



First Year University Mathematics Across Canada: Facts, Community and Vision . . 10

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CMS NOTES September / septembre 2018 de la SMC

President's Notes / Notes du président

Mark Lewis (*Alberta*)
President - CMS / Président - SMC

Hi!



I am looking forward to serving the Canadian Mathematical Society as President over the coming two years. There are big changes afoot. The biggest is the appointment of a new Executive Director as of September 1, 2018. I am delighted to welcome Dr. Termeh Kousha as the Executive Director of the CMS. She joins us from the University of Ottawa, bringing a very strong background in teaching and mentoring students in mathematics and she is keen to grow into the administrative role that the position provides. I believe Termeh is the perfect person to help lead the CMS forward as mathematics grows in new directions and becomes more diverse in its perspectives and in the groups it serves. I look forward very much to working with her.

Termeh will take over the reins from our current Executive Secretary, Dr. Graham Wright, a longstanding and steadfast supporter of the CMS, first as Executive Director of the CMS from 1979 to 2009 and then as Executive Secretary since 2016. The two will have a period of overlap until the end of December 2018. Graham tells me he now really looks forward to his (second) retirement. However, we will miss Graham tremendously when he steps down; he has provided an incredible level of effective support to the CMS through thick and thin.

The other big news is that we have just undertaken a major shift in the way that the two CMS journals are managed. The Society's journals, the *Canadian Journal of Mathematics* and the *Canadian Mathematical Bulletin*, will now shift from

Bonjour!

C'est avec plaisir que j'assumerai la présidence de la Société mathématique du Canada au cours des deux prochaines années. De grands changements sont en cours, le principal étant l'arrivée d'une nouvelle directrice administrative à compter du 1^{er} septembre 2018. C'est donc avec grand plaisir que je souhaite la bienvenue à M^{me} Termeh Kousha. Rattachée à l'Université d'Ottawa, elle possède une vaste expérience en enseignement et en mentorat d'étudiants en mathématiques, et elle espère évoluer dans le rôle administratif qu'offre le poste. J'estime que Termeh est la personne idéale pour faire progresser la SMC à une époque où les mathématiques évoluent dans de nouvelles directions et où la Société se diversifie sur le plan des perspectives et des groupes qu'elle sert. Je suis impatient de travailler avec elle.

Termeh prendra la relève de notre secrétaire exécutif actuel, Graham Wright, qui travaille pour la SMC depuis de nombreuses années, d'abord en tant que directeur administratif de 1979 à 2009, puis que secrétaire exécutif de 2016 à maintenant. Leurs mandats se chevauchent jusqu'à la fin de décembre 2018. Graham me dit qu'il attend maintenant avec impatience sa (deuxième) retraite. Toutefois, Graham nous manquera énormément à son départ, compte tenu de son apport et de son efficacité incroyables à la SMC à travers vents et marées.

L'autre grande nouveauté est le virage majeur que nous venons d'amorcer quant à la gestion de nos deux revues. En effet, la *Revue canadienne de mathématiques* et le *Bulletin canadien de mathématiques*, que nous éditions nous-mêmes jusqu'à maintenant, seront dorénavant publiés par Cambridge University

The Mathematics of Dry Feet

Robert Dawson, St. Mary's
CMS Notes Editor-in-Chief



Last spring, I worked with a group of Scouts and some other adult leaders to build a bridge across a river. It wasn't a very big river as rivers go; a kilometer away it was spanned by a steel trestle that you could drive across in a few seconds. But we had nothing to work with but wooden poles and rope, and to span twenty meters of fast-running water without dumping people in was quite a challenge. We started planning well ahead of time.

The spars were not big telephone-pole sized logs: those would have needed a crane to put them in place. They were light tapering spruce poles about five meters long, spars that youngsters could carry to the site. Such poles are flexible, and limited in length; no one of them could reach the far side, nor even two of them end to end. Where they joined, they would flex and sag; so either we would have to build several supports mid-river, or we could (as we did) go for a suspension bridge. One heavy cable would be stretched across the river, and the entire bridge would hang from it.

But lashed joints are not rigid. Bracing is heavy, and takes time; and this was only one activity during a busy weekend. So we needed to design the bridge so that its deck would flex in use, without sinking down to river level. That wouldn't be so hard with steel cable, or one of the super-expensive miracle fibers that they use for the rigging of racing yachts - but the inexpensive synthetic-fiber cable that we were hanging the bridge from would stretch in use. This was getting complicated. So what did we do?

Math, of course... Weeks before the first knot was tied, we modeled the whole bridge using MAPLE. With all the joints, it came out as a system of some twelve simultaneous nonlinear equations, modeling flexion, tension, and stretch. At first we used the parameters for polypropylene rope; but we found that the size we had available was too stretchy, and however tight we started it off, it would sag more when loaded and put simulated feet into the simulated water. So we changed to a less-stretchy material that we had access to, and the model was more encouraging. On the day of the camp, when we finally built it, it was a bit floppier than the model predicted, but not much. Basically it looked the way we'd expected.

We told the Scouts about the computer model, but I don't imagine many of them were paying attention: they were too excited about building and crossing it. But we felt much more confident, knowing that the equations predicted success (and dry feet.)

And the equations were right.

La mathématique des pieds secs

Ce printemps, j'ai travaillé avec un groupe de scouts et quelques autres chefs adultes à construire un pont sur une rivière. Et en fait de rivière, celle-là est plutôt large. Un kilomètre plus loin, elle est traversée par un pont sur chevalets d'acier qu'une voiture parcourt en quelques secondes. Nous, en revanche, n'avions que des perches de bois et de la corde pour jeter un pont sur vingt mètres d'eau bouillonnante sans jeter personne dedans. Tout un défi, qui appelait une longue planification.

Les perches n'étaient pas de la taille des poteaux de téléphone, car il aurait fallu une grue. Nous avions choisi des troncs d'épicéa, légers et fuselés d'environ cinq mètres de long, pour que les jeunes puissent les emporter sur le chantier. Aucun de ces troncs flexibles ne faisait toute la largeur de la rivière; même deux mis bout à bout n'auraient pas suffi. Une fois liés ensemble, d'ailleurs, ils se seraient arqués vers le bas, et il aurait fallu les soutenir au centre de la rivière ou (et c'est ce que nous avons fait) opter pour un pont suspendu. Il s'agissait donc de tendre un lourd câble d'un bord à l'autre, d'où pendrait tout le pont.

Par ailleurs, les joints réalisés avec des lanières sont trop mous, et les entretoises, trop lourdes et trop chronophages pour une fin de semaine très chargée. Il fallait donc concevoir le pont de sorte que le tablier plie sous une charge sans toucher l'eau. Pas très difficile avec un câble en acier ou l'une de ces fibres miracle archicoûteuses qu'on utilise pour le gréement des yachts de course, mais le câble auquel nous allions suspendre notre pont, composé d'une fibre synthétique peu coûteuse, s'étirerait à l'usage. L'activité se compliquait.

La solution? Les mathématiques, bien sûr! Plusieurs semaines avant de nouer le premier nœud, nous avons modélisé le moindre détail de l'ouvrage avec Maple. Compte tenu de tous les raccords, le système comportait douze équations non linéaires simultanées exprimant la flexion, la tension et l'étirement. Nous avons d'abord utilisé les paramètres d'une corde de polypropylène, mais avons constaté qu'étant donné son calibre, celle dont nous disposions serait trop extensible. Peu importe la tension de départ, elle s'affaissait sous les pas et trempait nos pieds simulés dans l'eau simulée. Nous avons donc choisi un autre matériau, moins extensible, et le modèle s'est montré plus encourageant. Au jour J, quand nous avons finalement construit notre pont, le résultat était certes un peu plus lâche que prévu, mais pas beaucoup. Notre construction ressemblait assez à ce que nous attendions.

Nous avons expliqué la modélisation à nos scouts, mais j'ai bien peur que peu d'entre eux aient été attentifs : ils étaient trop excités à l'idée de construire le pont et de le traverser. Quant à nous, nous étions bien plus sûrs de nous, sachant que les équations prédisaient le succès de l'entreprise (et promettaient de nous garder les pieds au sec).

Et les équations étaient justes!

Letters to the Editors

The Editors of the NOTES welcome letters in English or French on any subject of mathematical interest but reserve the right to condense them. Those accepted for publication will appear in the language of submission. Readers may reach us at the Executive Office or at notes-letters@cms.math.ca

Lettres aux Rédacteurs

Les rédacteurs des NOTES acceptent les lettres en français ou en anglais portant sur n'importe quel sujet d'intérêt mathématique, mais ils se réservent le droit de les comprimer. Les lettres acceptées paraîtront dans la langue soumise. Les lecteurs peuvent nous joindre au bureau administratif de la SMC ou à l'adresse suivante : notes-lettres@smc.math.ca.

2019 CMS MEMBERSHIP RENEWALS RENOUVELLEMENTS 2019 À LA SMC



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Le renouvellement pour l'an 2019 va commencer bientôt! S'il vous plaît renouveler votre adhésion en ligne dès que possible à portal.cms.math.ca et en vous connectant à votre compte de membre. Si vous avez des questions, s'il vous plaît écrivez-nous à adhessions@smc.math.ca

NOTES DE LA SMC

Les Notes de la SMC sont publiés par la Société mathématique du Canada (SMC) six fois par année (février, mars/avril, juin, septembre, octobre/novembre et décembre).

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Indiquer la section choisie pour votre article et le faire parvenir à l'adresse courriel appropriée ci-dessus.

Les Notes de la SMC, les rédacteurs et la SMC ne peuvent pas être tenus responsables des opinions exprimées par les auteurs.

CMS NOTES

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La Société mathématique du Canada appuie l'avancement, la découverte, l'apprentissage et l'application des mathématiques.

L'exécutif de la SMC encourage les questions, commentaires et suggestions des membres de la SMC et de la communauté.

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The CMS promotes the advancement, discovery, learning and application of mathematics. The CMS Executive welcomes queries, comments and suggestions from CMS members and the community.

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Continued from cover

being self-published to being published by Cambridge University Press. While we have a long history of successful self-publishing, this shift to Cambridge will provide new opportunities, including new expertise and worldwide advertising and promotion for these two flagship journals. We retain ownership of the journals and look forward to a long and productive relationship with Cambridge University Press.

These are exciting times in mathematics. At the time you read this, the International Congress of Mathematics (ICM) will have just been held in Rio de Janeiro, Brazil. This is the premiere mathematical meeting worldwide and is held every four years. There were four invited speakers from Canada at the ICM this year. Closer to home, the XIX International Congress on Mathematical Physics (ICMP) was held in Montreal in July, 2018. The relationship between mathematics and physics is deep and has continued to fascinate researchers since the time of Newton. We have a strong representation of Canadian researchers at the ICMP, and the Canadian Mathematical Society is a major sponsor of this meeting, providing administrative support.

There are many opportunities to highlight connections between mathematics and its applications. The International Congress on Industrial and Applied Mathematics is being held in Valencia, Spain in July 2019. I encourage interested CMS members to consider attending and also to organize mini-symposia for this meeting. The CMS is also finding new ways to connect to the Canadian Applied and Industrial Mathematics Society (CAIMS), our applied mathematics equivalent in Canada. Please stay tuned for more news on this!

One of the largest challenges for research mathematicians is to find sufficient resources to support the training of highly qualified personnel, whether undergrads, graduate students, or postdocs. Funds are tight, and it seems like grants from the Natural Science and Engineering Research Council never go quite far enough. However, there is some good news with respect to overall funding for the basic sciences. NSERC has recently received a significant

increase in funding. We are hoping that this increase in funding will translate into much-needed increases in both the basic Discovery Grant and in funding for the Canadian mathematics institutes.

Canada has much to be proud of with three main Canadian mathematics institutes (CRM, Fields, and PIMS), the associated institute AARMS, and finally the internationally funded Banff International Research Station (with support from the US and Mexico). These institutes are real gems and are the envy of many other countries. They leverage funding in significant ways and support new cutting-edge initiatives. However, these institutes rely crucially on federal support from NSERC, and thus establishing continued strong NSERC funding support for Canada's mathematics institutes is key to the long-term health of Canadian mathematics.

I wish you all a pleasant year ahead and hope it will be a great one for mathematics in Canada. Together we can build and strengthen the Canadian mathematical community. Do not hesitate to contact me if you have ideas you would like to see developed or issues you would like to see discussed. I am happy to talk in person or by email at any time at president@cms.math.ca.

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Suite de la couverture

Press. Bien que nous ayons accompli cette tâche avec brio pendant de nombreuses années, ce passage à Cambridge offrira de nouvelles avenues, dont une nouvelle expertise ainsi que la publicité et la promotion de ces deux revues phares dans le monde entier. Nous conservons la propriété des revues et nous nous souhaitons une relation longue et productive avec Cambridge University Press.

C'est une époque passionnante pour les mathématiques. Au moment où vous lirez ces lignes, le Congrès international des mathématiciens (CIM) viendra de se tenir à Rio de Janeiro, au Brésil. Le CIM est le plus grand rassemblement mathématique au monde et il est organisé tous les quatre ans. Cette année, quatre conférenciers invités du Canada y ont participé. Plus près d'ici, le XIX^e Congrès international de physique mathématique (ICMP) s'est tenu à Montréal en juillet dernier. Le lien est profond entre les mathématiques et la physique et il continue de fasciner les chercheurs depuis l'époque de Newton. Nous avons eu une forte représentation des chercheurs canadiens à l'ICMP, et la SMC était un commanditaire important de ce congrès, car elle a fourni le soutien administratif.

Les occasions sont nombreuses de mettre en évidence les liens entre les mathématiques et leurs applications. Le Congrès international de mathématiques appliquées et industrielles se tiendra à Valence (Espagne) en juillet 2019. J'encourage les membres de la SMC à envisager d'y participer et d'y organiser des mini-symposiums. La SMC cherche également de nouvelles façons de tisser des liens avec la Société canadienne de mathématiques appliquées et industrielles (SCMAI), notre équivalent en mathématiques appliquées au Canada. Restez à l'affût pour plus de détails à ce sujet!

L'un des plus grands défis pour les chercheurs mathématiciens est de trouver des ressources suffisantes pour assurer la formation de personnel hautement qualifié, qu'il s'agisse d'étudiants de premier cycle, d'étudiants diplômés ou de postdoctorants. Les budgets sont serrés, et il semble que les subventions du Conseil de recherches en sciences naturelles et en génie (CRSNG) ne suffisent jamais tout à fait. Nous avons toutefois reçu de bonnes nouvelles concernant le financement général des sciences fondamentales. Le CRSNG a récemment reçu une hausse importante de son financement. Nous espérons que cette hausse se traduira par des augmentations

vraiment nécessaires à la Subvention de base à la découverte et au financement des instituts de mathématiques canadiens.

Le Canada a bien des raisons d'être fier des trois principaux instituts de mathématiques (CRM, Fields et PIMS), de l'institut associé AARMS et de la Station internationale de recherche de Banff (qui reçoit aussi du financement des États-Unis et du Mexique). Ces instituts sont de véritables joyaux et font l'envie de bien d'autres pays. Ils tirent parti du financement de manières significatives et soutiennent de nouvelles initiatives de pointe. Ces instituts comptent toutefois énormément sur l'appui du fédéral par l'entremise du CRSNG, et l'établissement d'un soutien financier solide et continu du CRSNG pour les instituts de mathématiques du Canada est donc essentiel à l'essor à long terme des mathématiques canadiennes.

Je vous souhaite une année agréable et j'espère que ce sera une excellente année pour les mathématiques au Canada. Ensemble, nous pouvons bâtir et renforcer la communauté mathématique canadienne. N'hésitez pas à communiquer avec moi si vous avez des idées ou des problèmes à soulever ou dont vous aimeriez discuter. Je serai ravi de discuter avec vous en tout temps, en personne ou par courriel à president@smc.math.ca.

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The Calendar brings current and upcoming domestic and select international mathematical sciences and education events to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Denise Charron, Canadian Mathematical Society,
(managing-editor@cms.math.ca)

Le calendrier annonce aux lecteurs de la SMC les activités en cours et à venir, sur la scène pancanadienne et internationale, dans les domaines des mathématiques et de l'enseignement des mathématiques. Vos commentaires, suggestions et propositions sont le bienvenue.

Denise Charron, Société mathématique du Canada
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SEPTEMBER 2018 SEPTEMBRE

2-7	BIRS Workshop: Tau Functions of Integrable Systems and Their Applications , BIRS, Banff, Alta.
8-18	Fields-CRM Faces of Integrability Conference, CRM, Montreal, Que.
9-14	BIRS Workshop: Geometry and Physics of Quantum Curves , BIRS, Banff, Alta.
10-14	CRM Conference: Aisenstadt Chair: Robert Seiringer , CRM, Montreal, Que.
10-14	CRM Workshop: Many-Body Quantum Mechanics , CRM, Montreal, Que.
12	CRM Conference: « The Discrete Charm of Geometry » Grande conférence de Alexander Bobenko, CRM, Montreal, Que.
16-21	BIRS Workshop: Affine Algebraic Groups, Motives and Cohomological Invariants , BIRS, Banff, Alta.
17-21	CRM Workshop: Entanglement, Integrability and Topology in Many-Body Systems , CRM, Montreal, Que.
17-21	Blockchain Technology Symposium (BTS' 18) - from Hype to Reality, The Fields Institute, Toronto, Ont.
17-Oct 14	Algebra and Combinatorics at LaCIM, CRM, Montreal, Que.
20-23	PIMS Workshop on stochastic and deterministic modelling with PDEs, Palisades Stewardship Education Centre, Jasper, Alta.
23-28	BIRS Workshop: The Traveling Salesman Problem: Algorithms & Optimization , BIRS, Banff, Alta.
24-28	Statistical Inference, Learning and Models in Data Science, The Fields Institute, Toronto, Ont.

OCTOBER 2018 OCTOBRE

Sept 30-5	BIRS Workshop: Spin Glasses and Related Topics , BIRS, Banff, Alta.
1-5	Women in Academic Leadership , Inn at The Forks, Winnipeg, Man.
3-5	CRM-PCTS Workshop: Critical Phenomena in Statistical Mechanics and Quantum Field Theory , Princeton University, Princeton, U.S.A.
7-12	BIRS Workshop: Moduli Spaces: Birational Geometry and Wall Crossings , BIRS, Banff, Alta.

14-19	BIRS Workshop: Fusion Categories and Subfactors , BIRS, Banff, Alta.
15-19	CRM Workshop: Quantum Information and Quantum Statistical Mechanics , CRM, Montreal, Que.
19	PIMS UBC-Math Distinguished Colloquium: Jeremy Quastel , University of British Columbia, Vancouver, BC
21-26	BIRS Workshop: Crossing Numbers: Theory and Applications , BIRS, Banff, Alta.
21-26	BIRS Workshop: Hessenberg Varieties in Combinatorics, Geometry and Representation Theory , BIRS, Banff, Alta.
22-26	Workshop on Dynamics and Moduli Spaces of Translation Surfaces, The Fields Institute, Toronto, Ont.
	BIRS Workshop: Intersection of Information Theory and Signal Processing: New Signal Models, their Information Content and Acquisition Complexity , BIRS, Banff, Alta.
28-Nov 2	CRM Workshop: Entropic Fluctuation Relations in Mathematics and Physics , CRM, Montreal, Que.

NOVEMBER 2018 NOVEMBRE

4-9	BIRS Workshop: WOA: Women in Operator Algebras , BIRS, Banff, Alta.
5-9	2018 Fields Medal Symposium, The Fields Institute, Toronto, Ont.
9	Putting Women Into the Equation: Changing Dynamics in Research , The Fields Institute, Toronto, Ont.
10-11	ABC Algebra Workshop, University of Washington, Seattle, U.S.A.
11-16	BIRS Workshop: Mathematical and Statistical Challenges in Bridging Model Development, Parameter Identification and Model Selection in the Biological Sciences , BIRS, Banff, Alta.
12-16	CRM Workshop: Spectral Theory of Quasi-Periodic and Random Operators , CRM, Montreal, Que.
18-23	BIRS Workshop: Unifying Themes in Ramsey Theory , BIRS, Banff, Alta.
25-30	BIRS Workshop: Model Theory and Operator Algebras , BIRS, Banff, Alta.

DECEMBER 2018 DÉCEMBRE

7-10	2018 CMS Winter Meeting/Réunion d'hiver de la SMC 2018, Sheraton Vancouver Wall Centre, Vancouver, B.C.
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Book Reviews brings interesting mathematical sciences and education publications drawn from across the entire spectrum of mathematics to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

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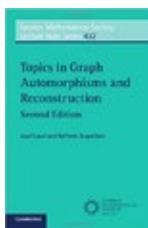
Topics in Graph Automorphisms and Reconstruction, 2nd Ed.

by Josef Lauri and Raffaele Scapellato

Cambridge University Press, 2016

ISBN: 978-1316610442

Reviewed by *Wendy Myrvold*, University of Victoria



This book is geared towards graduate students and researchers who plan to do research related to graph symmetry or the reconstruction problem. It includes basic graph and group definitions. However, in order to get the full benefit from this book, it would help to already have a strong foundation in basic graph theory and group theory, since the basics are presented quickly without many examples.

Chapters 2-4 discuss symmetry in graphs and give important theorems regarding symmetry properties of both graphs and digraphs. Cayley graphs are a well-studied class of graphs that are constructed from groups. Some of their properties are covered in Chapter 3. Strongly regular graphs are another well-studied class of graphs that are included in this chapter.

The reconstruction conjecture states that each graph on three or more vertices can be determined uniquely up to isomorphism from its collection of vertex deleted subgraphs (*cards*). The edge reconstruction conjecture states that each graph on three or more edges can be determined uniquely up to isomorphism from its collection of edge deleted subgraphs. Reconstruction problems have been called graphical diseases, and are intriguing open problems in graph theory. Early researchers made significant progress on these problems, but many of the proofs were tedious case by case analyses. This book focuses instead on more general tools for tackling the problem such as counting arguments whose use or generalization could potentially lead to progress on these conjectures. Two vertices u and v of a graph G are *pseudosimilar* if $G-u$ is isomorphic to $G-v$, but there is no automorphism of G that maps u to v . The study of pseudosimilarity has led to insights into the graph reconstruction problem. Chapter 5 surveys what is known about this (and also edge pseudosimilarity). If the reconstruction conjectures are not true, this topic is likely to provide clues as to how to construct a counterexample.

My personal thought is that understanding symmetry is going to be critical for a researcher who wants to make major progress on one of the reconstruction conjectures. If G and H have the same cards then there have to be isomorphisms that map the induced subgraphs on

Les comptes-rendus de livres présentent aux lecteurs de la SMC des ouvrages intéressants sur les mathématiques et l'enseignement des mathématiques dans un large éventail de domaines et sous-domaines. Vos commentaires, suggestions et propositions sont les bienvenus.

Karl Dilcher, Dalhousie University (notes-critiques@smc.math.ca)

$n-1$ vertices to each other, and understanding symmetry might aid a researcher to either discover how this could happen or to prove that it cannot happen unless G and H are isomorphic to each other. It should be noted however that the graphs with the most symmetry are actually amongst the easiest to reconstruct since they are regular graphs.

This book does an excellent job of bringing together powerful tools that might be useful for future research. Sometimes proofs are included, but in other cases where the proofs are long and tedious, just the results are stated. A researcher with these results in his or her toolbox is going to be well-positioned for making future research progress. The aim of the book seems to be to make sure that researchers have an awareness of some of the most critical results in these topics. I think that this book would be well-suited for a graduate course. I suspect, though, it would be too dense for most undergraduate students.

An Introductory Course in Lebesgue Spaces

By René Erlin Castillo and Humberto Rafeiro

CMS Books in Mathematics, Springer, 2016

ISBN 978-3-319-30034-4

Reviewed by *Mehdi S. Monfared*, University of Windsor



The L_p -spaces consisting of functions f such that $|f|^p$ is integrable, were introduced by Riesz [8], where "L" was apparently a homage to Lebesgue (hence the title of this book). These spaces serve as a good example of the applications of Lebesgue integration, and have been a subject of continued interest among mathematicians, statisticians and physicists. The book under review is a detailed study of L_p -spaces and its various descendants: $L_{(p,\infty)}$, $L_{(p,q)}$, $L_1 + L_\infty$, $L \exp$, $L \log L$, variable exponent, and grand Lebesgue spaces. Typical properties discussed are normability, estimations of norms, denseness, completeness, duality, separability and embeddings. With the exception of section 8.1 (Riesz–Thorin interpolation) the emphasis of the book is on real analysis (as a result, Hardy spaces H^p are not discussed). Inequalities play an essential role in this subject, and those proved in the book include Hölder, Jensen, Minkowski, Hardy, Hilbert, Chebyshev, Markov, Young, Hausdorff–Young, Kolmogorov, and Lyapunov's inequalities. The prerequisites for reading this book are Lebesgue integration and elementary functional analysis. There is a great deal of material in the eleven chapters of this book, so I will limit myself to a very brief description of each chapter.

Chapter 1 has a preliminary nature and contains a discussion of convex functions and Young and Jensen's inequalities.

Chapter 2, Lebesgue sequence spaces, is a prelude to Chapter 3, where L_p -spaces are discussed in their general settings. So there is an inevitable overlap between these two chapters. As an example of results in Chapter 2, I will mention Hardy's beautiful result that if $\{a_n\}$ is a sequence of positive numbers in $\ell_p(\mathbb{N})$, $1 < p < \infty$, so is the sequence of arithmetic means of its terms, and moreover

$$\sum_{n=1}^{\infty} \left(\frac{1}{n} \sum_{k=1}^n a_k \right)^p \leq \left(\frac{p}{p-1} \right)^p \sum_{n=1}^{\infty} a_n^p.$$

An integral version of this result is proved in Chapter 3. In addition to standard topics, Chapter 3 includes discussions of weighted Lebesgue spaces, uniform convexity, Lamperti's theorem on isometries of L_p , and L_p -spaces for $0 < p < 1$. Also, logarithmic convexity of the gamma function is derived as an application of Hölder's inequality.

Chapter 4 is a study of the distribution function D_f of a measurable function f , and the associated decreasing rearrangement f^* and the (Muirhead) maximal function f^{**} . The last section of this chapter deals with the rearrangement and the maximal functions of the Fourier transform \hat{f} .

Chapter 5 deals with the weak Lebesgue spaces $L_{(p,\infty)}$ consisting of functions f such that $\|f\|_{(p,\infty)} := \sup_{\lambda>0} \lambda(D_f(\lambda))^{1/p} < \infty$. Both L_p and $L_{(p,\infty)}$ are special cases of a two parameter family of spaces $L_{(p,q)}$, $1 \leq p, q \leq \infty$, such that $L_p = L_{(p,p)}$. These spaces, introduced by Lorentz [5], [6], are the subjects of Chapter 6.

Variable exponent Lebesgue spaces [7], and grand Lebesgue spaces [2] are subjects of Chapter 7. These subjects are still being developed and are currently of great interest in this field.

Chapters 8–11 form a selection of topics from harmonic analysis in the Euclidean spaces: interpolation of operators, Hardy–Littlewood maximal operator (studied in classical setting and in other Lebesgue spaces), integral operators, convolution of functions, and potentials.

The book has five appendices, providing background on integration, functional analysis, Eulerian integrals, Fourier transform, and a list of Greek letters. Each chapter ends with a set of exercises and brief bibliographic notes. The proofs are generally detailed and aimed at graduate students. Numerous examples in the book add to its usefulness for students.

Strong features of this book are its organization and presentation of material. These are of course very important for a book that is intended to be used both as a text for graduate students and a reference for researchers. Most of the misprints that I encountered are easily identifiable by an attentive reader (like those in the last line of page 1, in the statement of Theorem 1.2, and in the first line of its proof). Three times in section 3.5 we find that L_p -spaces are reflexive for $1 \leq p < \infty$ (which is of course wrong for $p = 1$). Hardy's inequality (3.40), as it stands, holds only for positive functions. In some references (e.g., [19], [32], [40]) the date of

publication appears twice. The reference [44] is a duplication of [43]. However, setting aside these quibbles, I may add that the proof of the completeness of $L_p(X)$ in Theorem 3.29, depends on results proved later in Chapter 5. I would have preferred a more direct proof, leaving the current proof as an application of material in Chapter 5. Chapter 11 has a discussion of Radon–Nikodym theorem which seems out of place in a book like this (even though the proof uses the properties of L_2 -spaces). The Hardy–Littlewood–Sobolev inequality is relegated to problems in Chapter 8, and in particular, Lieb's result [4] on the sharp constant of this inequality is not mentioned.

Harmonic analysis is a vast and multifaceted subject. The book [10], with its 880 references, is an exposition close to the outlook of this book. But Lebesgue spaces have influenced the development of harmonic analysis beyond Euclidean spaces (cf., [9]). A strong trend of researches in the last five decades has been connected to the Fourier algebra $A(G)$, and the convolution operators on $L_p(G)$, for G a locally compact group. For more on these topics we refer to [1] and [3], and the references therein.

The book under review is printed on high quality paper and bound in the beautiful cover of the CMS Books in Mathematics. With its choice of topics and detailed treatment of the subject, the book is a welcome addition to the literature on Lebesgue spaces. I recommend it to all graduate students and researchers interested in this fascinating subject.

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2018 CMS Winter Meeting

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

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First Year University Mathematics Across Canada: Facts, Community and Vision

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Andie Burazin (*University of Toronto Mississauga*)

Kseniya Garaschuk (*University of the Fraser Valley*)

Veselin Jungic (*Simon Fraser University*)

Miroslav Lovric (*McMaster University*)

Canada's university mathematical teaching community is facing a number of significant challenges and opportunities: from managing increasingly diverse classes of incoming students to understanding and dealing with the impact of contemporary technology on teaching and delivering courses, to keeping the content of mathematics courses relevant to various academic programs and, most importantly, to efficiently supporting students to achieve their personal, academic, and career goals. Furthermore, the changing landscapes in post-secondary education witness evolving knowledge about best practices for teaching, such as active learning approaches, high failure and withdrawal rates in first-year mathematics classes, as well as students' uncertainties about the benefits of learning mathematics for their future careers.

Between April 27th-29th, 2018, the Fields Institute hosted the *First Year University Mathematics Across Canada: Facts, Community and Vision* conference, referred to as "the conference" in this article. Here as the conference organizers, we summarize the main events from three fruitful days of discussions and experience sharing.

The conference was another iteration in the ongoing national dialogue about teaching first-year mathematics at Canadian universities. Previous events included the *Teaching First Year Mathematics Courses in Transition from Secondary to Tertiary* working group at the 2017 CMESG conference at McGill University and the *Rethinking First Year Experience* session at the Winter 2017 CMS Meeting at the University of Waterloo. In this context, we also mention the Oct/Nov 2017 publication in *CMS Notes* entitled *Call for National Dialogue: The Present and Future of Teaching First Year Mathematics at Canadian Universities* (by V. Jungic and M. Lovric).

Although first-year issues have been receiving national attention in recent years, the *First Year University Mathematics Across Canada: Facts, Community and Vision* conference (subsequently referred

Les Notes pédagogiques présentent des sujets mathématiques et des articles sur l'éducation aux lecteurs de la SMC dans un format qui favorise les discussions sur différents thèmes, dont la recherche, les activités et les nouvelles d'intérêt. Vos commentaires, suggestions et propositions sont les bienvenus.

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to as *the conference*) appears to have been the first of its kind. The conference was supported by a General Scientific Activity grant from the Fields Institute and contributions from our publishing sponsors, Nelson Education and Pearson.

There were 73 registered conference participants. The vast majority of them were post-secondary mathematics teaching practitioners (i.e., graduate students, contract/sessional faculty, teaching faculty, and research faculty) from eight Canadian provinces. Other participants came from outside of Canada (USA and Chile) or as representatives from MAPLE and the two participating publishers (Nelson Education and Pearson).

About 40% of the conference participants were female. This percentage reflects the fact that at the university level a large group of female mathematicians are involved in teaching lower division courses. This also validates the claim that to reduce the gender gap in mathematics, the Canadian mathematical community needs to truly recognize and value teaching at a higher degree than that at present. By giving teaching the same importance as research, making teaching positions permanent and job secure, and ensuring pay equity, Canada will see more women in mathematics! We said "see," because the female members of the Canadian teaching community appear to be invisible in most statistics including women in mathematics.

The conference audience was quite young as reflected by participation of nine graduate students and thirty-six others with recent Ph.D. degrees, i.e., defended over the past ten years. As a result, a large number of conference participants were in relatively junior positions in their departments. Yet, they do extremely important work – they teach courses at crucial moments when students make decisions to pursue mathematics; they interact with a large number of students and make important pedagogical decisions; they innovate when possible, and are energetic, motivated, and extremely hard working. And still, they are not often recognized for their contributions within their departments. Many are on contracts from year-to-year or have limited-term positions at multiple institutions. All of them have very limited opportunities (e.g., grants) to support their innovations. They carry out a large amount of work basically for free, driven only by their personal commitment to their students and their own passion for mathematics.

The conference began late afternoon on Friday, April 27. After the welcoming remarks from the Fields Institute's Deputy Dr.

Huaxiong Huang, the first keynote speaker – Dr. Peter Taylor from Queen's University – addressed the audience. Peter Taylor is one of the most prominent, long-time leaders in the Canadian mathematics teaching community. In his excellent presentation, he reflected on the changes in the ways first-year mathematics courses had been taught. His comparison between the textbook that he used as a student and the modern calculus textbooks was particularly memorable.

Peter Taylor commented on a troubling aspect of Calculus – applications, often referred to as “real-life” applications, even when it is absolutely clear that there is no real life in them. Calculus textbooks are full of artificial, “ready-to-use” problems (like most problems in the related rates or optimization sections) that typically require very little in terms of reasoning and problem-solving, but rather emphasize applying known algorithms (for computing derivatives, finding extreme values, integration, and so on). Another issue that was illustrated with a problem about ventilation during intensive care is that Calculus instructors do not devote (or cannot afford to devote) sufficient time in developing necessary background (in biology, chemistry, and otherwise). Without such background, guidance, and “feel” coming from it, even a true-life problem remains superficial.

The introductions and the keynote were followed by a reception in a nearby pub. As always, free food and a beverage were unifying factors for this quite diverse group of conference participants. The reception provided a space for socializing and getting to know each other, which the conference organizers felt was an important objective. Throughout the conference, lengthy coffee/refreshment breaks and lunch breaks were planned to continue the conversations.

The Saturday session started with a short introduction of the “First Year Math Courses in Canada Repository” (firstyearmath.ca). This shareable dynamic online database contains extensive data about first-year courses as collected from mathematics instructors across Canada. Data includes: course content; resources, and technology used; learning outcomes; modes of delivery; connections with other



courses; as well as informal descriptions of various practices in teaching these courses.

The Repository is built on the premise that only by experience sharing, data gathering, and looking at research-based decisions and strategies, our mathematical teaching community can come up with ideas and initiatives for university faculty and instructors. The hope is that information from the database will spark ideas for possibly restructuring programs and responding to the demands of today's realities placed on us, math instructors, and our students. It should be mentioned that the Repository is a grassroots initiative led by Veselin Jungic and Miroslav Lovric, in part supported by the Fields Institute, Simon Fraser University, McMaster University, and the EDC Grants for Exchange.

At the conference, or prior to it, every participant was granted access to the Repository. To familiarize the participants with the database, they were randomly assigned to one of ten working groups: *Teaching Linear Algebra; Global View of Courses; Teaching Strategies; Teaching Materials; Curriculum Across Universities; Calculus Content Across Universities; Computer Science Courses; ‘Outlier’ Courses; Patterns in Assessment Methods; and State of Math and the Present Work Force*. Each group was instructed to search the database and to discuss their findings. All participants were also encouraged to share their own relevant experiences and practices during the group activities.

To provide a (loose) framework for the working group discussions, the organizers provided each group with several “possible questions to explore.” For example, the *Calculus Content Across Universities* group members were prompted to explore the following questions:

- 1) What are the differences in calculus courses offered to students from different disciplines (e.g., students in engineering, physical, biological and/or economical sciences)?
- 2) Which universities divide the study of calculus into two or more terms? Which ones impart it as a single course? What are the advantages and disadvantages of each approach?
- 3) What is the prevalence of pre-calculus courses across universities?
- 4) What is the percentage of universities that have calculus courses as a prerequisite for upper division courses?

Groups had pre-assigned leaders who moderated activities and reported on their group's discussion in the afternoon plenary session.

In general, our feeling was that the Repository passed its first big test. There were no crashes. All different types of searches occurred smoothly and simultaneously, with no signs of lower speed of access due to the heavier usage. Participants were able to find (or not – that was also part of the learning experience) information they were looking for. They provided the database management team with useful feedback on the content and functionality of the database. More importantly, a consensus was reached among all participants that having this kind of database might be useful both for individual teaching practices and institutional planning



processes. Needless to say, the Repository was a hit with the representatives of textbook publishers (Nelson and Pearson).

The second keynote speaker was Dr. Jamie Mulholland from Simon Fraser University, one of the rising stars in the Canadian mathematics education community. As part of his presentation, Jamie Mulholland invited the audience to participate in a breadth-first-search algorithm *in-class* activity. He randomly distributed several cards and asked the cardholders to read aloud the content of their cards at the appropriate stage of the exercise. He used the blackboard to manage, guide, and record the procedure. At one point, Dr. Mulholland very skillfully avoided a request from the audience to define what the breadth-first-search was. It turned out that enough participants were familiar with the algorithm to enable us playing along as a group. Upon completion of the activity, all present knew how the breadth-first-search algorithm worked.

During the last session of the day, the group leaders reported on their working group's activities. To give the reader at least a taste of the group discussions and their findings, we offer excerpts from both the *Calculus Content Across Universities* and '*Outlier*' Courses working group reports.

While addressing the question "What are the differences in calculus courses offered to students from different disciplines?" the group summarized their findings in the Repository in the following way:

- Universities vary greatly: Some are very specific. For example, the University of Waterloo offers a (single semester, terminal) calculus course entitled "Mathematics for Accounting"; and some offer broad streams, like UBC's MATH 100 - Differential Calculus with Applications to Physical Sciences and Engineering, and MATH101 – Integral Calculus with Applications to Physical Sciences and Engineering that serve as prerequisites for other courses in multiple academic programs.
- Most common thing is that it is the same content regardless of disciplines, i.e., covering the same topics such as integration, Taylor series, introduction to differential equations (sometimes), parametric equations (sometimes), etc. Also, a standard class textbook: Stewart Calculus.
- Engineering calculus classes may cover double what the standard course does.

- Advanced calculus courses for math and statistics specific students offer much more of a theoretical and real analysis perspective to accompany (i.e., in addition) the standard calculus.
- Most bigger universities have much more different disciplines (wider variety) based on resources and the number of their students to offer.

At the other end of the spectrum - we asked participants to identify 'outlier' courses, i.e., the courses which are in some way unique (in terms of content, or based on the fact that only one, or possibly a very small number of universities offer it). Among the group's findings, we read:

- Many universities across Canada offer some 'outlier' course, such as a math course for teachers, a course on numeracy and useful mathematics called "Numbers for Life," "Mathematical Sciences and the Modern World," "Insights in Mathematics," "Math and Art," and so on.
- 'Outlier' courses are used as breadth requirements that help to build confidence, and can act as outreach or a bridge to help people develop an appreciation for mathematics.
- 'Outlier' courses are, in many cases, highly personalized, i.e., instructor-dependent. In the absence of these instructors, these courses could be (and are) difficult to maintain and staff.

Following the working groups' reports, key ideas were identified and posted throughout the room for participants to vote on using a DOTmocracy approach. This was a great way to conclude a long day of discussions and activities, and socialize some more.

The Sunday session began with a summary of our DOTmocracy activity. The "top five" items from our "vote" on Saturday were:

- accessibility of learning resources
- active learning from both students' and instructors' perspectives
- collaboration/cooperation with other departments
- assessments as a crucial component of the education process, and
- student (math) maturity.

Somewhat surprisingly, the item "Consistency of descriptions and course content and topics" ended up at a very modest 15th place. However, statements like "Teaching materials should be open and free to all" and "Cooperation between departments when designing and imparting interdisciplinary courses" ranked highly, which expressed wishful thinking rather than conference participants reflecting on the reality of the environment that we all work in.

Very strong feelings against the commercialization of learning resources were explicitly expressed during our discussion about the rankings of the items. Equally strong feelings were expressed against the move towards open source resources, because those creating learning resources need to be rewarded and production of high-quality materials should continue.

Also, one of the participants stated that the rankings (and the conference up to that point) were dominated by the practices,

approaches, and challenges of “big” universities. This was, in our opinion, a fair and important concern and something that we should be more sensitive to moving forward. We believe that it is the responsibility of the whole Canadian mathematics community to ensure that our colleagues from smaller universities have a chance to voice their concerns. We have to remind ourselves that discussions about the present and the future of teaching mathematics at the post-secondary level include challenges and experiences of all universities, in particular the issues within smaller universities can differ quite a bit from the (often heard) problems of a large, research-intensive university.

It should be mentioned that the representatives of the two publishers, Pearson and Nelson, gave short but informative presentations about their views on their current and future contributions to teaching mathematics at the post-secondary level. The particularly intriguing information was the acknowledgment that some of the post-secondary institutions had engaged in discussions with the publishers about a new business model in which the cost for the commercial learning resources would be part of student's tuition. Interestingly, it was also mentioned how the future of these educational publishing companies may be moving more towards their online homework systems and away from traditional textbooks.

The remainder of the conference was a true celebration of the devotion of attendees to our students and mathematics. At the conference opening, participants were invited to sign up for five-minute presentations on any topic related to teaching mathematics. There were 28 spots that filled up quickly. The topics ranged from the importance of the language used with our students to re-envisioning the class structure to a demonstration of math magic. To witness the talent, knowledge, and passion for teaching mathematics was more than exciting and very encouraging. The future of the art of teaching mathematics at the post-secondary level in Canada is in good hands!

It is important to mention that when we (Canadian math community, and in particular, those in positions of power) think about research in mathematics, we must include research in mathematics education. As well, we must support creation of (more) permanent teaching positions. We have seen many talented, excellent, math teachers who are unable to find tenure track positions which would recognize their skills and who are stuck teaching a heavy load with inadequate compensation.

With great certainty, the next iteration of the conference will be held at the University of Alberta in Edmonton at the end of April 2019. We are discussing possible themes of the April 2019 conference. At this point, we have two ideas: the practice of assessment in first-year math courses across Canada and the transition from secondary to post-secondary mathematics. We promise to give a more prominent voice to our colleagues from smaller universities, whose problems and challenges are often placed in the background, after those of large, research-intensive universities.

We were very happy to have three undergraduate student volunteers: Katie Chiasson (McMaster University), Olivia Eppelbaum

(McMaster University), and Laura Gutierrez-Funderbunk (Simon Fraser University). Being actively involved in and contributing significantly to all aspects of the conference, they were lot more than volunteers.

We thank the Fields Institute, in particular Esther Berzunza and June Rockwell, for their help in organizing the April 2018 conference.

To finish this summary, we quote one of the conference participants: “It felt like a community I have been seeking for a long time.” We were really happy to hear an acknowledgement that we have succeeded in building/strengthening university mathematics teaching community.



Appointment of CMS Executive Director

Dr. Mark Lewis (Alberta), president of the CMS is pleased to announce the appointment of Dr. Termeh Kousha effective September 1, 2018.

"I am delighted to welcome Dr. Termeh Kousha as the Executive Director of the CMS. I believe Termeh is the perfect person to help lead the CMS forward as mathematics grows in new directions and becomes more diverse in its perspectives and in the groups it serves. I look forward very much to working with her."

Dr. Termeh Kousha completed her undergraduate studies in Pure Mathematics at the Tehran Polytechnic University in 2004. In 2005, she moved to Canada to pursue graduate studies at the University of Ottawa. After receiving her Ph.D. in Mathematics in 2012, she received an NSERC Visiting Fellowship post-doc from Health Canada. In 2014, she accepted an offer from University of Ottawa to be an Assistant (replacement) Professor. Since her appointment to the Department of Mathematics and Statistics, she has supervised graduate and undergraduate students, advising them on their course choices and directing their theses and projects. Dr. Kousha has also been the course coordinator for a variety of courses in both English and French. Dr. Kousha has received excellent feedback and evaluations from the students during last 8 years, which keep her motivated to continue the great work.

Moreover, she has served on the Faculty of Science committee on Academic Standing and Academic Fraud (CAS) since 2014. Since her graduation, Dr. Kousha has been an active researcher. Over and above her teaching duties, Dr. Kousha has continued her collaboration with Health Canada and University of Ottawa researchers, and has published a total of 17 papers in applications of Statistics to Health Sciences and Epidemiology.

It has been her pleasure to participate in the CMS Math Camps at the University of Ottawa as a counselor and lecturer since 2007 and she is looking forward to the exciting challenges of her new position as Executive Director of the Canadian Mathematical Society.

Dr. Graham Wright will remain at the Society until the end of the year to provide guidance and history for a smooth transition during the initial few months of Dr. Kousha's appointment.



Nomination de la directrice administrative de la SMC

Mark Lewis (Alberta), président de la SMC, est heureux d'annoncer la nomination de Mme Termeh Kousha, qui occupera le poste de directrice administrative à compter du 1^{er} septembre 2018.

« C'est avec grand plaisir que je souhaite la bienvenue à notre nouvelle directrice administrative, Mme Termeh Kousha. J'estime que Termeh est la personne idéale pour faire progresser la SMC à une époque où les mathématiques évoluent dans de nouvelles directions et où elle se diversifie sur le plan des perspectives et des groupes qu'elle sert. Je suis impatient de travailler avec elle. »

Mme Termeh Kousha termine ses études de premier cycle en mathématiques pures à l'Université polytechnique de Téhéran en 2004. L'année suivante, elle arrive au Canada pour poursuivre des études supérieures à l'Université d'Ottawa. Après avoir obtenu son doctorat en mathématiques en 2012, elle reçoit de la part de Santé Canada une bourse de recherche scientifique postdoctorale du CRSNG. En 2014, elle accepte une offre de l'Université d'Ottawa comme professeure adjointe remplaçante. Depuis sa nomination au Département de mathématiques et de statistique, elle encadre des étudiants diplômés et de premier cycle, elle les conseille sur leurs choix de cours et dirige leurs thèses et projets. La professeure Kousha a également coordonné plusieurs cours en anglais et en français. Elle a reçu d'excellents commentaires et évaluations de la part des étudiants au cours des huit dernières années, ce qui la motive à poursuivre son excellent travail.

De plus, elle siège au comité responsable du statut universitaire et de la fraude de la Faculté des sciences depuis 2014. La professeure Kousha est une chercheuse active depuis la fin de ses études. Outre ses tâches d'enseignement, elle poursuit sa collaboration avec des chercheurs de Santé Canada et de l'Université d'Ottawa. Elle a publié 17 articles sur des applications de la statistique aux sciences de la santé et à l'épidémiologie.

Elle participe avec plaisir aux camps de mathématiques de la SMC à l'Université d'Ottawa en tant que conseillère et enseignante depuis 2007 et elle attend avec enthousiasme de relever les défis stimulants de son nouveau poste de directrice administrative de la Société.

Graham Wright restera à la SMC jusqu'à la fin de l'année pour la conseiller et lui transmettre ses connaissances de l'organisation afin d'assurer une transition en douceur au cours des premiers mois de son mandat.

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The Canadian Mathematical Society is pleased to announce the *2018 Endowment Grants Competition*. The CMS Endowment Grants fund projects that contribute to the broader good of the mathematical community. Projects funded by the Endowment Grants must be consistent with the interests of the CMS: to promote the advancement, discovery, learning and application of mathematics.

An applicant may be involved in only one proposal per competition as a principal applicant. Proposals must come from CMS members, or, if joint, at least one principal applicant must be a CMS member.

The deadline for applications is **September 30, 2018**. Successful applicants will be informed in January 2019 and the grants issued in February 2019.

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The Endowment Grants Committee (EGC) administers the distribution of the grants and adjudicates proposals for projects. The EGC welcomes questions or suggestions you may have on the program. Please contact the Committee by e-mail at chair-egc@cms.math.ca.

Appel de projets : Concours de bourses du fonds de dotation 2018

La Société mathématique du Canada (SMC) est heureuse d'annoncer la tenue du *Concours de bourses du fonds de dotation 2018*. Les bourses du fonds de dotation de la SMC finance des activités contribuant à l'essor global de la communauté mathématique. Les projets financés à partir des bourses du fonds de dotation doivent correspondre aux intérêts de la SMC : soit promouvoir et favoriser la découverte et l'apprentissage des mathématiques, et les applications qui en découlent.

Un demandeur ne peut présenter qu'un projet par concours en tant que demandeur principal. Les projets doivent venir de membres de la SMC. S'il s'agit d'un projet conjoint, au moins un des demandeurs principaux doit être membre de la SMC.

La date limite pour présenter sa demande est le **30 septembre 2018**. Les projets retenus seront annoncés en janvier 2019, et les bourses distribuées en février 2019.

Pour vous procurer un formulaire ou pour de plus amples renseignements sur l'appel de projets, passez sur le site de la SMC au : www.smc.math.ca/Grants/EGC/f

Le Comité d'attribution des bourses du fonds de dotation (CABFD) gère la répartition des bourses et évalue les projets. Pour toute question ou tout commentaire sur les bourses du fonds de dotation, veuillez communiquer par courriel avec le comité à pres-egc@smc.math.ca.



Research Notes brings mathematical research ideas forth to the CMS readership in a generally accessible manner that promotes discussion of relevant topics including research (both pure and applied), activities, and noteworthy news items. Comments, suggestions, and submissions are welcome.

Patrick Ingram, York University (notes-research@cms.math.ca)

Measuring the Complexity of Mathematical Objects

Matthew Harrison-Trainor,

What does it mean for a mathematical object to be complicated or simple? By a mathematical object, we mean such things as algebraic objects such as groups, rings, or fields, combinatorial objects such as graphs, trees, or linear orders, or analytic objects such as separable complete metric spaces. Formally, these are all examples of *structures*: an underlying domain together with functions, relations, and distinguished constants. It seems obvious that a finite dimensional vector space is relatively simple, while for example some graphs can be very complicated, but how can one make this rigorous and prove theorems about complexity?

For finite objects, this is the domain of complexity theory. For objects which are uncountable, this is the domain of descriptive set theory. Our focus will be on countable objects, where this is the domain of computable structure theory.

One measure of the complexity of a structure is the complexity of describing it (up to isomorphism). Scott [7] showed that every countable structure has a description which can be written down in the infinitary logic $\mathcal{L}_{\omega_1\omega}$. This logic is an extension of elementary first-order logic which allows countably infinite conjunctions and disjunctions. To understand what follows, it will not be important to have a formal definition of this logic, but to just have some kind of intuition. As an example, the countably infinite-dimensional \mathbb{Q} -vector space can be described by the vector space axioms together with the following sentence, which we write here in natural language but which can be expressed in $\mathcal{L}_{\omega_1\omega}$:

for all n , there are x_1, \dots, x_n such that for all $r_1, \dots, r_n \in \mathbb{Q}$
if $r_1x_1 + \dots + r_nx_n = 0$ then some $r_i = 0$.

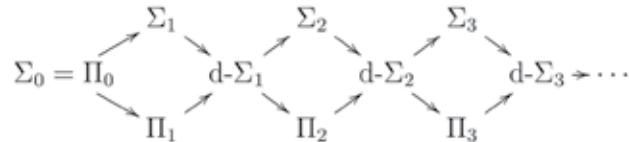
In general, a sentence φ is a *Scott sentence* of a structure \mathcal{A} if \mathcal{A} is, up to isomorphism, the only countable model of φ .

To say whether such a description is simple or complicated, we now need some kind of measure of the complexity of a sentence of the infinitary logic $\mathcal{L}_{\omega_1\omega}$. This can be done by measuring the number of alternations between existential and universal quantifiers. For example, the ϵ - δ definition of a limit has three alternations of quantifiers: $\forall\epsilon\exists\delta\forall x\dots$. The definition of uniform continuity, $\forall\epsilon\exists\delta\forall x\forall y\dots$ also has three alternations of quantifiers, because the $\forall x$ and $\forall y$ quantifiers are of the same type. The sentence

Les Notes de recherche présentent des sujets mathématiques aux lecteurs de la SMC dans un format généralement accessible qui favorise les discussions sur divers sujets pertinents, dont la recherche (pure et appliquée), les activités et des nouvelles dignes de mention. Vos commentaires, suggestions et propositions sont les bienvenus.

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defining the infinite-dimensional vector space above has three alternations of quantifiers as well. There is a hierarchy of formulas based on the number of alternations of quantifiers; the Σ_n sentences have n alternations of quantifiers, beginning with existential quantifiers; the Π_n sentences have n alternations of quantifiers, beginning with a universal quantifier; and the $d-\Sigma_n$ sentences are the conjunction of a Σ_n and a Π_n sentence. The Scott sentence for the infinite-dimensional vector space given above is Π_3 because it starts with a universal quantifier. This hierarchy of sentences can be extended through the countable transfinite, with Σ_α , Π_α , and $d-\Sigma_\alpha$ sentences for ordinals α .



One can now say that the complexity of a structure is the complexity of its least complex Scott sentence; this complexity is either Σ_α , Π_α , or $d-\Sigma_\alpha$. There has been a long and fruitful study of this notion of complexity. We will now describe two recent results.

Finitely generated structures. A structure \mathcal{A} is *finitely generated* if there is a finite tuple of elements $\bar{a} \in \mathcal{A}$ such that every other element of \mathcal{A} can be generated from \bar{a} by the application of functions in the language of \mathcal{A} . In familiar examples, such as vector spaces, groups, rings, and fields, this means exactly what it should mean, and it might help the reader to think, for example, of groups rather than arbitrary structures. A key fact is that a finitely generated structure is determined by the fact that it is finitely generated, and by the relations that hold of the generators. This is a familiar fact in group theory, where we write a finitely generated group as $\langle g_1, \dots, g_n \mid R \rangle$, knowing that this determines the group. So for example, given a group $G = \langle g_1, \dots, g_n \mid R \rangle$ (and assuming that R contains every relation true of g_1, \dots, g_n), G has a Σ_3 Scott sentence:

there exist x_1, \dots, x_n such that (a) for every element y , there is a word w such that $y = w(x_1, \dots, x_n)$, (b) for all relations $r \in R$, r holds of x_1, \dots, x_n , and (c) for all relations $r \notin R$, r does not hold of x_1, \dots, x_n .

The same is true of arbitrary structures. On the other hand, every finitely generated vector space and every finitely generated field has a $d - \Sigma_2$ Scott sentence. In both cases, some kind of dimension is involved; in the case of fields, this is the transcendence degree

and then the degree as an algebraic field extension over a purley transcendental extension of \mathbb{Q} . For a while, every known finitely generated group had a $d - \Sigma_2$ Scott sentence. For example, the group \mathbb{Z} has a Scott sentence which in addition to saying that \mathbb{Z} is a group (which is Π_2), also says:

- (a) for every pair of elements x and y , there are m, n such that $mx = ny$, and (b) there exists an element x which is not divisible by an $n \neq 1, -1$.

\mathbb{Z} is the only group satisfying (a) and (b), and (a) is Π_2 while (b) is Σ_2 . In general, every finitely generated nilpotent group and free group, and many other classes of groups arising in geometric group theory, have a $d - \Sigma_2$ Scott sentence [5, 1, 2]. In a paper with Ho, we showed that this is not true of all groups.

Theorem 0.1 (Harrison-Trainor, Ho [4]) *There is a finitely generated group with no $d - \Sigma_2$ Scott sentence.*

Thus finitely generated groups can be more complicated, in this sense, than finitely generated vector spaces or fields. It is still an open question whether a commutative ring must have a $d - \Sigma_2$ Scott sentence.

Scott ranks of models in a class. There is an older notion of *Scott rank* which has been given many different (non-equivalent) definitions over time. One of the more robust definitions, which is quite recent [6], is as follows: the Scott rank of a structure \mathcal{A} is the least ordinal α such that \mathcal{A} has a $\Pi_{\alpha+1}$ Scott sentence. This definition is nice in that it has several different characterizations, some of which are internal to the structure, but it is slightly coarser than measuring complexity using the classes Σ_α , Π_α , and $d - \Sigma_\alpha$.

Many classes which occur naturally in mathematics have a definition which is Π_2 , and almost no natural classes are more complicated than, say, Π_4 . The classes of torsion-free abelian groups and algebraically closed fields, for example, are defined by a Π_2 sentence. So suppose that one has a class of structures defined by a relatively simple sentence. Is it possible that every structure in that simply defined class is very complicated, in the sense that it has very high Scott rank? Surprisingly it turns out that the answer is yes:

Theorem 0.2 (Harrison-Trainor [3]) *Let α be any ordinal. There is a Π_2 sentence φ such that every model of φ has Scott rank α .*

So there are classes of structures none of whose members can be defined simply.

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Prime Statistics

Tristan Freiberg, University of Waterloo

Multiplicative number theory revolves around the distribution of primes. To investigate their statistical behaviour, take a large integer N , a relatively small integer H , and define a random variable X that counts the number primes in the interval $(n, n + H]$, as n runs over the positive integers up to N , i.e.

$$X(n) \sum_{h \leq H} \mathbf{1}_{\mathbb{P}}(n+h), \quad n \leq N,$$

$\mathbf{1}_{\mathbb{P}}$ being the characteristic function of the set of primes, \mathbb{P} . To sum $X(n)$ over $n \leq N$ is to count the primes between H and N exactly H times, and any other primes up to $N + H$, of which there are trivially at most $2H$, at most H times. The expected value of X is thus

$$(1) \quad \mathbb{E}(X) = \frac{1}{N} \sum_{n \leq N} X(n) = \frac{H}{N} \sum_{n \leq N} \mathbf{1}_{\mathbb{P}}(n) + \text{small error},$$

where the “small error” is at most of order H^2/N .

For $H = 100$ and N up to a few million, Gauss tabulated the frequencies with which X takes the values 0, 1, 2, and so on, and observed that, on average, X is approximately $H/\log N$, i.e. $\mathbb{E}(X) \approx H/\log N$. Indeed, by the prime number theorem,

$$\sum_{n \leq N} \mathbf{1}_{\mathbb{P}}(n) \sim \frac{N}{\log N}, \quad N \rightarrow \infty,$$

which, in view of [1], is equivalent to $\mathbb{E}(X) \sim H/\log N$, $N \rightarrow \infty$, provided H grows more slowly than $N/\log N$ (so that the “small error” is negligible). From now on, let’s fix a constant $\lambda > 0$, and assume $H \sim \lambda \log N$, so that $\mathbb{E}(X) \sim \lambda$, as $N \rightarrow \infty$.

Gauss did not speculate on the distribution of X , but it’s a natural question, which we can approach via the method of moments. It is straightforward to verify that for any positive integer r ,

$$\mathbb{E}(X^r) = \frac{1}{N} \sum_{n \leq N} \sum_{1 \leq h_1, \dots, h_r \leq H} \mathbf{1}_{\mathbb{P}}(n+h_1) \cdots \mathbf{1}_{\mathbb{P}}(n+h_r),$$

the inner sum being over ordered r -tuples of not necessarily distinct positive integers h_1, \dots, h_r . If we change order of summation, we see, for instance, that for $r = 2$, the inner sum over $n \leq N$ already counts generalized twin primes, which suggests this might be a rather difficult question!

Notwithstanding, assuming a certain version of the Hardy–Littlewood prime tuples conjecture, Gallagher [4] showed that $\mathbb{E}(X^r)$ tends (as $N \rightarrow \infty$) to the r^{th} moment of a Poisson distribution with parameter λ . As Poisson distributions are determined by their moments, this means that the probability that $X = m$, for any given integer $m \geq 0$, is asymptotically $e^{-\lambda} \lambda^m / m!$, i.e.

$$(2) \quad \frac{1}{N} \#\{n \leq N : \#\mathbb{P} \cap (n, n + H] = m\} \sim e^{-\lambda} \frac{\lambda^m}{m!}, \quad N \rightarrow \infty.$$

We can restrict our attention to intervals $(p, p + H]$ with p running over primes, where the case $m = 0$ is of special interest: if $\#\mathbb{P} \cap (p, p + H] = 0$ then the gap between p and the next prime is greater than H . On a suitable version of Hardy–Littlewood, we in fact have

$$(3) \quad \begin{aligned} \frac{1}{N} \# \left\{ 2 \leq n \leq N : \lambda_1 < \frac{p_{n+1} - p_n}{\log n} \leq \lambda_2 \right\} \\ \sim \int_{\lambda_1}^{\lambda_2} e^{-t} dt, \quad N \rightarrow \infty, \end{aligned}$$

where p_n denotes the n^{th} prime.

What can we prove unconditionally? Even partial results or approximations to [2] and [3] have come only after major advances in prime number theory. The prime tuples conjecture remains well beyond reach, but some spectacular progress in that direction has been made in recent years. Theorems 1 and 2 below were made possible by the breakthrough work of Maynard [6] and Tao on short gaps between primes. Their proofs involve incorporating a construction of Erdős and Rankin, for producing unusually large gaps between consecutive primes, into the Maynard–Tao sieve machinery. Integrating the two methods poses a number of challenges, and the proof of Theorem 2 in [1] contains a couple of innovations of possible independent interest.

Theorem 1. Fix $\lambda > 0$ and $m \geq 0$. For N sufficiently large in terms of λ and m , we have

$$\#\{n \leq N : \#\mathbb{P} \cap (n, n + \lambda \log n] = m\} \geq N^{1-\varepsilon(N)},$$

where $\varepsilon(N)$ is a certain function of N , for which $\varepsilon(N) \rightarrow 0$ as $N \rightarrow \infty$.

This is Theorem 1.1 of [3], and goes in the direction of (2). As for (3), note that by taking λ_1 and λ_2 arbitrarily close it implies, in a quantitative way, that every nonnegative real number is a limit point of the sequence $((p_{n+1} - p_n)/\log n)_{n>1}$, a conjecture of Erdős [2].

Theorem 2. Let \mathbf{L} be the set of limit points in $[0, \infty]$ of the sequence $((p_{n+1} - p_n)/\log n)_{n>1}$. Given any sequence of nine nonnegative real numbers $\beta_1 \leq \dots \leq \beta_9$,

we have $\{\beta_j - \beta_i : 1 \leq i < j \leq 9\} \cap \mathbf{L} \neq \emptyset$. Consequently, with $|\cdot|$ denoting the Lebesgue measure on \mathbb{R} , we have

$$|[0, T] \cap \mathbf{L}| \gtrsim \frac{T}{8}, \quad T \rightarrow \infty.$$

This is Theorem 1.1 and Corollary 1.2 of [1]. In other words, at least 12.5% of positive real numbers are in \mathbf{L} . Pintz [7] pointed out that the method in [1] actually establishes that at least 25% of positive real numbers are in \mathbf{L} . In spite of this, no elements of \mathbf{L} are known unconditionally, except for 0 and ∞ . That $\infty \in \mathbf{L}$ is an old theorem of Wessynthius [8]; that $0 \in \mathbf{L}$ has only been a theorem

since 2005, thanks to the groundbreaking work of Goldston, Pintz, and Yıldırım [5], precursor to Maynard–Tao.

Over 120 years have passed since the prime number theorem was first proved. It is a statement about the *average* behaviour of a random variable. Even the variance of said random variable lies as deep as the twin prime conjecture. Nevertheless, with current technology, and perhaps a few novel ideas, it ought to be possible to prove further interesting results on the finer aspects of the distribution of primes.

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Theory Over Practice in Soviet Mathematics Textbooks of the 1950s

Mariya Boyko, University of Toronto

My research focuses on mathematics-curriculum reforms in the Soviet Union throughout the 1960s and 1970s. A number of articles by Western and Russian historians provide a general overview of these efforts, but the details of the changes are often omitted. However—in part because prominent Russian mathematicians, such as Andrei Kolmogorov, played an important role in the educational reforms—identifying the intricacies of this movement is both important for better understanding of its causes and effects and inherently interesting. Changes in education systems often occur in response to scientific, cultural and geopolitical events that take place in a given society. These changes can be traced through a number of primary sources, such as textbooks, treatises on teaching methods, and government decrees. Here I discuss textbooks produced in the 1950s, prior to the 1958 beginning of Khrushchev's major education reforms, in order to show the gradual shift from theoretical toward practical in the focus of the Soviet curriculum.

Different areas of mathematics were placed in different textbooks in most Soviet schools. Arithmetic, algebra, geometry, and trigonometry were considered separate subjects. Arithmetic encompassed much more than just the study of addition, multiplication, division, and subtraction, so Soviet textbooks in that area added fundamental concepts of mathematics and strategies of problem-solving. Some problems focused on computations; many were striking in the complexity and volume of the required calculations, even at younger grades. Geometry textbooks focused on classic theorems and often contained constructions, proofs of simple theorems, conjectures, and historical notes. Diagrams were typically included, but they were minimalistic, lacking color and detailed annotations. Geometric constructions were discussed almost exclusively as theoretical concepts in the early 1950s; possibilities for practical applications appeared in textbooks only in the late 1950s and early 1960s.

Algebra textbooks contained few explanations of the practical use of equations. Many word problems were formulated without any real-world situations in mind. Instead, they emphasized theoretical

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knowledge of pre-calculus and of other complex topics, starting in grades seven and eight. It was probably unclear to ordinary students how this theoretical knowledge was related to anything useful. Textbooks rarely provided clear connections between topics within algebra. But methodological literature produced for teachers in the late 1950s emphasized that it was teachers' responsibility to provide the connections between theory and practice, as well as connections among the topics within a given area of mathematics.

Collection of Problems on Algebra for Grades 8–10 by Pavel Lalichev, published in Moscow in 1953, is representative of textbooks of the period. These textbooks' titles announced that they provided collections of problems for in-class and at-home use. The topics included reviews of linear functions and equations, roots and exponents, quadratic equations, number systems, graphs of quadratic functions, systems of quadratic functions, multivariable quadratic equations, algebraic and geometric progressions, negative and rational exponents, logarithms, the binomial theorem, complex numbers, divisibility rules and division of polynomials. It would be natural to assume that some of the problems in the texts would relate to applications of algebra in chemistry, physics, and engineering; but in fact these word problems rarely provided any practical context at all, except in certain instances. For example, a problem at the end of the chapter on exponents asked the students to "investigate using examples that the given equalities express the following properties of numbers: if each of the two numbers is the sum of the two squares, then the product of these numbers can be represented as a sum of two squares" (p. 25). This problem tested students' ability to apply their theoretical knowledge of squares and square roots and allowed them to investigate these properties further. Thus it did not provide real-life context, but it did expand students' understanding of squares and of operations with exponents.

Another prominent textbook that was used until the late 1950s, immediately before Khrushchev's education reforms, was Nikolai Glagolev's *Elementary Geometry: Planimetrics for Grades 6–8* (Moscow, 1954). Like algebra texts, the geometry textbooks were theory-focused, with very limited notions of application. Nevertheless, some investigative components were present. The main topics included lines, angles, symmetry, fundamentals of proofs, triangles and their properties such as similarity and congruence, quadrilaterals, polygons, transformations of geometric

figures, circles and measurements. Basic facts were presented at the beginning of each chapter. Practice problems were not provided within the chapter's text; instead, all the problems were presented in a completely separate section at the chapter's end. The context of each chapter shows that the isolation of the problems was intended to create a cumulative understanding of each topic. There might indeed be good reasons for presenting all the facts first and testing the students' cumulative understanding. But the information in the textbooks was dense, and students could very likely forget the knowledge from the beginning of the chapter if it was not reinforced with concrete problems and applications along the way.

By the end of the 1950s the community of mathematics educators was ready to adopt a curriculum that contained more practical components, things more closely related to students' everyday lives. Khrushchev's reforms thus can be seen, in the case of

mathematics, as a continuation of changes that were occurring already. At that time the Soviet Union gained a significant advantage over the U.S. in the space race, when the Earth satellite Sputnik 1 was launched in 1957. This event impressed the community of scientists and politicians alike. The Soviet government wished to prolong this winning streak. Modifying and enhancing education, while focusing it more on practical applications and on the specific industrial and academic needs of the state, was a natural move.

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Further details about the math competitions grants and the application process are available on the CMS website: <https://cms.math.ca/Competitions/grants>

The Committee on Grants for Provincial Competitions (CGPC) adjudicates proposals for support. Should you have further questions or comments, please contact the Committee by e-mail at chair-grants-pc@cms.math.ca

Applications should be submitted electronically, preferably in PDF format, **no later than November 15, 2018** to mathgrants@cms.math.ca.

Appel de projets : Subventions pour les concours mathématiques de la SMC 2019

La SMC accepte maintenant des demandes de subventions pour le programme des concours de mathématiques de la SMC 2019. La SMC appuie des activités qui favorisent l'apprentissage des mathématiques chez les jeunes canadiens. En plus d'organiser ses propres concours de mathématiques, la SMC offre des subventions pour les concours de mathématiques pour les activités scolaires au niveau primaire et secondaire.

La date limite pour présenter sa demande est **le 15 novembre 2018**. Les projets retenus seront annoncés en janvier 2019, et les bourses distribuées en février 2019.

Pour vous procurer un formulaire ou pour de plus amples renseignements sur l'appel de projets, passez sur le site de la SMC au : <https://cms.math.ca/Concours/grants>

Le Comité du financement des concours provinciaux (CFCP) évalue la répartition des bourses. Pour toute question ou tout commentaire sur le financement des concours provinciaux, veuillez communiquer par courriel avec le comité à pres-grants-pc@smc.math.ca

Les demandes devraient être présentées par voie électronique, préféablement en format PDF, **au plus tard le 15 novembre 2018**, à l'adresse suivante : subventionsmaths@smc.math.ca



CMS 2018 Summer Meeting Recap

Patricia Dack, Fundraising and Communications Officer, CMS

Some 300 mathematicians were welcomed to the University of New Brunswick for the 2018 CMS Summer Meeting, June 1-4th. Participants attended 20 Scientific Sessions; six Plenary Lectures; three Prize Lectures and one Public Lecture over the course of the meeting. The Plenary Lecture Spkeakers were: Jason Bell (Waterloo); Lia Bronsard (McMaster); Nassif Ghoussoub (UBC); Allen Knutson (Cornell); Mark Lewis (Alberta); and Carl Pomerance (Dartmouth College).

The Public Lecture, entitled *Why Math?* was given by Patrick Reynolds (New Brunswick).

The conference started with a well-attended Welcome Reception where participants got the chance to visit with one another and catch up on current developments!

During the CMS Annual General Meeting, Michael Bennett's (UBC) two-year term as President of the CMS came to an end and Mark Lewis (Alberta) took up the reigns as President.

On Sunday June 3rd the CMS Awards Banquet recognized the 2018 CMS Award winners: They are: Professor Gary MacGillivray (Victoria) recipient of the Excellence in Teaching Award; Professor Gordon Slade (UBC) recipient of the Jeffery-Williams Prize; and Professor Megumi Harada (McMaster) recipient of the Krieger-Nelson Prize.

The Student Poster Awards were also presented at the banquet:

AARMS Prize: Sudan Xing (Memorial); CMS President's Prize: Navaneeth Mohan (Western); and CMS Student Committee Prize: Jonathan Godin (Montréal).

Part of the festivities of the banquet included acknowledging three milestone birthdays: Renzo Piccinini, David Rodgers and Yvette Roberts.

The CMS would like to acknowledge the financial support from University of New Brunswick particularly Co-Scientific Directors, Colin Ingalls (Carleton formerly at New Brunswick) and Alexandre Girouard (Laval) and the staff at the University of New Brunswick, especially Barry Monson for their part in making the 2018 CMS Summer Meeting such a success.



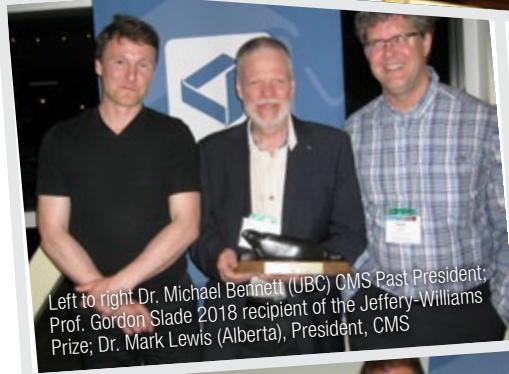
Happy Birthday Yvette Roberts!



Happy Birthday David Rodgers!



Dr. Mark Lewis (Alberta) left, receives the gavel from outgoing CMS president Dr. Michael Bennett (UBC).



Left to right Dr. Michael Bennett (UBC) CMS Past President; Prof. Gordon Slade 2018 recipient of the Jeffery-Williams Prize; Dr. Mark Lewis (Alberta), President, CMS



Professor Megumi Harada receives the Krieger-Nelson Prize from CMS Past President Dr. Michael Bennett (UBC)



Jean Legacé (right) Congratulations CMS Student Committee Prize winner Jonathan Godin (Montréal).



Newly minted CMS President Mark Lewis (Alberta) congratulates CMS President's Prize winner Navaneeth Mohan (Western)



Réception d'accueil



Le professeur Gary MacGillivray (au centre), lauréat du Prix d'excellence en enseignement de la SMC, en compagnie de Michael Bennett, président sortant de la SMC (à gauche), et de Mark Lewis, président.



Le directeur de l'AARMS, Sanjeev Seahra (à droite), et Alexis Langlois-Rémillard (Montréal) remettent le prix de l'AARMS à Sudan Xing (Memorial).



Joyeux anniversaire à Renzo Piccinini!



Directeurs scientifiques : Collin Ingalls (Carleton, ancienement de l'Université du Nouveau-Brunswick) (à gauche) et Alexandre Girouard (Laval) en compagnie de Barry Monson (à droite).

Bilan de la Réunion d'été de 2018 à la SMC

Patricia Dack, agente de la collecte de fonds et des communications, SMC

Quelque 300 mathématiciens ont été accueillis à l'Université du Nouveau-Brunswick à l'occasion de la Réunion d'été de la SMC, du 1^{er} au 4 juin 2018. Au programme : vingt sessions scientifiques, six conférences plénières, trois conférences de remise de prix et une conférence publique. Les conférences plénières ont été prononcées par Jason Bell (Waterloo); Lia Bronsard (McMaster); Nassif Ghoussoub (UCB); Allen Knutson (Cornell); Mark Lewis (Alberta); et Carl Pomerance (Dartmouth College).

La conférence publique, intitulée *Why Math?* (pourquoi les mathématiques?) a été prononcée par Patrick Reynolds (Nouveau-Brunswick).

La Réunion a commencé par une réception qui a permis aux nombreux participants de faire connaissance ou de renouer et d'apprendre les dernières nouvelles.

Au cours de l'assemblée générale annuelle de la SMC, le mandat de deux ans de Michael Bennett (UCB) à la présidence de la Société s'est terminé, et Mark Lewis (Alberta) a pris le relais.

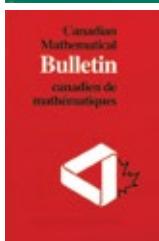
Le banquet du dimanche 3 juin était consacré à la remise des prix de la SMC pour 2018. Le professeur Gary MacGillivray (Victoria) a reçu le Prix d'excellence en enseignement; le professeur Gordon Slade (UCB) s'est vu décerner le prix Jeffery-Williams; et la professeure Megumi Harada (McMaster) a reçu le prix Krieger-Nelson.

Toujours au banquet, des prix ont également été décernés aux étudiants auteurs des meilleures présentations par affiche : le prix de l'Atlantic Association for Research in the Mathematical sciences est allé à Sudan Xing (Memorial); le Prix du président de la SMC a été remis à Navaneeth Mohan (Western); et le Prix du Comité étudiant de la SMC a été décerné à Jonathan Godin (Montréal).

Entre prix et agapes, trois importants anniversaires ont été soulignés : ceux de Renzo Piccinini, de David Rodgers et d'Yvette Roberts.

La SMC tient à remercier l'Université du Nouveau-Brunswick pour son soutien financier. Soulignons aussi, en particulier, le travail des codirecteurs scientifiques Colin Ingalls (Carleton, auparavant N.-B.) et Alexandre Girouard (Laval), et celui du personnel de l'Université, et notamment de Barry Monson, pour leur contribution au succès de cette Réunion d'été.

CJM/CMB Associate Editors



The Publications Committee of the CMS solicits nominations for Associate Editors for the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB). The appointment will be for five years beginning January 1, 2019. The current members (with their end of term) are below.

For over fifty years, the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB) have been the flagship research journals of the Society, devoted to publishing original research works of high standard. The CJM publishes longer papers with six issues per year and the CMB publishes shorter papers

with four issues per year. CJM and CMB are supported by respective Editors-in-Chief and share a common Editorial Board.

Expressions of interest should include your curriculum vitae and your cover letter and sent electronically to: cjmcm-bcm-rednom-2018@cms.math.ca before September 15, 2018.

Current Members of CJM/CMB Editorial Board

Louigi Addario-Berry (McGill)	12/2021	Editor-in-Chief CJM
Eyal Goren (McGill)	12/2021	Editor-in-Chief CJM
Jie Xiao (Memorial)	12/2019	Editor-in-Chief CMB
Xiaoqiang Zhao (Memorial)	12/2019	Editor-in-Chief CMB
Fabrizio Andreatta (Università Studi di Milano)	12/2021	Associate Editor
Jason Bell (Waterloo)	12/2020	Associate Editor
Hans Boden (McMaster)	12/2020	Associate Editor
Alexander Brudnyi (Calgary)	12/2020	Associate Editor
Krzysztof Burdzy (University of Washington)	12/2021	Associate Editor
Guillaume Chapuy (CNRS, Paris)	12/2021	Associate Editor
Ilijas Farah (York)	12/2020	Associate Editor
Ailana Fraser (UBC Vancouver)	12/2020	Associate Editor
Alexander Furman (Illinois Chicago)	12/2021	Associate Editor
Wee Teck Gan (National University of Singapore)	12/2021	Associate Editor
Dragos Ghioca (UBC Vancouver)	12/2018	Associate Editor
Philippe Gille (CNRS & Université Claude Bernard)	12/2021	Associate Editor
Vojkan Jaksic (McGill)	12/2021	Associate Editor
Lisa Jeffrey (Toronto)	12/2021	Associate Editor
Javad Mashreghi (Laval)	12/2020	Associate Editor
Marco Merkli (Memorial)	12/2020	Associate Editor
Assaf Naor (Princeton)	12/2018	Associate Editor
Nilima Nigam (Simon Fraser)	12/2020	Associate Editor
Alistair Savage (Ottawa)	12/2021	Associate Editor
Juncheng Wei (UBC Vancouver)	12/2018	Associate Editor
Daniel Wise (McGill)	12/2018	Associate Editor

Rédacteur(trice) associé(e) pour le JCM et le BCM

Le Comité des publications de la SMC sollicite des mises en candidatures pour des rédacteurs associés pour le Journal canadien de mathématiques (JCM) et pour le Bulletin Canadien de mathématiques (BCM). Le mandat sera de cinq ans qui commencera le 1er janvier 2019. Les membres actuels (avec la fin de leur terme) sont ci-dessous.

Revues phares de la Société depuis plus de 50 ans, le Journal canadien de mathématiques (JCM) et le Bulletin canadien de mathématiques (BCM) présentent des travaux de recherche originaux de haute qualité. Le JCM publie des articles longs dans ses six numéros annuels, et le BCM publie des articles plus courts quatre fois l'an. Le JCM et le BCM ont chacun leur rédacteur en chef et partagent un même conseil de rédaction.

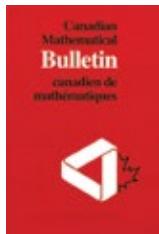
Les propositions de candidature doivent inclure votre curriculum vitae, votre lettre de présentation et doivent être envoyé par courriel électronique à : cjmcm-bcm-rednom-2018@smc.math.ca au plus tard le 15 septembre 2018.

Membres actuels du Conseil de rédaction scientifique pour le JCM et le BCM

Louigi Addario-Berry (McGill)	12/2021	Rédacteur en chef JCM
Eyal Goren (McGill)	12/2021	Rédacteur en chef JCM
Jie Xiao (Memorial)	12/2019	Rédacteur en chef BCM
Xiaoqiang Zhao (Memorial)	12/2019	Rédacteur en chef BCM
Fabrizio Andreatta (Università Studi di Milano)	12/2021	Rédacteur associé
Jason Bell (Waterloo)	12/2020	Rédacteur associé
Hans Boden (McMaster)	12/2020	Rédacteur associé
Alexander Brudnyi (Calgary)	12/2020	Rédacteur associé
Krzysztof Burdzy (University of Washington)	12/2021	Rédacteur associé
Guillaume Chapuy (CNRS, Paris)	12/2021	Rédacteur associé
Ilijas Farah (York)	12/2020	Rédacteur associé
Ailana Fraser (UBC Vancouver)	12/2020	Rédactrice associée
Alexander Furman (Illinois Chicago)	12/2021	Rédacteur associé
Wee Teck Gan (National University of Singapore)	12/2021	Rédacteur associé
Dragos Ghioca (UBC Vancouver)	12/2018	Rédacteur associé
Philippe Gille (CNRS & Université Claude Bernard)	12/2021	Rédacteur associé
Vojkan Jaksic (McGill)	12/2021	Rédacteur associé
Lisa Jeffrey (Toronto)	12/2021	Rédactrice associée
Javad Mashreghi (Laval)	12/2020	Rédacteur associé
Marco Merkli (Memorial)	12/2020	Rédacteur associé
Assaf Naor (Princeton)	12/2018	Rédacteur associé
Nilima Nigam (Simon Fraser)	12/2020	Rédactrice associée
Alistair Savage (Ottawa)	12/2021	Rédacteur associé
Juncheng Wei (UBC Vancouver)	12/2018	Rédacteur associé
Daniel Wise (McGill)	12/2018	Rédacteur associé

CANADIAN MATHEMATICAL BULLETIN (CMB)

EDITOR-IN-CHIEF (EIC)



The CMS invites expressions of interest for the Editor-In-Chief (EIC) of CMB; two EICs are being solicited, with a term scheduled to commence January 1, 2020. Funding support from the CMS is available for both these EIC positions.

Since 1958, the Canadian Mathematical Bulletin (CMB) has been committed to publishing original mathematical research of high standard following rigorous academic peer review. New research papers are published continuously online and collated into print issues four times each year.

Expressions of interest should include a covering letter indicating the type of editorships you are interested in or becoming involved with, your curriculum vitae, and an expression of views regarding the publication. For EIC consideration, please also include an indication of support from your respective university.

Please submit your expression of interest electronically to: CMB-EIC-2019@cms.math.ca before April 15, 2019.

Current CJM/CMB Editorial Board

Louigi Addario-Berry (McGill)	12/2021	Editor-in-Chief CJM
Eyal Goren (McGill)	12/2021	Editor-in-Chief CJM
Jie Xiao (Memorial)	12/2019	Editor-in-Chief CMB
Xiaoqiang Zhao (Memorial)	12/2019	Editor-in-Chief CMB
Fabrizio Andreatta (Università Studi di Milano)	12/2021	Associate Editor
Jason Bell (Waterloo)	12/2020	Associate Editor
Hans Boden (McMaster)	12/2020	Associate Editor
Alexander Brudnyi (Calgary)	12/2020	Associate Editor
Krzysztof Burdzy (University of Washington)	12/2021	Associate Editor
Guillaume Chapuy (CNRS, Paris)	12/2021	Associate Editor
Ilijas Farah (York)	12/2020	Associate Editor
Ailana Fraser (UBC Vancouver)	12/2020	Associate Editor
Alexander Furman (Illinois Chicago)	12/2021	Associate Editor
Wee Teck Gan (National University of Singapore)	12/2021	Associate Editor
Dragos Ghioca (UBC Vancouver)	12/2018	Associate Editor
Philippe Gille (CNRS & Université Claude Bernard)	12/2021	Associate Editor
Vojkan Jaksic (McGill)	12/2021	Associate Editor
Lisa Jeffrey (Toronto)	12/2021	Associate Editor
Javad Mashreghi (Laval)	12/2020	Associate Editor
Marco Merkli (Memorial)	12/2020	Associate Editor
Assaf Naor (Princeton)	12/2018	Associate Editor
Nilima Nigam (Simon Fraser)	12/2020	Associate Editor
Alistair Savage (Ottawa)	12/2021	Associate Editor
Juncheng Wei (UBC Vancouver)	12/2018	Associate Editor
Daniel Wise (McGill)	12/2018	Associate Editor

BULLETIN CANADIEN DE MATHÉMATIQUES (BCM)

RÉDACTEUR EN CHEF

La SMC invite les personnes intéressées par un poste de rédacteur en chef au BCM à lui faire part de leur intérêt. Deux postes de rédacteurs en chef sont à pourvoir, pour un mandat qui commencera en le 1 janvier 2020. La SMC offre du soutien financier pour ces deux postes.

Depuis 1958, le Bulletin canadien de mathématiques s'engage à publier des recherches en mathématiques, originales et de haut niveau, suivant de rigoureux examens par des pairs. Les articles de recherches sont disponibles en tout temps en ligne et sont rassemblés en quatre éditions imprimées par année.

Les propositions de candidature comprendront les éléments suivants : une lettre de présentation précisant le type de poste qui vous intéresse, votre curriculum vitae et un texte dans lequel vous exprimez votre opinion et vos idées par rapport à la publication. Pour les postes de rédacteur en chef, veuillez ajouter une preuve du soutien de votre université.

Veuillez faire parvenir votre candidature par courriel à : BCM-REC-2019@smc.math.ca au plus tard le 15 avril 2019.

Conseil de redaction pour le JCM et le BCM à présent :

Louigi Addario-Berry (McGill)	12/2021	Rédacteur en chef JCM
Eyal Goren (McGill)	12/2021	Rédacteur en chef JCM
Jie Xiao (Memorial)	12/2019	Rédacteur en chef BCM
Xiaoqiang Zhao (Memorial)	12/2019	Rédacteur en chef BCM
Fabrizio Andreatta (Università Studi di Milano)	12/2021	Rédacteur associé
Jason Bell (Waterloo)	12/2020	Rédacteur associé
Hans Boden (McMaster)	12/2020	Rédacteur associé
Alexander Brudnyi (Calgary)	12/2020	Rédacteur associé
Krzysztof Burdzy (University of Washington)	12/2021	Rédacteur associé
Guillaume Chapuy (CNRS, Paris)	12/2021	Rédacteur associé
Ilijas Farah (York)	12/2020	Rédacteur associé
Ailana Fraser (UBC Vancouver)	12/2020	Rédactrice associée
Alexander Furman (Illinois Chicago)	12/2021	Rédacteur associé
Wee Teck Gan (National University of Singapore)	12/2021	Rédacteur associé
Dragos Ghioca (UBC Vancouver)	12/2018	Rédacteur associé
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Vojkan Jaksic (McGill)	12/2021	Rédacteur associé
Lisa Jeffrey (Toronto)	12/2021	Rédactrice associée
Javad Mashreghi (Laval)	12/2020	Rédacteur associé
Marco Merkli (Memorial)	12/2020	Rédacteur associé
Assaf Naor (Princeton)	12/2018	Rédacteur associé
Nilima Nigam (Simon Fraser)	12/2020	Rédactrice associée
Alistair Savage (Ottawa)	12/2021	Rédacteur associé
Juncheng Wei (UBC Vancouver)	12/2018	Rédacteur associé
Daniel Wise (McGill)	12/2018	Rédacteur associé

CMS Research Prizes

The CMS Research Committee is inviting nominations for three prize lectureships. These prize lectureships are intended to recognize members of the Canadian mathematical community.

The **Coxeter-James Prize** Lectureship recognizes young mathematicians who have made outstanding contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. Nominations may be made up to ten years from the candidate's Ph.D. A nomination can be updated and will remain active for a second year unless the original nomination is made in the tenth year from the candidate's Ph.D. For more information, visit: <https://cms.math.ca/Prizes/cj-nom>

The **Jeffery-Williams Prize** Lectureship recognizes mathematicians who have made outstanding contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for three years. For more information: <https://cms.math.ca/Prizes/jw-nom>

The **Krieger-Nelson Prize** Lectureship recognizes outstanding research by a female mathematician. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for two years. For more information: <https://cms.math.ca/Prizes/kn-nom>

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 for research in the mathematical sciences regardless of race, gender, ethnicity or sexual orientation. A candidate can be nominated for more than one research prize in the applicable categories; several candidates from the same institution can be nominated for the same research prize.

CMS research prizes are gender-neutral, except for the Krieger-Nelson prize, which is awarded to women only. Nominations of eligible women for the general research prizes in addition to the Krieger-Nelson Prize are strongly encouraged.

The deadline for nominations, including at least three letters of reference, is **September 30, 2018**. Nomination letters should list the chosen referees and include a recent curriculum vitae for the nominee. Some arms-length referees are strongly encouraged. Nominations and the reference letters from the chosen referees should be submitted electronically, preferably in PDF format, to the corresponding email address and **no later than September 30, 2018**:

Coxeter-James: cjprize@cms.math.ca

Jeffery-Williams: jwprize@cms.math.ca

Krieger-Nelson: knprize@cms.math.ca

Prix de recherche de la SMC

Le Comité de recherche de la SMC lance un appel de mises en candidatures pour trois de ses prix de conférence. Ces prix ont tous pour objectif de souligner l'excellence de membres de la communauté mathématique canadienne.

Le **Prix Coxeter-James** rend hommage aux jeunes mathématiciens qui se sont distingués par l'excellence de leur contribution à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Les candidats sont admissibles jusqu'à dix ans après l'obtention de leur doctorat. Toute mise en candidature est modifiable et demeurera active l'année suivante, à moins que la mise en candidature originale ait été faite la 10 année suivant l'obtention du doctorat. Pour les renseignements, voir : <https://cms.math.ca/Prix/cj-nom>

Le **Prix Jeffery-Williams** rend hommage aux mathématiciens ayant fait une contribution exceptionnelle à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant trois ans. Pour les renseignements, voir : <https://cms.math.ca/Prix/jw-nom>

Le **Prix Krieger-Nelson** rend hommage aux mathématiciennes qui se sont distinguées par l'excellence de leur contribution à la recherche mathématique. La lauréate doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant deux ans. Pour les renseignements, voir : <https://cms.math.ca/Prix/info/kn>

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs de département et les comités de mise en candidature à proposer des collègues exceptionnels pour la recherche dans les sciences mathématiques sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle. Une personne peut être mise en candidature pour plus d'un prix de recherche dans les catégories applicables ; plusieurs candidats d'un même institut peuvent être nommés pour le même prix de recherche.

Les prix de recherche de la SMC sont non sexistes, à l'exception du prix Krieger-Nelson, qui est décerné uniquement aux femmes. Les candidatures de femmes éligibles pour les prix de recherche généraux en plus du prix Krieger-Nelson sont fortement encouragées.

La date limite pour déposer une candidature, qui comprendra au moins trois lettres de référence, est **le 30 septembre 2018**. Le dossier de candidature doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent du candidat ou de la candidate. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, avant la date limite, à l'adresse électronique correspondante et **au plus tard le 30 septembre 2018** :

Coxeter-James : prixcj@smc.math.ca

Jeffery-Williams : prixjw@smc.math.ca

Krieger-Nelson : prixkn@smc.math.ca

2019 Excellence in Teaching Award

The CMS Excellence in Teaching Award Selection Committee invites nominations for the **2019 Excellence in Teaching Award**.

The Excellence in Teaching Award focuses on the recipient's proven excellence as a teacher at the undergraduate level, including at universities, colleges and cégeps, as exemplified by unusual effectiveness in the classroom and/or commitment and dedication to teaching and to students. The dossier should provide evidence of the effectiveness and impact of the nominee's teaching. The prize recognizes sustained and distinguished contributions in teaching at the post-secondary undergraduate level at a Canadian institution. Only full-time teachers or professors who have been at their institution for at least five years will be considered. The nomination will remain active for three years, with a possibility to update.

Nomination letters, *including at least three letters of reference*, should list the chosen referees and include a recent curriculum vitae for the nominee, if available.

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 or sexual orientation.

Nominations and reference letters should be submitted electronically, preferably in PDF format, to: etaward@cms.math.ca no later than the deadline of **November 15, 2018**.

Prix d'excellence en enseignement 2019

Le Comité de sélection du Prix d'excellence en enseignement de la SMC sollicite des mises en candidature pour le **Prix d'excellence en enseignement 2019**.

Le Prix d'excellence en enseignement de la SMC récompense l'excellence reconnue d'un enseignant ou d'un professeur de niveau postsecondaire (universités, collèges et cégeps), telle qu'illustrée par son efficacité exceptionnelle en classe et/ou son engagement et son dévouement envers l'enseignement et les étudiants. Le dossier de candidature doit montrer l'efficacité et les effets de l'enseignement du candidat ou de la candidate. Ce prix récompense des contributions exceptionnelles et soutenues en enseignement collégial et de premier cycle universitaire dans un établissement canadien. Seules les candidatures d'enseignants et de professeurs à temps plein qui travaillent dans le même établissement depuis au moins cinq ans seront retenues. Une candidature peut être mise à jour et demeure active pendant 3 ans.

Le dossier de candidature, *comportant au moins trois lettres de référence*, doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent du candidat ou de la candidate, dans la mesure du possible.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs 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. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, à : prixee@smc.math.ca avant la date limite du **15 novembre 2018**.



A Taste of Mathematics (ATOM)

EDITOR-IN-CHIEF

The Publications Committee of the CMS solicits expressions of interest for the Editor-in-Chief position for ATOM.

The appointment will be for a five-year term beginning as soon as possible. Currently this position is vacant and we would like to fill this position quickly. **The deadline for submissions is September 30, 2018.**

The booklets in the series, A Taste of Mathematics, are designed as enrichment materials for high school students with an interest in and aptitude for mathematics. Some booklets in the series will also cover the materials useful for mathematical competitions at national and international levels.

Since editorial responsibilities often necessitate a lessening of responsibilities in an individual's normal work, individuals should review their candidacy with their university department.

Expressions of interest should include:

- a formal covering letter;
- a curriculum vitae;
- an expression of views regarding the publication; and
- an inclusion of support from their university department.

Please submit your expression of interest electronically, preferably in PDF format, to: ATOM-EIC-2018@cms.math.ca

Current ATOM Editorial Board

Kseniya Garaschuk (Fraser Valley), Associate Editor to 12/2020

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Le comité des publications de la SMC sollicite des mises en candidature pour le poste de rédacteur-en-chef pour l'ATOM. Le mandat sera pour cinq ans et débutera le plus tôt possible car ce poste est présentement libre. **La date limite pour les soumissions est le 30 septembre 2018.**

Les livrets de la série, Aime-T-On les Mathématiques, sont conçus comme des matériaux d'enrichissement pour les élèves du secondaire ayant un intérêt et des aptitudes pour les mathématiques. Quelques livrets de la série couvriront également le matériel utile pour les compétitions mathématiques aux niveaux national et international.

Puisque les responsabilités de rédaction nécessitent souvent une réduction dans la charge normale de travail, les individu(e)s devraient vérifier leur candidature avec leur département.

Les mises en candidature doivent inclure :

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- un curriculum vitae;
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