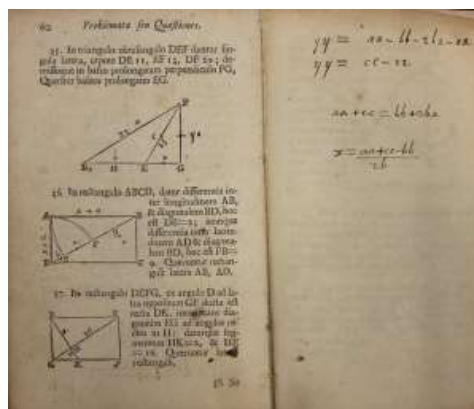


Figure 4. Page 60 (and its facing blank page with student work) from Alexander's 1693 *Synopsis Algebraica*. [Convergence Mathematical Treasures](#).

The full collection can be perused via an [index organized alphabetically by author/creator](#) as well as in several subindices by repository or form of material. Is there a historical document or object that you like to use in class which is not yet represented in Mathematical Treasures? Submissions can be sent to convergence@maa.org and should include:

- **High-quality and informative images** of a historical mathematics book or object. Images of books typically include the title page and one or more samples of the content. Check the [Index of Mathematical Treasures](#) for works that are already included in the collection.
- **Permission** from the owner of the book or object to publish the images, if the repository has not already contributed to *Convergence's* collection (a list is provided at the bottom of the [Index](#)). If necessary, provide information on the **owning library/archives/website** for these Acknowledgments.
- Approximately 300 words of **text describing the historical significance** of the book and author (or object and creator). The text should also explain why the content samples you have chosen are historically or pedagogically interesting. Think about why or how another instructor might want to use these images in the classroom. **This text must be original to you;** do not copy from *Wikipedia*, *MacTutor*, or any other source.
- A **bibliography** of any sources consulted in preparing the description.

References

- [1] Barnett, Janet Heine. (2018) [Why Use Primary Sources in a Mathematics Classroom?](#) *CMS Notes* 50(6), 16–17. "TRIUMPHS" is an acronym for the NSF-funded project, "Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources."
- [2] Ellerton, Nerida, and M. A. (Ken) Clements. (2012) *Rewriting the History of School Mathematics in North America, 1607–1861: The Central Role of Cyphering Books*. Dordrecht: Springer.
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- [4] Swetz, Frank J. (2013, August) [Mathematical Treasure: Mary Serjant's Copybook](#). *Convergence* 10.
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[6] Swetz, Frank J. (2019, February) [Mathematical Treasure: Newton's Fluxions Owned by De Morgan](#). *Convergence* 16.

[7] Swetz, Frank J. (2019, November) [Mathematical Treasures – Leonhard Euler's Differential Calculus](#). *Convergence* 16.

Amy Shell-Gellasch is serving her second term on the CSHPM Executive Council. She teaches mathematics at Eastern Michigan University and has held numerous positions in the MAA, where she is currently Past Chair of the Special Interest Group in History of Mathematics and Chair of the Michigan Section. This column is based upon her ongoing series in MAA FOCUS, "A Quick Look Back: Mathematical Treasures on Convergence."

Andrijana Burazin (University of Toronto, Mississauga)

Lauren DeDieu (University of Calgary)

Veselin Jungić (Simon Fraser University)

Miroslav Lovrić (McMaster University)

Education Notes bring mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, issues, and noteworthy news items. Comments, suggestions, and submissions are welcome.

Kseniya Garaschuk, University of Fraser Valley (kseniya.garaschuk@ufv.ca)
John Grant McLoughlin, University of New Brunswick (johngm@unb.ca)

In this article we report on a recent survey conducted among mathematics and statistics teaching faculty at Canadian universities. To provide context for our analysis, in the opening section we offer a few references and background information about the so-called teaching-stream faculty in general. Next, we discuss the findings of our survey and comment on certain developments in the Canadian community of mathematics and statistics teaching-stream faculty. We finish this article with a call for action with an aim to further improve students' undergraduate learning experience by strengthening the position of the teaching-stream faculty at their institutions.

Introduction: From casual appointments to teaching stream

It is a well-documented fact (Mohamed, 2022), that over the years and across the world the proportion of the full-time tenure-track faculty in academia has declined. This trend has been present in Canada as well.

For many years, universities in Canada have been relying on a precarious workforce (non-permanent, part-time, casual, contract, temporary type employment, with, in general, teaching rather than research assignments) to fill in ever-increasing demands for classroom instruction (Pasma & Shaker, 2018, Murray, 2019).⁹

In the report published by the Canadian Association of University Teachers (Foster & Birdsell Bauer, 2018), which draws data from the Statistics Canada 2016 Census, we read: "The drop in full-time, full year positions is evident, for instance, in the Census which shows a decline of 10% from 2005 to 2015. During the same period, university professors working part-time, part-year increased by 79%." The paper by Rose (2020) reports on the "extent of the reliance on precariously employed contract faculty across Canada."

A 2018 study by the Council of Ontario Universities (COU, 2018) establishes that only 42.3% of academic staff in Ontario are tenure track or tenured, 5.8% are full-time non-tenured stream, and 51.9% are precarious academic workers. Statistics from the Canadian Union of Public Employees (Pasma, 2019) shows that Ontario is between the extremes: Quebec universities rely the most of all Canadian provinces on precarious faculty, and only about 40% of their faculty are tenure track or tenured. At the other end, in Alberta and Prince Edward Island, a bit over 60% of faculty are tenure track or tenured.

The COU study states that "Part-time instructors teach 45% of all students, focusing particularly on the undergraduate level – where they teach 46% of students and 50% of courses" (COU, 2018). In discussing the situation, the authors have been trying hard to convince us that many part-time instructors are "very likely unqualified for a tenure-stream appointment" and that "a minority of part-time instructors (9% to 23%) would potentially fit the common public perception of part-time instructors seeking to make a full-time academic career." This, in our view, narrow data interpretation cannot hide the fact that the tenure-track professoriate meets, at best, one half of the current university teaching commitments.

One may wonder why the employment of tenure-track and tenured faculty at Canadian universities did not keep up with the pace of the growth of the student body (see the above employment Census data as reported in Foster & Birdsell Bauer (2018), contrasted with an evident increase in the number of students at Canadian universities). The Canadian Association of University Teachers (CAUT) document "Out of the shadows: Experiences of contract academic staff" (Foster & Birdsell Bauer, 2018) offers a possible explanation:

At Canadian universities, academic rank salaries as a percentage of total expenditures have steadily declined from 34% in 1973 to 23% in 2016. Spending on academic rank salaries increased by 166% in constant 2015 dollars from 1972 to 2016, while spending on administration and general funds increased by 228% during the same period. Other expenses also showed a higher percentage of growth during the period. Building, land and land improvements grew by 366%, for example. The casualization of the academic labour force is therefore only one component of the shift in priorities at Canadian universities.

Hence, as a manifestation of "the casualization of the academic labour force," part-time instructors became an instrumental component of Canadian academia and its business model.

CAUT's data indicates that a sessional instructor is currently paid between \$5,000-\$10,000 (Canadian dollars) per one-semester course. This agrees with the comment made by the authors of the Centre for the Study of Canadian and International Higher Education (CIHE) publication "A Survey of Sessional Faculty in Ontario Publicly Funded Universities" (Fields & Jones, 2016):

For many instructors, income levels from part-time² sessional contracts are significantly less than the low-income measure after tax (LIM-AT) measure of the poverty line.³

We wonder if there is any other occupation in Canada where a group of highly educated individuals would be expected to provide a first-class "product" for a salary that would keep them around the poverty line, and with no job security whatsoever.

This absurd, unfair, and unsustainable situation (see the CBC News article “Ontario college strike spotlights ‘new norm’ of precarious labour in academia,” published in 2017⁴) has led to a gradual but steady acceptance of the fact that the creation of continuous teaching-stream faculty positions would bring multiple benefits to the entire university teaching and learning practice.

For example, Vajoczki, Fenton, Menard, and Pollon (2011) stated that

Protecting the rights and privileges of instructors, by creating TSF [teaching-stream faculty] positions rather than large numbers of adjunct positions ultimately benefits students and has a positive impact on teaching and learning. Faculty members who have

secure employment commit to students, the department and their institutions because they have the time to invest in their role and develop their pedagogical expertise.

The process of establishing teaching-stream faculty positions has been challenged, often by the tenure-track research faculty. In the 2013 The Globe and Mail article “For a new kind of professor, teaching comes first”⁵ we read:

“When you’re also a researcher, you’re a different kind of teacher. You’re bringing something else to the classroom,” said Jim Turk, executive director of the Canadian Association of University Teachers. “It’s what distinguishes a university. Otherwise, it really is no different than a high school.” [...] faculty at the University of Ottawa are not persuaded. Last week, they rejected a university proposal to make 10 per cent of professorial jobs teaching focused by 2020. Christian Rouillard, president of the university’s faculty association, echoed Mr. Turk’s fears, and worried a teaching stream would create “Balkanization” among professors. In 2008, faculty at the University of Windsor turned down a similar proposal.

Putting aside the fact that Turk and Rouillard’s statements were made at the time when, as we learn from COU (2018), about 50% of undergraduate classes in Ontario were taught by part-time instructors, we observe that “Balkanization” among academic staff was already there. At about the same time Vajoczki, Fenton, Menard, and Pollon (2011) wrote:

Some CAS [contract academic staff] reported feeling invisible and disrespected at work. In some of the answers to survey questions, CAS self-describe as “second class citizens” and “untouchables,” and say they are treated with “contempt” because of their contract status.

Mathematics and Statistics Teaching-Stream Faculty

In 2017, two co-authors of this article (Jungić & Lovrić, 2017) published the “Call for National Dialogue: The Present and Future of Teaching First Year Mathematics at Canadian Universities.” The call ended with the statement:

Therefore, first-year math courses present unique opportunities and challenges to substantially influence Canadian students regarding their attitude towards, and knowledge and significance of mathematics. To use this opportunity and meet the challenge

in this fast-changing academic world, all of us who teach, or are otherwise involved in post-secondary math courses in Canada must communicate, share our experiences, coordinate our efforts, and work together.

It turned out that post-secondary mathematics teaching practitioners were ready and eager to establish a platform for a dialogue. Over the last several years, members of the grassroots teaching community First-Year Math & Stats in Canada (FYMSiC)⁶, have organized annual conferences and workshops and have been running a well-attended online seminar series; they established an online repository of the first-year mathematics and statistics courses taught at Canadian universities, and have been publishing a newsletter. For further information about FYMSiC, see the article by Burazin, Jungić, and Lovrić (2020).

As well, the Canadian Mathematics Society has witnessed a large increase in education activities. One half of the presentations in the first virtual CMS meeting (CMS COVID-19 Research and Education Meeting) in 2020 were related to mathematics education. CMS meetings now routinely host between 3 and 5 education sessions, which, in terms of attendance, are often the largest sessions.

Even though the FYMSiC events are attended by teaching practitioners from all walks of academic life, including retirees, graduate students, college instructors, and tenured-track faculty, the core of the community is comprised of teaching stream faculty, both continuing and part-time. For this reason, a session at the May 2022 online FYMSiC conference was devoted to the discussion about the teaching faculty ranks across Canada.

In preparation for the conference, members of the FYMSiC community were invited to complete a short survey about the status of the teaching-stream faculty ranks at their institutions. There were 12 complete responses, coming from 12 universities (a mix of medical-doctoral, comprehensive and primarily undergraduate universities) located in six Canadian provinces.

Of the 12 universities covered in the survey, eight had a collective agreement between the university and the local faculty association that included teaching-stream faculty; one was in the process of negotiating such an agreement; one opted for using the term “academic teaching staff” rather than “teaching faculty;” and two universities did not have any kind of recognized continuous teaching-stream faculty

In general, responses by our colleagues from institutions with the established teaching streams indicated a variety of approaches when defining the teaching-stream faculty ranks, their workload, job expectations (including the level of courses taught), and so on. This is in line with research conducted by Mohamed (2022).

We now summarize the responses to our survey.

Ranks: In Table 1 we present different approaches in defining teaching ranks.

In general, there are three levels, mimicking the ranks of tenure-track faculty. From the survey responses and from the discussion during the FYMSiC conference session in May 2022, it became clear that the most common approach to naming teaching ranks is to use the traditional ranking (assistant professor – associate professor – professor) and add, or insert, “of teaching,” or “teaching,” or “teaching stream.”

We have also learned that there are different approaches towards granting tenure, i.e., the permanent employment status, to the teaching-stream faculty. Some universities do not have that as an option, such as those classified under ‘C’ and ‘D’ in Table 1; some treat the highest rank as tenured (‘A’), and some mirror the research-stream pattern and award tenure at the second rank level (‘B’ and ‘E’).

Sometimes the term “tenured” is avoided, even though the position is permanent. One of the survey respondents said:

Every Assistant Teaching Professor is required to eventually apply for “continuing” status, and the definition of “continuing status” in our collective agreement is word-for-word the same as the definition of “tenure.” In addition, we have the option of applying to the rank of Teaching Professor, which confers tenure.

University	A	B	C	D	E
Ranks	Lecturer	Instructor	Instructor I	Lecturer	Assistant Professor of Teaching
Ranks	Senior Lecturer	Senior Instructor*	Instructor II	Assistant Professor of Academic Programming	Associate Professor of Teaching*
Ranks	University Lecturer*	Teaching Professor*	Senior Instructor	Associate Professor of Academic Programming	Professor of Teaching*

Table 1 Teaching stream faculty ranks at various Canadian universities, from the lowest to the highest. Ranks marked by a (*) are tenured

Workload: We asked our survey participants about the standard teaching-stream faculty workload split. Table 2 summarizes their responses.

Teaching	Service	Educational Leadership and Scholarship	# of responses/8
80%	20%		5
85%	15%		1
70%	20%	10%	2

Table 2 Workload split for teaching stream faculty

Teaching: The teaching load (“Teaching” column in Table 2) amounts to teaching six one-semester courses per year or fewer, in which case the remaining load consists of performing “equivalent” duties. Those duties may include math help centre coordination; coordination of courses offered in the multi-section mode and taught by multiple instructors; major administrative duties, such as chairing the undergraduate studies committee; teaching releases for various projects; teaching large classes; supervision of graduate students and supervision of undergraduate research projects; and education-related research.

Our discussion during the FYMSIC Conference in 2022 suggested that, in a typical semester, a teaching-stream faculty member can expect to teach courses as well as, for example, coordinate the work of teaching assistants and tutors in a math help centre.

Our survey also asked about the range of mathematics courses that the teaching-stream faculty typically teach. The consensus was that “this was not set in stone.” Nevertheless, the following quote provides the best summary of the responses:

Due to the large number of service courses we teach, I think that almost all research-stream faculty teach some first-year courses. I've never seen a teaching-stream faculty member teaching a graduate course, and the majority of us are only teaching first- and second-year courses (e.g. I taught an upper-division abstract algebra course once, but now it's taught by our new abstract algebra research-stream hire). The majority of teaching-stream faculty also coordinate the majority of our large multi-section courses.

Service: This component includes serving on various institutional and/or professional committees and bodies, as well as serving the community at large. Such an involvement may range from the departmental level to the national level. In addition, it is common to see the members of the teaching-stream faculty as leads on various outreach and professional development initiatives.

Educational Leadership and Scholarship: Defining the expectations of the tenure-stream faculty, McMaster University regulations about tenure and promotion? state:

“The role of teacher is the principal one; the expectation for a permanent Teaching Professor is continued exceptional teaching as the primary way by which academic excellence is demonstrated. In keeping with the research-intensive nature of McMaster, this teaching role will ideally (but not always) be complemented by scholarship related to teaching. Examples include contributions to curriculum development beyond the course level, and presentations or publications on teaching or pedagogy.”

We believe that the terms such as “continued exceptional teaching” and “scholarship related to teaching” have been left vague by design, to keep them open and flexible when interpreted for a specific teaching-stream position.

This, we believe, is true in general: the “educational leadership and scholarship” component of a teaching faculty's job is not always precisely defined, nor is consistent across universities. For illustration, we offer three responses from our survey:

It's valued but not necessary for promotion. “Educational leadership” is understood to be flexible. Certainly, it's necessary for a faculty member to disseminate their knowledge somehow, but some of this could be done through non-scholarly networks – for example, through administrative work at and beyond the university.

When discussing this with my colleagues, my understanding is that scholarship is broadly defined; in particular, publishing peer-reviewed publications is not required. It is not expected or required that teaching-stream faculty members do mathematics research.

The exact expectation is not clear, but even just attending workshops/ conferences do show that one is mindful of improving their teaching and is looked upon favourably. Presentations and publications of course do carry more weight, but again since there are zero precedent for my type of position, there isn't any concrete cases of what's enough and what's not.

Similarly, one of the leading Canadian universities defines⁸ educational leadership very broadly as:

An activity taken at UBC and elsewhere to advance innovation in teaching and learning with impact beyond one's classroom.

This document provides examples of activities that count as active engagement in the scholarship of teaching and learning: pedagogical innovation and other initiatives that extend beyond the member's classroom; formal educational leadership responsibilities; organization of and contributions to conferences; and contributions to the theory and practice of teaching and learning, including publications.

Promotion Process: Our final survey question inquired about the promotion process. Here is an answer that details the promotion procedure at a Canadian university, often classified as "comprehensive":

Initially you're appointed to a three-year term as an Assistant Teaching Professor, which is renewed for a second term. When the second term is up, you either apply for a second renewal or you apply for promotion. If your renewal is successful, you become an Assistant Teaching Professor with continuing status. If your application for promotion is successful, you become an Associate Teaching Professor with continuing status. If your renewal is not successful, you have a one-year terminal position during which to find another job.

Promotion to Associate rank is like the process for research stream. The only differences are (a) the weight each part of your package carries, and (b) the rules for selecting external reviewers. Teaching stream faculty can have one or two 'external' reviewers who are from [University], which is not allowed for research faculty. I suppose another important difference is that you don't HAVE to do it at all; you can stay a continuing Assistant Teaching Professor forever (but will stop being eligible for pay increases, so it's not in fact a good idea).

Promotion to full Professor rank is like the process for research stream. I don't know anyone in our department who has done that yet; the current collective agreement makes it sound as if you'll have a harder time getting pay increases because the standards will be higher, so it's not well-incentivized currently. You may apply after being Associate for four years, but I gather it is uncommon to do so that quickly (which I gather is the case for research stream folk too). Promotion requires substantial evidence of scholarly work, curriculum development, and service.

We mention that not all universities covered by our survey had a well-established promotion process. One of the survey respondents wrote: "This has been somewhat ad hoc. This issue is currently being addressed."

Call for Action

It is our strong conviction that the significance of the teaching-stream faculty as an integral part of the Canadian post-secondary education system will continue to grow. The reasons for this growth will continue to be:

- Educational: The teaching stream faculty are innovative, dedicated to their teaching, and are continuously exploring and introducing new teaching techniques. Through our FYMSiC events we have witnessed some extraordinary talent among our colleagues that are not just excellent teachers and skilful administrators but also inspiring role-models for their students.
- Economical: Having a group of academics whose primary task is teaching will continue to improve students' learning experience, better meet the learning needs of an already diverse student population, and therefore, increase levels of retention.

Canadian universities should create a respectful and supportive environment for the teaching faculty and offer full-time, permanent employment while allowing for a small number of emergency short-term contractual positions.

By implementing a well-defined set of expectations and a fair and meaningful promotion process, all teaching faculty should be encouraged to continue with their own academic and personal growth for the benefit of their own well-being, their students learning, and their institutions success. Consequently, the teaching-stream faculty should be both encouraged to and awarded for their contributions to educational leadership and scholarship.

Therefore, we invite the entire academic community in Canada, the research-stream faculty, administration, and the teaching-stream faculty to work together to further strengthen the position of the teaching-stream faculty.

Hence our call for action:

- Standardize the teaching-stream academic ranks across Canadian universities to Assistant Professor of Teaching, Associate Professor of Teaching, and Professor of Teaching, or equivalent ranks that follow the established ranks for research faculty.
- Standardize the workload split to 70% teaching, 20% service, and 10% scholarship.
- Standardize tenure and promotion processes, to mirror the processes for research faculty.

By mirroring the research-stream faculty ranks, the two ranks, research and teaching, would be both distinguished and better balanced. This would allow for easier mobility across Canadian academic institutions. In addition, it might encourage more young academics to consider joining teaching-stream faculty, thus, through competition, further improve its quality.

References

[1] <https://www.caut.ca/resources/almanac/3-academic-staff>

[2] In this context, an instructor teaching any number of courses smaller than the number that is considered a full-time teaching load is viewed as a part-time instructor.

[3] In 2020 LIM-AT for a 1-person family was \$26,570 and for a 2-person family was \$37,576 (<https://www150.statcan.gc.ca/t1/tb1h/en/tv.action?pid=1110023201>). So, a single parent would need to teach six courses per year at \$8000/course to be, after tax, over the poverty line.

[4] <https://www.cbc.ca/news/canada/ontario-college-strike-academia-1.4364735>

[5] Available at: <https://www.theglobeandmail.com/news/national/education/new-breed-of-university-faculty-puts-focus-on-teaching-over-research/article14117866/>

[6] <https://firstyearmath.ca/>

[7] <https://macfaculty.mcmaster.ca/policies-2/tenure-promotion-policy/>

[8] https://hr.ubc.ca/sites/default/files/documents/Faculty-CA2019-2021_o.pdf

[9] Note: we did not find a (unique) definition of “part-time” related to academic appointments in the documents that we examined. The implicit understanding is that “part-time employee” is an employee who works fewer hours per week than a full-time employee.

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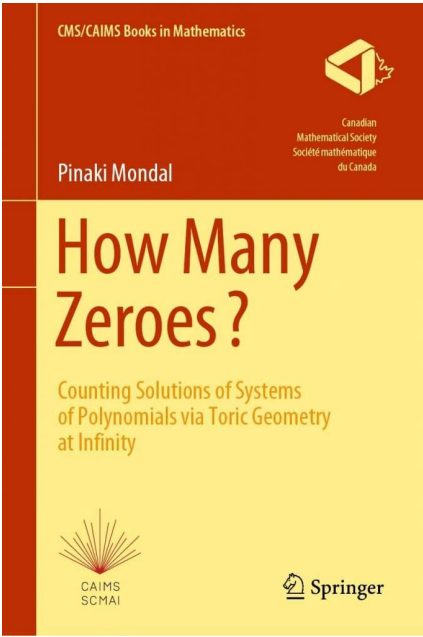
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Karl Dilcher (Dalhousie University)

Since its inception in 2000 with Jon and Peter Borwein as first Editors-in-Chief, 45 titles were published in the book series "CMS Books in Mathematics" with Springer until 2021. That year, CAIMS/SCMAI (the Canadian Applied and Industrial Mathematics Society – Société Canadienne de Mathématiques Appliquées et Industrielles) joined forces with the CMS, and the book series was renamed "CMS/CAIMS Books in Mathematics". The Editors-in-Chief for CAIMS are Frithjof Lutscher and Nilima Nigam, while Keith Taylor and Karl Dilcher have remained editors for the CMS.

Five volumes have so far been published in this new series; they are listed below, along with the publisher's descriptions as printed on the back covers of the books. Full reviews will likely be published in later issues of the Notes. All titles are available as eBooks, as well as in softcover and hardcover editions. Information about prices, how to order, and how to submit a proposal for this book series can be found at <https://www.springer.com/series/16627>.

– Karl Dilcher.



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– Karl Dilcher.

How Many Zeroes?
Counting Solutions of Systems of Polynomials via Toric Geometry at Infinity
By Pinaki Mondal
Springer, 2021
ISBN: 978-3-031-10081-9

This graduate textbook presents an approach through toric geometry to the problem of estimating the isolated solutions (counted with appropriate multiplicity) of n polynomial equations in n variables over an algebraically closed field. The text collects and synthesizes a number of works on Bernstein's theorem of counting solutions of generic systems, ultimately presenting the theorem, commentary, and extensions in a comprehensive and coherent manner. It begins with Bernstein's original theorem expressing solutions of generic systems in terms of the mixed volume of their Newton polytopes, including complete proofs of its recent extension to affine space and some applications to open problems. The text also applies the developed techniques to derive and generalize Kushnirenko's results on Milnor numbers of hypersurface singularities, which has served as a precursor to the development of toric geometry. Ultimately, the book aims to present material in an elementary format, developing all necessary algebraic geometry to provide a truly accessible overview suitable to second-year graduate students.

Pinaki Mondal lives in Toronto and works in quantitative finance.

Non-Local Cell Adhesion Models
Symmetries and Bifurcations in 1-D
By Andreas Butenschön and Thomas Hillen

Springer, 2021
ISBN: 978-3-030-67110-5

This monograph considers the mathematical modeling of cellular adhesion, a key interaction force in cell biology. While deeply grounded in the biological application of cell adhesion and tissue formation, this monograph focuses on the mathematical analysis of non-local adhesion models. The novel aspect is the non-local term (an integral operator), which accounts for forces generated by long ranged cell interactions. The analysis of non-local models has started only recently, and it has become a vibrant area of applied mathematics. This monograph contributes a systematic analysis of steady states and their bifurcation structure, combining global bifurcation results pioneered by Rabinowitz, equivariant bifurcation theory, and the symmetries of the non-local term. These methods allow readers to analyze and understand cell adhesion on a deep level.

Authors' affiliations
Andreas Buttenschön: Department of Mathematics, UBC Vancouver.
Thomas Hillen: Department of Mathematical and Statistical Science, University of Alberta.

A Primer of Subquasivariety Lattices
By Kira Adaricheva, Jennifer Hyndman, J. B. Nation, and Joy N. Nishida
Springer, 2022
ISBN: 978-3-030-98087-0

This book addresses Birkhoff and Mal'cev's problem of describing subquasivariety lattices. The text begins by developing the basics of atomic theories and implicational theories in languages that may, or may not, contain equality. Subquasivariety lattices are represented as lattices of closed algebraic subsets of a lattice with operators, which yields new restrictions on the equaclosure operator. As an application of this new approach, it is shown that completely distributive lattices with a dually compact least element are subquasivariety lattices. The book contains many examples to illustrate these principles, as well as open problems. Ultimately this new approach gives readers a set of tools to investigate classes of lattices that can be represented as subquasivariety lattices.

Authors' affiliations
Kira Adaricheva: Department of Mathematics, Hofstra University.
Jennifer Hyndman: Department of Mathematics and Statistics, UNBC, Prince George, BC.
J. B. Nation and Joy N. Nishida: Department of Mathematics, University of Hawaii at Manoa.

Numerical Methods for Solving Discrete Event Systems
With Applications to Queueing Systems
By Winfried Grassmann and Javad Tavakoli
Springer, 2022
ISBN: 978-3-031-10081-9

This graduate textbook provides an alternative to discrete event simulation. It describes how to formulate discrete event systems, how to convert them into Markov chains, and how to calculate their transient and equilibrium probabilities. The most appropriate methods for finding these probabilities are described in some detail, and templates for efficient algorithms are provided. These algorithms can be executed on any laptop, even in cases where the Markov chain has hundreds of thousands of states. This book features the probabilistic interpretation of Gaussian elimination, a concept that unifies many of the topics covered, such as embedded Markov chains and matrix analytic methods. The material provided should aid practitioners significantly to solve their problems. This book also provides an interesting approach to teaching courses of stochastic processes.

Authors' affiliations
Winfried Grassmann: Department of Computer Science, University of Saskatchewan.
Javad Tavakoli: Department of Mathematics, UBC Okanagan.

Numerical Analysis: A Graduate Course
By David A. Stewart
Springer, 2022
ISBN: 978-3-031-08120-0

This book aims to introduce graduate students to the many applications of numerical computation, explaining in detail both how and why the included methods work in practice. The text addresses numerical analysis as a middle ground between practice and theory, addressing both the abstract mathematical analysis and applied computation and programming models instrumental to the field. While the text uses pseudocode, Matlab and Julia codes are available online for students to use, and to demonstrate implementation techniques. The textbook also emphasizes multivariate problems alongside single-variable problems and deals with topics in randomness, including stochastic differential equations and randomized algorithms, and topics in optimization and approximation relevant to machine learning. Ultimately, it seeks to clarify issues in numerical analysis in the context of applications, and presenting accessible methods to students in mathematics and data science.

Author's affiliation
Department of Mathematics, University of Iowa.

Call for Submissions: CMS Notes Mathematics, Outreach, Society, Accessibility and Inclusiveness Column (MOSAIC)



MOSAIC

February 2023 (Vol. 55, No. 1)

The Canadian Mathematical Society (CMS) invites you to submit articles to be featured in the MOSAIC column of the [CMS Notes](#).

[MOSAIC \(Mathematics, Outreach, Society, Accessibility, and Inclusiveness Column\)](#) is directed by the CMS Equity, Diversity, and Inclusion (EDI) committee.

The column offers a space of expression for you to ask, listen, learn, share experience, and propose solutions to build a more diverse, just, and stronger mathematical community. For instance, you are welcome to submit an article sharing challenges and successes in enacting EDI initiatives within your university, with competitions, outreach activities, or other events.

Your email submission should include your article in both Word and PDF formats. Please submit your article to the EDI Committee at edic@cms.math.ca.

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Call for Speakers

CMS Meetings
 2023 CMS Summer Meeting

February 2023 (Vol. 55, No. 1)

The Canadian Mathematical Society (CMS) invites you to submit an abstract to participate in one of the [planned sessions at the 2023 CMS Summer Meeting](#) which will take place from June 2-5, 2023.

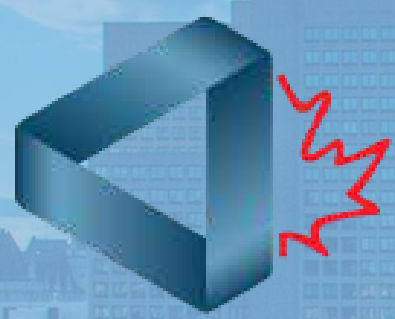
The Canadian Mathematical Society has created an open abstract submission process to support session organizers in their important work and in their efforts towards inclusivity and diversity. We encourage applications from members who identify as part of traditionally under-represented groups, including, but not limited to: Women, Indigenous Peoples, Persons with Disabilities, Members of Visible Minorities and/or Racialized Groups, and members of the LGBTQ+ Community. The CMS also welcomes applications from Graduate Students.

Deadlines

Applicants must submit their abstracts for approval to the session organizers using our abstract submission form no later than **Friday, March 31, 2023**. Please submit your abstract to only one session.

The CMS encourages organizers review submitted abstracts on an ongoing basis and to accept all eligible speakers. Successful applicants must register for the meeting and submit their abstract to the CMS website by **Monday, May 1, 2023**.

Apply



Canadian Mathematical Society
Société mathématique du Canada

2023

CMS SUMMER MEETING RÉUNION D'ÉTÉ DE LA SMC

2023

JUNE **2-5** JUIN

Ottawa, Ontario, Canada

Speakers | Conférenciers



John Urschel
Harvard University



Deborah Hughes Hallett
Harvard Kennedy School



Jude Dzevela Kong
York University



Emmy Murphy
Princeton University

University of Ottawa | l'Université d'Ottawa

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Professional Development | Le développement professionnel
Mini Courses | Mini-cours
Book Swap | Échange de livres
Awards Banquet | Banquet des prix

Scientific Directors | Directeurs Scientifiques

MONICA NEVINS (UNIVERSITY OF OTTAWA)
AARON TIKUISIS (UNIVERSITY OF OTTAWA)



uOttawa

summer23.cms.math.ca
ete23.smc.math.ca

Sarah Watson (CMS)



The Canadian Mathematical Society (CMS) welcomes and invites session proposals for the 2023 CMS Summer Meeting in Ottawa from June 2 to 5, 2023.

Sessions are scheduled in 2.5-hour blocks and take place **June 3-5, 2023**. Typical scientific sessions have between 10 and 20 talks of 30 minutes each but 1-hour talks are possible.

In accordance with the CMS mandate to propose conferences that are accessible and welcoming to all groups, diversity amongst organizers and speakers is strongly encouraged. To support organizers in their important work and their efforts towards inclusivity and diversity, the CMS will host an **open call for abstracts** for all sessions, and asks organizers to consider all eligible abstract submissions for their session.

Diversity includes topics of interest, career stages, geographic location, and demographics; designated underrepresented groups include, but are not limited to, women, Indigenous Peoples, persons with disabilities, members of visible minority/racialized groups, and members of LGBTQ+ communities

Proposals should include:

1. Names, affiliations, and contact information for all session co-organizers. Early career researchers are encouraged to propose sessions.
2. A title and a brief description of the topic and purpose of the session. This can include a brief overview of the subject. Include a two to three-sentence summary that will be posted on the website for potential speakers.
3. The number of 2.5-hour blocks expected, and a list of possible speakers.
4. For education sessions: additionally specify the structure of their session (e.g., 20-minute talk followed by 5-minute Q&A and 5-minute transition; or a panel, or interactive session/workshop, etc.).

Proposals for scientific sessions will be selected by the Scientific Organizing Committee, and proposals for education sessions will be selected by the Education Committee, limited by available classroom space, with priority for sessions that show intention to include a mix of senior and junior researchers, to make parts of their session accessible to graduate students, and to include speakers from designated underrepresented groups.

If you would like to speak in a session, please visit our [website](https://summer23.cms.math.ca) and submit your abstract for consideration by the organizers

Deadlines:

Proposals for scientific sessions submitted by **February 28, 2023**, to the Scientific Directors with the CMS Office in cc will be considered as they are received, with responses as soon as they are approved. Proposals for education sessions submitted by **February 28, 2023**, to the Education Committee with the CMS Office in cc will be evaluated after the deadline and results communicated to potential organizers in early March.

Monica Nevins mnevins@uottawa.ca

Aaron Tikuisis Aaron.Tikuisis@uottawa.ca

Andie Burazin a.burazin@utoronto.ca

CMS Office: meetings@cms.math.ca

**Carleton**
UniversitySchool of Mathematics
and Statistics**About the Position:**

Field of Specialization: Data Science and Analytics

Academic Unit: School of Mathematics and Statistics

Category of Appointment: Tenure Track

Rank/Position Title: Assistant Professor

Start Date: July 1, 2023

Closing Date: February 15, 2023, or until position filled

The School of Mathematics and Statistics invites applications from qualified candidates for a tenure-track appointment in Data Science and Analytics at the rank of Assistant Professor beginning July 1, 2023.

To see the full position posting, please visit Carleton University's [Deputy Provost's website](https://carleton.ca/deputyprovost/jobs/academics/) at <https://carleton.ca/deputyprovost/jobs/academics/>.

Candidates will have a PhD in Data Science and Analytics, Statistical Science or a related field. The successful candidate will be expected to undertake teaching and research in these disciplines. The Candidate should have expertise in data-driven problem solving including statistical / machine learning, applied computational statistics, reproducible research and data sciences. The candidate will direct the research of undergraduate and graduate students, interact with students and mentors at other units on campus, as well as develop and teach various undergraduate and graduate data science or statistics courses.

We encourage applications from candidates from underrepresented groups and/or with experience in mentoring students from such groups. The successful candidate is expected to have a desire to promote interest in our students, particularly those in underrepresented groups, in a career in applied statistics and to interact with members of the statistical science community to develop and promote data science and statistics at Carleton.

About the Academic Unit:

The School of Mathematics and Statistics offers diverse undergraduate and graduate programs in Mathematics and Statistics with outstanding research expertise in several areas. See

<https://carleton.ca/math/research-areas/>

Qualifications:

The position requires a PhD in data science and analytics, statistical science, or a related field with a strong track record of peer-reviewed research.

A strong potential for innovative methods of teaching, and demonstrated teaching excellence in the field of data science or statistics.

A strong potential for developing interactions with industry and government partners to enhance research efforts, classroom experiences, and teaching relevance.

Application Instructions:

Applications will be received via mathjobs.org only <https://www.mathjobs.org/jobs/list/22007> and must include the following:

- Curriculum vitae
- Research statement
- Teaching philosophy and dossier
- Sample Publications
- Please provide a statement that identifies your strengths in advancing equity, diversity, and inclusion in your discipline and on campus as well as your future plans.

Please indicate in your application if you are currently legally eligible to work in Canada.

Applicants should also arrange for at least two letters of recommendation to be uploaded via mathjobs.org.

About Carleton University

Located in Ottawa, Carleton is an innovative teaching and research institution with a tradition of leading change. Internationally recognized academics, staff, and researchers engage more than 31,000 students in over 100 programs of study. Carleton has long been known for promoting research excellence and connectedness and is involved in partnerships around the globe. With strong leadership, it enjoys a healthy financial position and our proximity to government and cultural institutions, media, and a thriving knowledge economy make Carleton and Ottawa a great place to work, learn, and live. Our picturesque campus is fully accessible and, along with award-winning student services, Carleton's Paul Menton Centre for Students with Disabilities has been heralded as the gold standard for disability support services in Canada. Learn more about [our university and the city of Ottawa](#).

Carleton University is committed to fostering diversity within its community as a source of excellence, cultural enrichment, and social strength. We welcome those who would contribute to the further diversification of our university including, but not limited to: women; visible minorities; First Nations, Inuit and Métis peoples; persons with disabilities; and persons of any sexual orientation, gender identity and/or expression. Furthermore, Carleton understands that career paths vary and interruptions will not prejudice the assessment process. We invite you to review our revitalized Indigenous strategy, [Kinàmàgawin](#) and visit our [Department of Equity and Inclusive Communities](#) for information about our commitment to leadership in the areas of equity, diversity, and inclusion.

Accessibility is a university strategic priority and applicants selected for an interview who require accommodations are invited to contact the Chair as soon as possible to ensure that appropriate arrangements may be made.

All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. All positions are subject to budgetary approval.

Call for Nominations for the 2023 Fellows of the CMS

Calls for Nominations

February 2023 (Vol. 55, No. 1)

The Fellowship recognises CMS members who have made excellent contributions to mathematical research, teaching, or exposition; as well as having distinguished themselves in service to Canada's mathematical community. In exceptional cases, outstanding contributions to one of these areas may be recognized by fellowship.

The CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity and sexual orientation.

Nominations should include a reasonably detailed rationale and be submitted by **March 31, 2023**.

All documentation should be submitted electronically, preferably in PDF format, by the appropriate deadline, to awards-prizes@cms.math.ca

For more information on this award, please visit: <https://cms.math.ca/awards/fellows-of-the-cms/>

Appel de mises en candidature pour les Fellows de la SMC 2023

Le Programme des fellows récompense les membres de la SMC qui ont fait une contribution exceptionnelle aux mathématiques en recherche, en enseignement ou en représentations, tout en se distinguant au service de la communauté mathématique canadienne. Dans des cas exceptionnels, une contribution extraordinaire à l'un des domaines ci-dessous peut être reconnue par un titre de fellow.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs ou les directrices de département et les comités de mise en candidature à proposer des collègues exceptionnels sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle.

Pour les mises en candidature prière de présenter des dossiers avec une argumentation convaincante et de les faire parvenir, le 31 mars 2023 au plus tard.

Veuillez faire parvenir tous les documents par voie électronique, de préférence en format PDF, avant la date awards-prizes@cms.math.ca

Pour de plus amples renseignements sur ce prix, veuillez cliquer: <https://smc.math.ca/prix/fellows-de-la-smc/>

In Memoriam: Pieter Hofstra (1975-2022)

Obituaries

February 2023 (Vol. 55, No. 1)

Richard Blute (University of Ottawa)

Philip Scott (University of Ottawa)



Pieter Hofstra (1975-2022), who passed away suddenly in May, was a mathematician in the Dept. of Mathematics and Statistics at the University of Ottawa. He was a dedicated teacher and a creative and brilliant scientist. Pieter grew up in the Netherlands, where his parents were music teachers and his father a concert pianist. He studied piano from age 3, and continued music throughout his life, mostly jazz piano and guitar. Indeed, while in graduate school, he earned extra money playing jazz in night clubs. He did his graduate work at the University of Utrecht, getting a Master's Degree in Philosophy and then a Phd in mathematics under Jaap van Oosten.

In 2003, shortly after getting his Phd, Pieter came to the University of Ottawa Mathematics Department for a postdoctoral fellowship with the categorical logic group. From 2005-2007 he was a postdoctoral fellow in the Calgary Computer Science Department with Robin Cockett, and then returned to Ottawa in 2007 to take up a full-time position in the Mathematics Department.

Pieter was remarkably gifted in many areas. In his youth, he spent his summers in Switzerland climbing mountains, and maintained his love for serious mountaineering throughout his life. Even as a young student he had a photographic memory, and in graduate school—according to his supervisor—he never took notes of their long discussions, but could remember them in detail. The mathematical logic group at Utrecht had expertise in multiple areas of logic, all of which Pieter rapidly assimilated.

Let us mention just a few of his major scientific works. His Phd thesis was in category theory (specifically topos theory) and abstract recursion theory. He went on to publish a series of increasingly influential papers from his thesis on the foundations of so-called Realizability Toposes. In Calgary, he began a collaboration with Robin Cockett on a category-theoretic approach to computability and complexity theory called Turing Categories, which resulted in a series of important papers laying a new foundation for the subject.

Starting over 10 years ago, Pieter, with Jonathan Funk (CCNY), introduced a new concept: isotropy groups of toposes. This work led to an extensive and influential literature, with contributions by many colleagues and graduate students. Another series of papers in the Funk-Hofstra collaboration examines the foundations of inverse semigroups, groupoids and pseudo-groups via Grothendieck topos theory. Pieter was also interested in higher dimensional categories as well as the developments surrounding Voevodsky's Homotopy Type Theory; in the latter area, he wrote papers with two of the fundamental developers of the subject, Michael Warren and Steve Awodey.

Pieter was a superb, award-winning teacher. A skilled poker player, for many years he taught an extremely popular first-year course called Poker 101, a course which attracted a large audience from all areas of the university. He illustrated the mathematical foundations of such games using vivid real-time presentations; this course led many students from other departments to major in mathematics. He was a lively and appealing lecturer, whom the students adored. His exceptional teaching skills were rewarded when Pieter received the University Of Ottawa Excellence in Education prize.

But more than all of these fine attributes, Pieter was a dear friend who will be missed terribly.