



The Power of Relationship Building for Indigenous Student Success 10

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CMS NOTES de la SMC

June / juin
2018

President's Notes / Notes du président

Michael Bennett (UBC Vancouver)
President - CMS / Président - SMC

A Year in Review



In 2017, the Canadian Mathematical Society (CMS) experienced another year of change and challenge. In the summer, we played host to the largest mathematics conference to be held in Canada since the International Congress of 1974, the Mathematical Congress of the Americas (MCA) 2017, in Montreal, QC. In addition, we had a highly-successful Winter meeting in Waterloo, Ontario, coinciding with the 50th anniversary of the founding of their Faculty of Mathematics. Many special thanks are owed to the scientific directors, session organizers, committee members, volunteers and staff who made these meetings successful. In the coming year, the 2018 Summer Meeting will be held in Fredericton, New Brunswick, and the 2018 Winter Meeting will take place in Vancouver, British Columbia.

The Society also saw plans advanced for transforming our journal publishing through a partnership with an internationally recognized academic publisher, the details of which will be forthcoming. This transition from our own highly-regarded “in-house” publishing operation in Manitoba is of critical importance, in helping to ensure the financial health of the Society going forward. At the same time, we must make every effort to strive to maintain the high production quality that is a hallmark of our journals.

The CMS Executive Office has continued to run smoothly during this period thanks to our dedicated staff in Ottawa and the remarkable work of Graham Wright. Our single most

Revue de l'année

In 2017, la Société mathématique du Canada (SMC) a connu une autre année de changements et de défis. En été, nous avons accueilli à Montréal le plus grand congrès mathématique à se tenir au Canada depuis le Congrès international de 1974 : le Congrès mathématique des Amériques (CMA) 2017. Notre Réunion d'hiver de Waterloo (Ontario) a également connu un vif succès, d'autant plus qu'elle a coïncidé avec le 50^e anniversaire de la Faculté de mathématiques de l'université hôte. Nous tenons à remercier sincèrement les directeurs scientifiques, les organisateurs de sessions, les membres du comité organisateur, les bénévoles et le personnel de la SMC, à qui l'on doit le succès de ces événements. En 2018, la Réunion d'été se déroulera à Fredericton, au Nouveau-Brunswick, et la Réunion d'hiver, à Vancouver, en Colombie-Britannique.

La Société a également vu progresser son projet de transformer ses activités de publication grâce à un partenariat avec un éditeur universitaire de renommée internationale, et en dévoilera les détails sous peu. Cette transition de nos propres activités de publication « maison » de haut calibre, au Manitoba, est d'une importance cruciale pour assurer la santé financière de la Société. Nous devons cependant tout mettre en œuvre pour maintenir la qualité élevée de production qui caractérise nos revues.

Le Bureau administratif de la SMC a continué à fonctionner rondement durant cette période grâce à notre personnel dévoué à Ottawa et au travail remarquable de Graham Wright. Notre plus grand défi en 2018 est d'ailleurs de trouver un successeur à Graham au poste de secrétaire exécutif.

En 2017, la Société a rendu hommage à une grande variété d'éducateurs et de

The Unofficial Mathematician

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



This weekend I was doing some preparation for a Scout camp. We were putting spars for a pioneering project onto a trailer. Working beside me were, among others, an engineer; a lawyer; and a geologist. Somebody asked me “Hey, Robert! When are you mathematicians going to get a professional designation?”

My immediate answer was “when hell freezes over!” Our tradition has been, I think, that a mathematician is somebody who does mathematics, and that Pierre Fermat (a lawyer), Percy MacMahon (a career soldier) or John Napier (Laird of Merchiston and part-time magician) are as much members of our group as somebody with three math degrees and tenure in a math department. But the question got me thinking: what purpose would a P. Math designation serve, and what would the effect be?

I think we can say, to start with, that it would have little or no effect on pure mathematics. Even if such a designation had existed, it would not have prevented the late Marjorie Rice, a homemaker, from tiling pentagons at her kitchen table, or a journal from publishing the result. Especially as such designations are at national or provincial levels, it seems absurd to suppose that a journal in another country would bother to check. Last time I submitted a paper to a journal (last week), I do not recall anybody even asking if I had a degree; and *Crux Mathematicorum* gets some excellent papers from high school students. One important reason why no one is going to bother: pure mathematics involves little risk to public or individual safety.

Would it make any sense for applied mathematics? I'd argue, on rather more pragmatic ground, that it would not. Certainly, applied mathematics has the potential to cause injury or damage in various ways. However, the nature of applied mathematics is that it has to be applied to some other field of endeavor; and it's the application that will be regulated. Engineers, actuaries, and many other professionals make heavy use of mathematics, but they would not be covered by this designation. Furthermore, I think it's safe to say that in the case of such a conflict of jurisdictions, mathematics would lose out. The CMS, or whoever conferred the “P. Math” designation, would not be in a position to tell engineers to stop using calculus (though I've had a few first-year engineering majors who would have been glad to.) Nor would it permit mathematicians to take on work currently reserved for engineers. This isn't a matter of who got recognized first – it's because (for instance) engineering has, and has always been seen to have, a strong mathematical component. A person who's qualified as an engineer is qualified to do the required mathematics.

So I think that it's safe to say – if you're doing mathematics, you're a mathematician.

Le mathématicien : un professionnel sans titre

La fin de semaine dernière, j'aidais aux préparatifs d'un camp scout. Nous chargions une remorque de perches pour la construction des installations. Parmi mes compagnons de travail se trouvaient notamment un ingénieur, un avocat et un géologue. « Alors Robert, m'a lancé l'un d'eux, quand les mathématiciens auront-ils un titre professionnel ? »

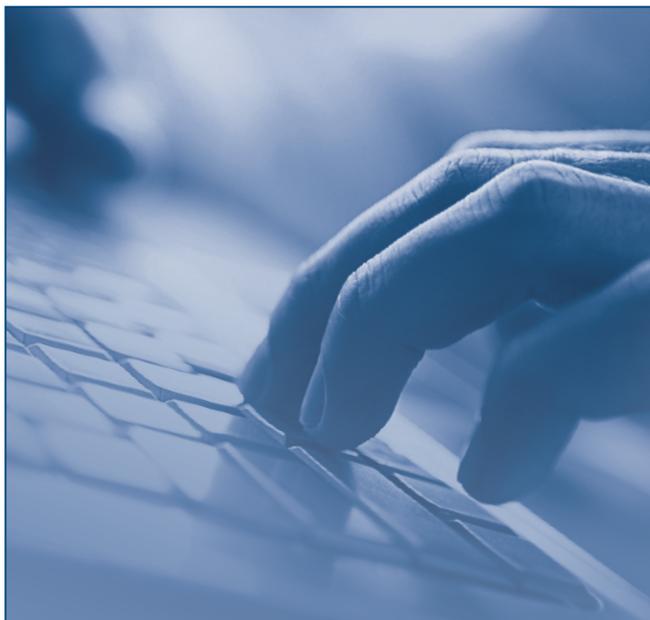
« Quand les poules auront des dents! » fut ma première réaction. Parce que pour nous, me semble-t-il, toute personne qui fait des mathématiques peut se dire mathématicien. Ainsi, Pierre Fermat (un avocat), Percy MacMahon (un militaire de carrière) ou John Napier (Laird de Merchiston et magicien à ses heures) sont aussi dignes du titre de mathématicien qu'un titulaire de trois diplômes de mathématiques et d'un poste dans un département de mathématiques. Mais la question m'a laissé songeur. À quoi servirait un titre de « mathématicien agréé » et quels en seraient les effets?

Tout d'abord, je crois pouvoir affirmer qu'un titre professionnel aurait un effet limité (voire nul) dans le domaine des mathématiques pures. L'existence d'un titre professionnel n'aurait jamais empêché feu Marjorie Rice, femme au foyer de son état, de faire des pavages de pentagones sur la table de sa cuisine ni une revue spécialisée de publier ses résultats. En outre, l'idée qu'une équipe éditoriale d'une revue étrangère se préoccuperait de vérifier si l'auteur d'un article est agréé par un ordre professionnel provincial ou national me semble plutôt farfelue. Si je me souviens bien, la dernière fois que j'ai soumis un article (la semaine dernière), personne n'a tenu à savoir si j'avais un diplôme. Et d'excellents articles publiés dans *Crux Mathematicorum* sont l'œuvre d'élèves du secondaire. Autre bonne raison pour laquelle on ne se souciera jamais d'encadrer la pratique : les mathématiques pures ne recèlent pas de véritable menace pour la sécurité collective ou individuelle.

Serait-ce plus indiqué dans le domaine des mathématiques appliquées? Pour des raisons d'ordre pratique, je dirais que non. Les mathématiques appliquées sont certainement susceptibles de causer des blessures ou des dommages divers. Cependant, par définition, les mathématiques appliquées sont justement utilisées dans un autre domaine d'activités : c'est donc le domaine d'application qui est réglementé. Les ingénieurs, les actuaires et bien d'autres professionnels font un usage extensif des mathématiques, mais ils n'auraient pas accès au titre de mathématicien agréé. En outre, on peut avancer sans trop de risque que, dans l'éventualité d'un conflit de compétences, les mathématiques n'auraient certainement pas le gros bout du bâton. La SMC, ou toute autre instance responsable de l'agrément des mathématiciens, n'aurait jamais le pouvoir d'ordonner à des ingénieurs de ne plus faire appel au calcul différentiel et intégral (perspective qui réjouirait fort certains étudiants de première année de génie de ma connaissance). L'agrément ne permettrait jamais, non plus, aux mathématiciens d'exercer des actes actuellement

réservés aux ingénieurs. Pas parce que le génie a préséance sur les mathématiques, mais (notamment) parce que les mathématiques sont très imbriquées dans le génie (et qu'elles y ont toujours été fortement associées). Ainsi, un ingénieur agréé aura forcément les compétences mathématiques requises dans le cadre de sa pratique.

Je ne pense donc pas me tromper en affirmant que toute personne qui fait des mathématiques peut se dire mathématicien.



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.

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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Les rédacteurs des Notes de la SMC accueillent vos articles, lettres et notes. 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

The CMS Notes is published by the Canadian Mathematical Society (CMS) six times a year (February, March/April, June, September, October/November and December).

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The editors welcome articles, letters and announcements. Indicate the section chosen for your article, and send it to CMS Notes at the appropriate email address indicated above.

No responsibility for the views expressed by authors is assumed by the CMS Notes, the editors or the CMS.

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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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ISSN : 1193-9273 (imprimé/print) | 1496-4295 (électronique/electronic)

Continued from cover

major challenge facing us in 2018 is our search for Graham's successor as Executive Secretary.

In 2017 the Society was able to honour a wide variety of distinguished educators and researchers : Robert McCann (Jeffery-Williams Prize), Stephanie van Willigenburg (Krieger-Nelson Prize), Sabin Cautis (Coxeter-James Prize), Konstantin Tikhomirov (Doctoral Prize), Richard Hoshino (Adrien-Pouliot Award), Bernard Hodgson (Excellence in Teaching Award), Alan Beardon (G de B Robinson Award) and Joseph Houry (Graham Wright Award for Distinguished Service). These remarkable people represent the breadth and diversity of Mathematics at the University level in Canada.

Math Team Canada placed 29th at the 2017 International Mathematical Olympiad (IMO) in Rio de Janeiro, Brazil, bringing home 1 gold, 2 silver and 2 bronze medals. The first of these was awarded to William Zhao who placed 14th overall. Congratulations to the team and everyone involved.

My term as President ends on June 3, 2018 and I wish to thank the Executive, Board, Staff and CMS members and volunteers for their support during my two years as President. In addition, I would like to express my gratitude to Graham Wright for his continued service to the CMS. I welcome Mark Lewis as incoming President and wish him every success.

Michael Bennett
CMS President

2018 CMS MEMBERSHIP RENEWALS RENOUVELLEMENTS 2018 À LA SMC



The 2018 membership renewal is underway! Please renew your membership online at portal.cms.math.ca by logging into your member account. Should you have any questions, please email us at memberships@cms.math.ca

Le renouvellement pour l'an 2018 est en cours! S'il vous plaît renouveler votre adhésion en ligne à portail.smc.math.ca et en vous connectant à votre compte de membre. Si vous avez des questions, s'il vous plaît écrivez-nous à adhesions@smc.math.ca



**La Société
mathématique du
Canada (SMC) est
fière d'annoncer ...**



**The Canadian
Mathematical Society
(CMS) is pleased
to announce ...**

Après 35 ans, le Congrès international de physique mathématique (CIPM) reviendra en Amérique du Nord en 2018 et se déroulera au Canada pour la première fois. Tenu tous les trois ans, le CIPM est l'événement le plus important de l'Association internationale de physique mathématique. Le XIXe CIPM aura lieu à Montréal en 2018 et, selon la nouvelle tradition, il sera précédé du Symposium des jeunes chercheurs. Ce Symposium se tiendra à l'Université McGill les 20 et 21 juillet, et le CIPM se déroulera au Centre Mont-Royal et à l'Université McGill du 23 au 28 juillet. Le Canada se réjouit à l'idée d'accueillir le monde de la physique mathématique en 2018!

Le CIPM 2018 sera organisé par la SMC en collaboration avec de nombreuses associations des domaines de la physique et des mathématiques, notamment : le CRM, l'Université McGill, le PIMS, l'Institut Fields, l'ISM, l'AARMA, le CANSSI, la SRIB, l'Institut Périmètre, l'Université de Montréal et l'UQAM.

<https://icmp2018.org/fr/inscription>

After 35 years, the International Congress on Mathematical Physics (ICMP) will return to North America in 2018, which will also mark the first time that Canada will host the congress. The ICMP, on its three year cycle, is the most important event of the International Association of Mathematical Physics. The XIXth ICMP will take place in Montreal, 2018, and, following recent tradition, it will be preceded by the Young Researchers Symposium (YRS). The YRS will be held at McGill University from July 20 to July 21 and the ICMP will be held at the Centre Mont-Royal and McGill University from July 23 to July 28. Canada is looking forward to welcoming the world of mathematical physics in 2018!

ICMP 2018 will be staged by the CMS in collaboration with many physics and mathematics organizations, including: CRM, McGill University, PIMS, FIELDS, ISM, AARMS, CANSSI, BIRS, Perimeter Institute, U. Montréal, and UQAM.

<https://icmp2018.org/en/registration>

Suite de la couverture

chercheurs exceptionnels : Robert McCann (prix Jeffery-Williams), Stephanie van Willigenburg (prix Krieger-Nelson), Sabin Cautis (prix Coxeter-James), Konstantin Tikhomirov (Prix de doctorat), Richard Hoshino (prix Adrien-Pouliot), Bernard Hodgson (Prix d'excellence en enseignement), Alan Beardon (prix G.-de-B.-Robinson) et Joseph Khoury (prix Graham-Wright pour service méritoire). Ces personnes remarquables représentent l'étendue et la diversité des mathématiques universitaires au Canada.

L'équipe Math Canada s'est classée 29^e à l'Olympiade internationale de mathématiques 2017 à Rio de Janeiro, au Brésil, remportant 1 médaille d'or, 2 d'argent et 2 de bronze. La médaille d'or a été

décernée à William Zhao, qui s'est classé au 14^e rang mondial. Félicitations à l'équipe et à toutes les personnes impliquées.

Mon mandat de président prenant fin le 3 juin 2018, je tiens à remercier les membres de l'exécutif, du conseil, du personnel et de la Société ainsi que les bénévoles pour leur soutien durant mes deux années à la présidence. J'aimerais en outre exprimer ma gratitude à Graham Wright pour son service continu à la SMC. Je souhaite la bienvenue à notre nouveau président Mark Lewis et lui adresse mes meilleurs vœux de succès.

Michael Bennett

Président de la SMC

Fundraising Key to CMS Success

In the spring of 2017, a Fundraising and Communications Officer, Patricia Dack, was hired with the goal of expanding the funds available to support CMS activities. With a full-time staff member responsible for Fundraising, the CMS hopes to obtain more regular donations from foundations, corporations, governments, institutions, friends of the CMS and members who are interested in supporting CMS programs and activities.

Sponsorships and donations from foundations and corporations often have programs that match their employee's donations. Fundraising efforts will continue to support on-going CMS programs such as the Math Competitions, Math Camps, CMS Meetings and Publications.

The CMS encourages you to consider donations by **Planned or Estate Giving**.

You can help:

Contributing to the CMS. What is most important is your support for the society through regular donations - not necessarily the *size* of the gift. You can donate online at cms.math.ca

- If you have contacts in private industry who we can contact to explore partnerships, please let Patricia know.
- If you are interested in volunteering for a CMS committee, please contact the chair of the nominating committee at chair-nomc@cms.math.ca
- Encourage colleagues to join the CMS!

Working together, we can promote the advancement, discovery, learning, and application of mathematics. If you have questions or want more information, please contact Patricia Dack at pdack@cms.math.ca or at 613-733-2662 ext. 728.

Les collectes de fonds : essentielles à l'essor de la SMC

À u printemps 2017, la SMC a embauché une agente de la collecte de fonds et des communications, Patricia Dack, dans le but d'intensifier la recherche de financement pour ses activités. Grâce à cet ajout à son personnel à plein temps, la SMC espère recueillir des dons plus réguliers de fondations, d'entreprises, de gouvernements, d'établissements, d'amis de la SMC et de membres désireux de soutenir ses programmes et ses activités.

Les fondations et les entreprises qui font des commandites et des dons ont souvent des programmes qui permettent de jumeler la contribution de leurs employés. Les collectes de fonds permettront à la Société de continuer à financer ses programmes, notamment ses concours et ses camps mathématiques, ses Réunions et ses publications.

La SMC vous invite à réfléchir à la possibilité de faire un don **planifié ou par planification successorale**.

Ce que vous pouvez faire :

Contribuer à la SMC. Ce qui compte le plus pour la Société, c'est la régularité de votre don, pas nécessairement le *montant* que vous donnez. Pour faire un don en ligne, passez à la page smc.math.ca.

- Si vous connaissez des gens dans le secteur privé que nous pourrions contacter pour discuter de partenariats, veuillez en informer Patricia.
- Si vous avez le goût de faire du bénévolat au sein d'un comité de la SMC, veuillez communiquer avec le président du comité des mises en candidature à l'adresse chair-nomc@smc.math.ca.
- Encouragez vos collègues à adhérer à la SMC!

Ensemble, nous pouvons promouvoir l'avancement, la découverte et l'apprentissage des mathématiques, et les applications qui en découlent. Pour toute question ou pour de plus amples renseignements, veuillez contacter Patricia Dack à l'adresse pdack@smc.math.ca ou au 613-733-2662 poste 728.

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
(redacteur-gerant@smc.math.ca)



JUNE 2018 JUIN

- 1-4 2018 CMS Summer Meeting / Réunion d'été de la SMC 2018, University of New Brunswick – Fredericton / Université du Nouveau-Brunswick – Frédéricton, Fredericton, N.B.
- 1-5 CMESG (Canadian Mathematics Education Study Group) 2018 Conference, Quest University, Squamish, B.C.
- 3-6 2018 SSC Annual Meeting, McGill University, Que.
- 3-7 15th International Conference on Quantum Physics and Logic, Dalhousie University, Halifax, N.S.
- 3-8 BIRS Workshop: Hydraulic Fracturing: Modeling, Simulation, and Experiment, BIRS, Banff, Alta.
- 4-6 CSHPM 2018 Annual Meeting, Université du Québec à Montréal (UQAM), Montreal, Que.
- 4-7 CAIMS Annual Meeting 2018, Ryerson University, Toronto, Ont.
- 4-15 Séminaire de Mathématiques Supérieures, Université de Montréal, Montréal, Qué.
- 12-15 Prairie Discrete Mathematics Workshop, Brandon University, Brandon, Man.
- 17-22 BIRS Workshop: Advanced Developments for Surface and Interface Dynamics - Analysis and Computation, BIRS, Banff, Alta.
- 24-29 BIRS Workshop: New Trends in Syzygies, BIRS, Banff, Alta.

JULY 2018 JUILLET

- 1-6 BIRS Workshop: Spectral Geometry: Theory, Numerical Analysis and Applications, BIRS, Banff, Alta.
- 1-7 18th International Conference on Fibonacci Numbers and Their Applications, Dalhousie University, Halifax, N.S.
- 3-14 59th International Mathematical Olympiad, Cluj-Napoca, Romania
- 8-13 BIRS Workshop: Mathematical Approaches to Cell-Cell Communication and Collective Behaviours, BIRS, Banff, Alta.
- 9-20 Montreal Summer Workshop on Challenges in Probability and Mathematical Physics, a satellite activity of ICMP 2018, Montreal, Que.

- 11-15 Canadian Undergraduate Mathematics Conference (CUMC) 2018 / Congrès canadien des étudiant.e.s en mathématiques (CCÉM) 2018, University of Saskatchewan, Saskatoon, Sask.
- 15-20 BIRS Workshop: Around Quantum Chaos, BIRS, Banff, Alta.
- 16-20 CRM Workshop: Algebraic Methods in Mathematical Physics, a satellite activity of ICMP 2018, Montreal, Que.
- 16-20 Thirteenth Algorithmic Number Theory Symposium, University of Wisconsin, Madison, USA
- 22-27 BIRS Workshop: Complex Fluids in Biological Systems, BIRS, Banff, Alta.
- 23-28 XIX International Congress on Mathematical Physics / XIX^e Congrès international de la physique mathématique, Centre Mont-Royal, Montreal, Que.

AUGUST 2018 AOÛT

- 1-9 International Congress of Mathematicians (ICM 2018), Rio de Janeiro, Brazil
- 5-10 BIRS Workshop: New Statistical Methods for Family-Based Sequencing Studies, BIRS, Banff, Alta.
- 6-7 Graph Searching in Canada (GRASCan) Workshop 2018, University of Regina, Regina, Sask.
- 8-10 Canadian Conference on Computational Geometry (CCCG 2018), University of Manitoba, Winnipeg, Man.
- 12-17 BIRS Workshop: Mathematics of the Cell: Mechanical and Chemical Signaling across Scales, BIRS, Banff, Alta.
- 19-24 BIRS Workshop: Regularity and Blow-up of Navier-Stokes Type PDEs using Harmonic and Stochastic Analysis, BIRS, Banff, Alta.
- 26-31 BIRS Workshop: Interacting Particle Systems and Parabolic PDEs, BIRS, Banff, Alta.
- 27-31 Workshop on Geometry of Teichmüller Space, Field's Institute, Toronto, Ont.

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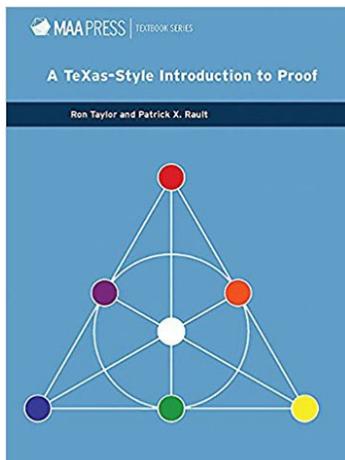
A TeXas-Style Introduction to Proof

by Ron Taylor and Patrick X. Rault

MAA Press, 2017

ISBN 978-1-93951-213-0

Reviewed by *Karl Dilcher*, Dalhousie University



What is the best way to teach proofs to our students? Most of us will have grappled with this question at different times during our teaching careers. In my department, most students will first be exposed to a consistent use of complete proofs, and learn their first steps toward constructing proofs, in a second-year real analysis or an honours linear algebra course.

Would it make sense to teach a course just on proofs? I used to be very skeptical since proofs are so closely connected to a particular course or subject matter that it seems to be impossible, or at least not a good idea, to “teach proofs” in isolation. I felt this way even though in my classes I usually point out certain universal proof methods that go beyond the commonly used, and quite easily understood, proofs by contradiction or by induction. For instance, there is the “glorified example”, which often occurs in linear algebra. Or the “bookkeeping proof”, which is nothing but a straightforward and linear sequence of known facts. Still, I remained skeptical.

The delightful little book under review shows that it is indeed possible to teach a meaningful and engaging one-semester “Introduction to Proof” course. At first sight, this book contains all the main topics one would expect, organized by way of the following seven main chapters: Symbolic Logic, Proof Methods, Mathematical Induction, Set Theory, Functions & Relations, Counting, and Axiomatics.

A few words about the first two chapters. The first one, Symbolic Logic, emphasizes the importance of good and clear statements, and how to construct them. Next, the chapter on Proof Methods is not so much a collection or discussion of such methods – that comes later in the book. Instead, the chapter begins with a short list of important and sensible hints, with a paragraph of explanations devoted to each of them. These hints are worth quoting here: Know and understand the definitions; Work out some examples; Look for counterexamples; Use standard proof methods; Give the proof a skeleton; Start with your assumptions; Be careful of your intellectual biases; Ockham’s razor (“All else being equal, the simplest solution is the best”); Mathematical writing; and Contextual consistency.

Particular advice and opinions can be found throughout the book, for instance the statement that “many students will try to use proof by contradiction as their default proof strategy, but this method really should be our last line of defense.” (p. 36). Or the good advice that “a proof by induction should always begin by announcing itself as a proof by induction.” (p. 57).

Each chapter contains numerous definitions, statements, questions, examples, exercises, and “challenges”; even some jokes appear as numbered items. In spite of these many numbered items, the book is written in a chatty and overall light-hearted style. Interesting quotations, from Aristotle to Whitehead, appear throughout the book.

The title, “A TeXas-Style Introduction to Proof”, hints at a second purpose of this book, namely to introduce students early on to LaTeX, and also to the elements of good writing. This is a particularly successful and appealing aspect of the book. The Appendix contains a very short, but useful, introduction to LaTeX; just 16 pages, including a few pages of tables with the most important special symbols. In addition, throughout the book there are many small and unobtrusive typesetting remarks concerning special symbols as they first appear. This is an excellent way of introducing students to LaTeX, without overwhelming them with a thick LaTeX book or comprehensive online resources.

Why “TeXas-Style”? This was never quite clear to me. The urbandictionary.com defines the term as “big, loud, totally outrageous, gargantuan (sic) and over-the-top”. Certainly not this book! Perhaps it’s nothing more than a play on the word “TeX”? Or perhaps it’s a subtle reference to the famous Moore Method? (R.L. Moore spent most of his career at the University of Texas.) Indeed, in the “To the Instructor” part of the Introduction the authors write,

“There is a purposeful dearth of worked out examples. This is so that students are encouraged to dig into mathematics, get their hands dirty, and create knowledge for themselves.” The authors then go on to indicate how they have used the text themselves: “[...] you may find yourself watching students write something on the board that you know is not good mathematics. The temptation will be to chime in to help set this wayward student on the right path toward a proof. But you must resist this temptation. It is hard. We know this.” Instead, the authors suggest to be patient, and “guide students toward asking good questions of their classmates and accepting good questions from their classmates.” This is certainly good advice, but the authors are probably right in that it may be difficult to follow.

With regards to good mathematical writing, the Appendix of the book also contains two very short essays, one by Neal Carothers (“Mathematical Writing”) and the other by James Munkres (“Comments on Style”). Both essays contain lists of recommendations, and interestingly, both put “Write in complete sentences” as their first recommendation. Munkres puts “Punctuate! (Correctly, if possible.)” in second place, and in a similar vein Carothers suggests, “Proofread, edit, rewrite, proofread, edit, rewrite

...". Another important suggestion is Carothers' #5: "Write. You will notice that most "professional" proofs are absolutely thick with prose. Very few intelligible proofs are written using only mathematical symbols." Munkres, too, has a very similar recommendation.

If your department offers a course on Introduction to Proof, or on Methods of Research in Mathematics, I can highly recommend this book as textbook, or at least as accompanying reading. If such a course is not offered, it may still be useful in various ways. For instance, graduate students or Summer Research students would profit from reading it and (ideally) working through the many exercises and examples. But also, as university teachers and graduate and undergraduate supervisors, we will get some new ideas about how to teach proofs (and good writing) to our advanced students. Finally, to quote the back cover blurb by Michael Starbird, "From this book, students and their instructors will find many proofs of the joy of mathematics."

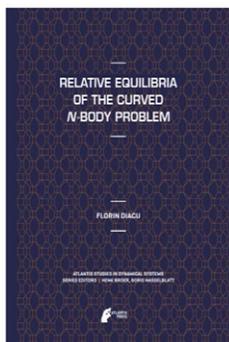
Relative Equilibria of the Curved N-Body Problem

by Florin Diacu

Atlantis Press, Paris, 2012

ISBN: 978-9491216671

Reviewed by *Robert Dawson*, St. Mary's University



As readers will be aware, the late Dr. Florin Diacu edited the Research Notes for some years. He was also a prolific writer, with books on mathematics, on an unconventional theory of history, and on disasters. It was always a pleasure to work with him on the essays that he elicited from various researchers, and it is a melancholy honour to review this, as far as I know his last book. (Memoirs of the AMS Number 1171, "Relative Equilibria

of the 3-Dimensional Curved N-Body Problem" is essentially a second edition; few readers will need both.)

The Newtonian N-body problem in Euclidean 3-space, for $N > 2$, is famously intractable, with many solutions chaotic; but there are a

few special cases for which exact solutions are known. For instance, any two-body system has five Lagrangian points - three metastable points where a third body will remain in line with the primary and secondary but drift away if perturbed, and two stable points leading and lagging the secondary by sixty degrees. The stability of the fourth and fifth Lagrangian points has been a matter of some interest among those interested in space exploration for many years, as it could make them good places for space colonies.

In this book, Diacu considers the corresponding problem in spherical and hyperbolic spaces, with appropriate central forces $F(d)m_1m_2$ taking the place of Newton's inverse-square force law. The force law that he considers is the "cotangent potential" first introduced by Schering in 1870. This potential, defined for any 3-space of constant curvature, reduces to the inverse-square law as $\kappa \rightarrow 0$, and shares many of its good properties. In hyperbolic spaces, the gravitational force drops off exponentially with distance; in spherical spaces, it reaches a minimum halfway to the antipodal point, and then grows stronger again: the antipodal point of a mass essentially exhibits antigravity!

It should be stressed that this is a book of mathematics inspired by physics, rather than a book of real-world physics. When the author says that the results of this book show space to be Euclidean on the scale of ten astronomical units, he means just that and no more. He derives this intriguing if unsurprising fact from the stability of the orbits of the asteroids that congregate near Jupiter's L4 and L5 points; this configuration turns out to be unstable in the curved geometries! There is (as the author makes clear) no real question of space having significant global curvature at such a scale. (We can easily verify this by looking up on a clear night: a universe spherical on such a scale would be a tiny bubble with no room for other stars, while in the hyperbolic case, starlight would fade exponentially with distance and be far too dim to detect.)

The mathematics is elegant, and the book is self-contained (though a familiarity with Lagrangian and Hamiltonian dynamics, as well as standard undergraduate mathematics, would be of some help to the reader.) Various interesting stable configurations are exhibited, including one in a spherical universe with six bodies in two linked rings of three that will test most readers' visualization powers. Overall, it's an entertaining read, mixing geometry, dynamics, and a touch of erudite whimsy. *Ave atque vale*, Florin!

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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.

John McLoughlin, University of New Brunswick
(johngm@unb.ca)

Kseniya Garaschuk, University of Fraser Valley
(kseniya.garaschuk@ufv.ca)

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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Kseniya Garaschuk, University of Fraser Valley
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This issue features discussion of a bridging program at University of Manitoba. The article by Darja Barr discusses a collaborative effort between the College of Nursing and the Department of Mathematics designed to promote mathematical success amongst the Indigenous student population. Such contributions concerning innovations at a local level are welcomed in Education Notes.

The Power of Relationship Building for Indigenous Student Success

Darja Barr, University of Manitoba
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Context

At post secondary institutions across Canada, the recruitment and retention of Indigenous and First Nations students is receiving ever more attention and resources (4-12). At the University of Manitoba, one of the Five Strategic Priorities that are laid out in our strategic plan is *Creating Pathways for Indigenous Achievement*. In this section, the University outlines its commitment to “building a culturally rich, safe and supportive learning and work environment in which an increasing number of Indigenous students, faculty and staff succeed” through increasing Indigenous student enrolment and increasing Indigenous student retention and graduation rates. However, in Manitoba, as of 2011, those

identifying as Indigenous or Aboriginal peoples made up around 17% of the population, and census data predicts that this number will increase to 19% by 2026 (1). On the other hand, at the University of Manitoba, our student body in 2016 was made up of only 8% Indigenous or Aboriginal identifying peoples (2,3). Clearly, this group is underrepresented at our University, and continues to be despite significant efforts to increase numbers and graduation rates. This reflects a broader trend where Indigenous students and other minorities are underrepresented and have lower retention rates in STEM (Science, Technology, Engineering and Math) programs across North America (4). There are many complex issues associated with the underrepresentation of Indigenous peoples in post-secondary education. In fact, the transition from high school to university is difficult for many students because of the differences in expectations, environment, teaching style, and a variety of other factors. These challenges are only enhanced and made more significant for students who come from First Nations communities, where the culture and environment may be very different than that experienced on a university campus. Thus, faculty members across a variety of Departments are being encouraged to explore different ways in



which to attract and retain Indigenous students and support them towards achieving success.



In the Department of Mathematics, we have a somewhat unique challenge in that not only are Indigenous students are highly underrepresented in our field and in our courses (4), but that the incoming mathematical knowledge of our students from First Nations communities is highly varied. These students may not have had access to high school mathematics courses or teachers with strong mathematical backgrounds. This in turn can lead to difficulty completing first year mathematics requirements, leading to withdrawal from courses, programs of choice, and the university in general. This reality motivated us to seek opportunities to link with other Faculties whose Indigenous students were taking our first year mathematics courses as a gateway into their field of choice. One of these was the College of Nursing. Through partnership and a joint sense of purpose we were able to collaboratively develop a program which addressed Indigenous Nursing hopefuls' struggles with university mathematics within the orientation program that they were already offering. The hope was that this joint effort would result in increased success in both their coursework and retention in the Nursing program.

The Aboriginal Nursing Cohort Initiative

At the University of Manitoba, the *Aboriginal Nursing Cohort Initiative* (ANCI), the College of Nursing and the Department of Mathematics came together to develop a program that aimed to increase student success overall and more specifically in *Applied Finite Mathematics* (MATH 1010). This mathematics course has long been a significant barrier to the ability of students in this cohort to successfully be accepted into the Nursing Program. In the summer of 2015, the Faculty of Nursing approached the Department of Mathematics and the Dean's office of the Faculty of Science to begin a strategic partnership that would address the cohort's struggles with mathematics. Rather than attempting to remove or bypass the mathematics requirement for their students, the ANCI team was dedicated to supporting students in mathematics and to cooperating with our Department in any way necessary to achieve success. In the fall of 2015, the first attempt to improve ANCI student performance in MATH 1010 consisted of creating a

special section of the course, reserved for the ANCI students only. The thought was that these students would feel more comfortable in a small classroom environment, surrounded by their peers, rather than in the typical, large (100+) classes. Though there was no significant change in student outcomes from the previous class format to the small class format, the students expressed their preference for the small class format. After the term, we again came together to reflect and rethink our approach. This time, we wanted to align with research that has identified various factors that can enhance the experiences (and thus retention and persistence) of Indigenous students at University, and specifically in STEM disciplines. Some of these factors include:

- 1) Building strategic partnerships (6),
- 2) Reinforcing cultural identity (7,8),
- 3) Creating opportunities to connect with other Indigenous students (8),
- 4) Building relationships between faculty and Indigenous students (8).

ANCI Orientation

At that time, the MATH 1010 course was also undergoing an overhaul, with the format changing to a two-track system meant to provide early alerts and support to struggling students, while allowing for a parallel environment that would challenge students who could advance quickly through the material (13). Through discussions and research, the ANCI program coordinators decided to implement a significant Math Academy as a required part of their orientation program in August 2016. This orientation was geared specifically to their incoming ANCI cohort – a cohort of First Nations students who were completing the first year prerequisite coursework to apply to the Nursing program. It aimed to bring these students together in a peer group where they could meet other students with similar backgrounds and ambitions. The orientation was mandatory for these students, and was designed to address several purposes as follows: prepare the ANCI students for university through identification of resources and support centers on campus; focus on cultural identity through the inclusion of Elders as speakers and identity-focused activities; and build foundational mathematics skills. The timing during the last week in August, facilitated participation of students from towns or First Nations communities outside of Winnipeg who would be coming to campus to begin the school term. The program was funded jointly by the Faculty of Nursing and the Pacific Institute for the Mathematical Sciences (PIMS).

Each morning was devoted to mathematics in a PIMS Math Academy led by myself and a mathematics graduate student (Lindsay Wessel in the first year, Jane Breen in the second). The first day of the Orientation began with Introductions of the ANCI team, and a prayer and short talk about Indigenous history and the importance of giving back to the community by the Elder-in-residence. Following that, each student came up in turn and shared information about their First Nation community, their ancestry, and

the types of traditions and ceremonies that they participated in. Students represented Metis, Cree, Dene, and Ojibwe backgrounds from a variety of communities – from right outside of Winnipeg all the way to the Northwest Territories. They shared information about powwows, sweat lodges, and traditional dances that they enjoyed participating in, and the activity showcased the uniqueness and variety of the participants, while giving them the opportunity to find common ground with one another.

We began the Math Academy on the second day of the week. First, we gave the students a short (15 question) multiple choice diagnostic test to identify levels of students' incoming mathematical background so that we could plan for activities and content that would best suit the group's needs. For the rest of the Academy we partnered with JUMP Math to provide a PIMS funded resource designed especially for this group. The resource consisted of a workbook that covered the number line, fraction arithmetic, linear equations, graphing and word problems. Our mornings were spent doing mini-lectures, following which the ANCI students worked on materials in groups throughout the mornings. We found that the groups naturally formed themselves with peers of similar mathematical background and abilities, and this allowed us to differentiate and target instruction in a streamlined way. We were able to speed the faster groups through the material independently, while taking the time to provide the other groups with additional attention and guidance.

Afternoons were spent exploring the campus, learning about services on campus, effective tools for success, tutorials and tutors, reading high volumes, note taking, and creating a student survival kit. Overall, the goal of the week was to familiarize the participants with campus and the resources available to them, while targeting mathematics enrichment or remediation as needed on an individual basis.

An ANCI student from the first year of the program wrote the following:

"Before the Math Academy took place, I had not been enrolled in a math course for quite some time. The academy refreshed my mind and gave me a head start as to what to expect in a university math course. It set the ground work for my mind to become in tune with

understanding problems, setting up equations and properly utilizing formulas. This all was an effective lead into Math 1010. If any student was to ask me, "Was the Math Academy time worth spent" my answer would be it was absolutely time worth spent with an amazing professor who was as excited to see me learn as I was myself."

– Lisa Schick

Results

All of the PIMS Math Academy students were registered to take the MATH 1010 Applied Finite Mathematics course in the Fall 2016 term, directly following the Academy. The following table summarizes the Fall 2016 post-Academy results in comparison to Fall 2015's small class size format results (which mirrored the usual results for this cohort before ANCI and the Department of Mathematics began working together):

| Format | Small Class Size (Fall 2015) | Track A/B (Fall 2016) |
|---|------------------------------|------------------------------|
| Total ANCI Students Enrolling | 19 | 18 |
| Total ANCI Students Completing (C or better) | 7 (36.8%) | 9 (50%) |
| ANCI Failure and Withdrawal (DFW) | 14 (73.7%) | 9 (50%) *All Withdrawals* |
| ANCI Average GPA | 1.65 (D-C) | 3.17 (B-B+) |

The most significant quantitative result was the distribution of grades. The Track A/B system identified the students who were in need of significant remediation early on in the term. This allowed them to withdraw from the course without spending the rest of the term struggling, while supporting those who needed some remediation (Track B) or no remediation (Track A) to achieve their full potential. This can be seen in the average GPA results of those completing



the course. Students either withdrew from the course, or ended with a grade of C or better (none finished with an F or D). Overall, more (both in number and proportionally) students completed the course successfully this year as compared to the past year, and those who did complete the course did so with significantly higher grades. With this system in place, we were able to close the gap between average GPA for the ANCI students and the average GPA of the class overall (which was around 3.6, or B+). Of the 9 students who withdrew from the course, they re-registered for the course in the Winter 2017 or Fall 2017 term, and all have completed the course successfully since.

Empowerment Through Volunteer Experiences

Another notable result of the PIMS Math Academy is that several of the ANCI students have become a valuable addition to our Math Mania team. Though the CMS notes have highlighted Math Mania activities before (<https://cms.math.ca/notes/v45/n5/Notesv45n5.pdf> and <https://cms.math.ca/notes/v46/n3/Notesv46n3.pdf>), it has not been explored from the perspective of the impact of and on the volunteers. The ANCI volunteer group has travelled to numerous communities around the province, including Opaskwayak Cree Nation, Sagkeeng, Lake St. Martin, Pinaymootang, Little Saskatchewan, Crane River, Jackhead, and Peguis First Nations. This group of students went from a space of general anxiety and apprehension about mathematics, to being key members in the provision of mathematics games and activities to young Indigenous students. They have found a new sense of empowerment with mathematics, now passing along a confidence and enthusiasm for mathematics to other Indigenous students. An ANCI student had the following to say about her experiences with Math Mania:

"I really liked seeing the children's faces light up when they understood how each of the math games worked. I was working the 'pathways to the star' game and it was amazing to see how each child quickly understood what they were doing. Once they figured out one puzzle, the expression on their face was priceless; they felt confident in what they were doing and continued on. I've never seen children so excited about doing anything science or math related. It's really amazing to bring activities like these to different schools and get the children to enjoy these subjects and continue on with their academic journey. I was never really confident with math or science as a kid and I really wish there was a program like Math Mania to get me more excited about science and math. The program that Darja and Kristie [another volunteer] do is truly amazing and I cannot wait to help and participate in the next Math Mania we do!"

– Linda Maclean

Closing Comments

In reflecting on the experiences with this cohort of students, I believe that the relationship building that occurred throughout the week of Academy had the biggest impact. We were able to get to know each other outside of the traditional classroom environment, and built personalized, authentic relationships that all students,



especially First Nations students, are most likely to respond to (7,8). The students felt comfortable approaching me, their instructor, during the MATH 1010 course in the term following the Academy, both over email and in person. They not only were able to succeed in their own coursework, but went further to participate in activities that brought the joy of mathematics to young First Nations students all around the Province. It was the openness to learning from and about each other that, I feel, was truly the factor that led to these students' success in the mathematics course and beyond.

Summer bridge programs such as the PIMS Math Academy at the University of Manitoba have been shown to have success with underrepresented minority populations, specifically in STEM fields (5-7). However, it is much more than the content delivered during these bridge programs that leads to Indigenous students' success at university. It is the dedication that these programs show to relationship building – between peers, between students and faculty, and between faculty members who are committed to Indigenous student success – that contains the potential to change the story of First Nations students in University STEM programs. Because of the success of the program in its initial year, the ANCI orientation and PIMS Math Academy ran again in the summer of 2017, and will run for the third time in the summer of 2018. In the next run of the orientation, we will be modifying our approach once again. This time, we will be combining the Track A/B format with the small class format by creating a separate Track B class, specifically reserved for the ANCI students who are struggling in the course. In this way, we hope to see both the achievement benefits from the altered course delivery format, as well as the student engagement and comfort benefits of the small class size.

Many of the students from the initial Academy have now completed their prerequisite course work and have gone on to be accepted into the Nursing program. If we continue to build such programs that value cultural identity and encourage Indigenous students to see themselves as a part of the post-secondary experience, we can continue to foster success for all of our students.

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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**.

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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**.

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Learning mixtures of high-dimensional Gaussians

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Suppose we are given an i.i.d. sample generated from an unknown probability distribution μ , and are asked to approximate μ . That is, given an $\epsilon > 0$, we are asked to find a distribution $\hat{\mu}$ satisfying $\text{TV}(\mu, \hat{\mu}) \leq \epsilon$, where TV denotes the *total variation distance*: if Ω is the sample space, then $\text{TV}(\mu, \hat{\mu}) := \sup_{A \subseteq \Omega} |\mu(A) - \hat{\mu}(A)|$. This fundamental problem is called *density estimation* in statistics, and *distribution learning* in computer science and machine learning. We are interested in knowing how many samples from μ is needed to be able to find an ϵ -close $\hat{\mu}$. In this short note we review some techniques for bounding sample complexity of density estimation, focusing on the class of mixtures of high-dimensional Gaussians. Note that we assume access to infinite computational power, i.e., we focus on the information-theoretic (or statistical) aspects of the problem and do not discuss computational complexity issues, which become important if one wants to *implement* the method.

Definition (sample complexity of learning a distribution class).

If we do not know anything about μ , solving the problem would be hopeless, i.e., the sample complexity will not be finite. So, we would typically assume the target distribution μ belongs to some known class \mathcal{F} of distributions.¹ We define the *sample complexity function* $m_{\mathcal{F}} : (0, 1] \rightarrow \mathbb{Z}_{\geq 0}$ as follows: for any $\epsilon \in (0, 1]$, $m_{\mathcal{F}}(\epsilon)$ is the smallest integer m such that there exists a density estimation method that given an i.i.d. sample of size m from any $\mu \in \mathcal{F}$, with probability at least $2/3$ outputs a distribution $\hat{\mu}$ satisfying $\text{TV}(\hat{\mu}, \mu) \leq \epsilon$.² Note that $\hat{\mu}$ is not required to belong to \mathcal{F} . The method knows the class \mathcal{F} but does not know the particular μ . We say \mathcal{F} can be *learned/estimated* with $m_{\mathcal{F}}(\epsilon)$ samples. This uniform notion of learning (where $m_{\mathcal{F}}$ is independent of the particular choice of μ) is sometimes called *minimax* density estimation in the statistics literature. For the fundamental case

¹ It is possible to relax this by only assuming that μ is close to a member of \mathcal{F} . See e.g., [2].

² Since the sample is randomly generated, one cannot hope to succeed deterministically.

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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when \mathcal{F} is a finite class of distributions, [4, Theorem 6.3] gives $m_{\mathcal{F}}(\epsilon) = O(\log |\mathcal{F}|/\epsilon^2)$.

An $O(d^2/\epsilon^2)$ upper bound for d -dimensional Gaussians using VC-dimension. Suppose \mathcal{F} is the class of d -dimensional normal distributions. We shall show that \mathcal{F} can be learned with $O(d^2/\epsilon^2)$ samples. Suppose we are given an i.i.d. sequence $X_1, \dots, X_m \sim \mu$, for some unknown $\mu \in \mathcal{F}$. These m points define an *empirical distribution* μ' on \mathbb{R}^d : $\mu'(A) := |A \cap \{X_1, \dots, X_m\}|/m$. Unfortunately, μ' is not a good estimate for μ ; indeed, it is not hard to see that $\text{TV}(\xi, \mu') = 1$ for any $\xi \in \mathcal{F}$ and any finite m . So, all normal distributions are equidistant from μ' if we use the total variation distance. It turns out that we need to switch to another distance measure, called the *Yatacos distance*: the *Yatacos class* of \mathcal{F} , denoted $\mathcal{Y}(\mathcal{F})$, is a family of subsets of \mathbb{R}^d , with $A \in \mathcal{Y}(\mathcal{F})$ iff there exist $\xi_1, \xi_2 \in \mathcal{F}$ with $A = \{x \in \mathbb{R}^d : \text{density of } \xi_1 \text{ at } x > \text{density of } \xi_2 \text{ at } x\}$. This set system induces a distance between distributions, defined as $d_{\mathcal{Y}(\mathcal{F})}(\xi_1, \xi_2) := \sup_{A \in \mathcal{Y}(\mathcal{F})} |\xi_1(A) - \xi_2(A)|$. We let $\hat{\mu} := \operatorname{argmin}_{\xi \in \mathcal{F}} d_{\mathcal{Y}(\mathcal{F})}(\xi, \mu')$. Then, the uniform convergence theorem (e.g., [4, Page 31]) gives that with probability at least $2/3$, $\text{TV}(\hat{\mu}, \mu) = O(\sqrt{v/m})$, where v is the *VC-dimension* of the set system $\mathcal{Y}(\mathcal{F})$.³ This implies that, for any class \mathcal{F} , $m_{\mathcal{F}}(\epsilon) = O(\text{VC-dim}(\mathcal{Y}(\mathcal{F}))/\epsilon^2)$. For the class of normal distributions, one can give an upper bound of $O(d^2)$ for $\text{VC-dim}(\mathcal{Y}(\mathcal{F}))$ using standard methods, and this gives $m_{\mathcal{F}}(\epsilon) = O(d^2/\epsilon^2)$. We refer the reader to [2] for the details.

Definition (mixture distributions). Let $k \in \mathbb{Z}_+$, and let \mathcal{F} be a distribution class. The *k-mixture* of \mathcal{F} , written $k\text{-mix}(\mathcal{F})$, is the class of distributions of the form $\sum_{i=1}^k w_i \mu_i$, where each $\mu_i \in \mathcal{F}$, the w_i 's are nonnegative and sum to 1. Let $\mathcal{G}_{d,k}$ denote the class of k -mixtures of d -dimensional normal distributions. We will show $\tilde{\Theta}(dk^2/\epsilon^2)$ samples are necessary and sufficient for learning this class.⁴ We have already discussed the case $k = 1$; next, we consider the case $k > 1$.

A generic upper bound for mixtures. We prove that for any class \mathcal{F} we have $m_{k\text{-mix}(\mathcal{F})}(\epsilon) = O(k \log k \cdot m_{\mathcal{F}}(\epsilon)/\epsilon^2)$. Suppose the target distribution is $\mu = \sum_{i=1}^k w_i \mu_i$, where each $\mu_i \in \mathcal{F}$. Consider a die with k faces, such that when you roll

³ VC-dimension is a measure of complexity of a set system; see wikipedia for its definition.

⁴ The \sim at the top of Θ allows for logarithmic factors.

it, the i th face has probability w_i of coming. To generate a point according to μ , one can roll this die and if the i th face comes, generate a point according to μ_i . So, any i.i.d. sample generated from μ can be coloured with k colours, such that almost a w_i fraction of points have colour i , and the points with colour i are i.i.d. distributed as μ_i . Now, if the colouring was given to the algorithm, there was a clear way to proceed: estimate each of the μ_i using the \mathcal{F} -learner, and estimate w_i by the proportion of points with colour i , and then output the resulting mixture. The issue is that the colouring is not known. However, the algorithm can do an exhaustive search over all possible colourings, and ‘choose the best one.’ More precisely, the algorithm has two main steps. In the first step, by considering all possible colourings, we generate a finite set of ‘candidate distributions,’ such that at least one of them is ϵ -close to μ . In the second step, we take lots of additional samples and use [4, Theorem 6.3] to choose the best one among the candidates, obtaining a distribution that is ϵ -close to μ . It turns out the total number of candidate distributions is bounded by $k^{O(km_{\mathcal{F}}(\epsilon))} = \exp(O(k \log k \cdot m_{\mathcal{F}}(\epsilon)))$, which gives the generic mixture bound. Details can be found in [2].

An $\tilde{O}(kd^2/\epsilon^2)$ upper bound for mixtures of Gaussians using compression schemes. Given the bound $O(d^2/\epsilon^2)$ for learning $\mathcal{G}_{d,1}$, the generic mixture bound gives $m_{\mathcal{G}_{d,k}}(\epsilon) = \tilde{O}(kd^2/\epsilon^4)$. An improved upper bound of $\tilde{O}(kd^2/\epsilon^2)$ can indeed be proved for this class using a technique called *compression schemes*. Informally speaking, we say class \mathcal{F} of distributions can be *compressed* if, given a large enough sample from some $\mu \in \mathcal{F}$, one can ‘encode’ μ via an appropriate small subset of the sample. In other words, the sample can be ‘compressed.’ One would then show, using ideas from convex geometry and random matrix theory, that the class $\mathcal{G}_{d,1}$ is compressible, and that if a class of distributions is compressible, then so is the class of mixtures of those distributions. This implies $\mathcal{G}_{d,k}$ is compressible as well. Finally, a learning algorithm can do an exhaustive search over the sample to ‘guess’ the small subset, and then ‘decode’ the distribution. Details can be found in [1].

An $\tilde{\Omega}(kd^2/\epsilon^2)$ lower bound for $\mathcal{G}_{d,k}$. We next describe a tight (module logarithmic factors) sample complexity lower bound of $\tilde{\Omega}(kd^2/\epsilon^2)$ for $\mathcal{G}_{d,k}$. First, observe that by choosing the components far enough, it suffices to give a lower bound of $\tilde{\Omega}(d^2/\epsilon^2)$ for $\mathcal{G}_{d,1}$. Using Fano’s inequality from information theory, to prove a lower bound of $\tilde{\Omega}(\log M/\epsilon^2)$ for any class \mathcal{F} , it suffices to find M distributions $\mu_1, \dots, \mu_M \in \mathcal{F}$ with $\text{KL}(\mu_i \parallel \mu_j) = \tilde{O}(\epsilon^2)$ and $\text{TV}(\mu_i, \mu_j) > \epsilon$ for all $i \neq j$.⁵ We construct a family of size $2^{\Omega(d^2)}$ of zero-mean Gaussians with different covariance matrices. To construct the covariance matrices, we sample $2^{\Omega(d^2)}$ matrices from the following probabilistic process: start with an identity covariance matrix. Then choose a random subspace of dimension $d/9$ and slightly increase the eigenvalues

corresponding to this eigenspace from 1 to $1 + \epsilon/\sqrt{d}$. It is easy to bound the KL divergence between the constructed Gaussians. To lower bound the total variation distance, we show that for every pair of these distributions, there is some subspace for which a vector drawn from one Gaussian will have slightly larger projection than a vector drawn from the other Gaussian. We refer the reader to [1] for details.

Further reading. A longer version of this note can be found in [3]. The reader is referred to [5] for a broader, recent survey. For a general, well written introduction to density estimation, read [4].

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⁵ $\text{KL}(\cdot \parallel \cdot)$ denotes the Kullback-Leibler divergence, or the relative entropy, between two distributions; see Wikipedia for its definition.

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Les articles de la SCHPM présente des travaux de recherche en histoire et en philosophie des mathématiques à la communauté mathématique élargie. Les auteurs sont membres de la Société canadienne d'histoire et de philosophie des mathématiques (SCHPM). Vos commentaires et suggestions sont le bienvenue; ils peuvent être adressées à l'une des co-rédacteurs:

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Joseph Fourier on convolution and the memory problem

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After d'Alembert and Euler, applications of convolution integrals appeared at the end of the 18th century and the beginning of the 19th century. These were in potential theory, the heat conduction equation, and the wave equation as developed by Lagrange, Laplace, Legendre, Fourier, Cauchy, and Poisson. Here we emphasize Fourier's contribution, in a relatively unknown article, to the superposition principle for memory, time-delay and superposition of events. Fourier's Superposition Integrals correspond to an earlier development of a *special version* of the Duhamel Principle for partial differential equations [7, pp. 463–466]. This note illustrates also Fourier's talents as a mathematical modeler.

We can explain the superposition principle as follows. How can we represent a function of time in terms of the past values of its derivative (the memory effect)? We can integrate numerically the derivative by the rectangular rule, and we obtain:

$$f(t) \approx f(0) + (f'(0)u(t) + f'(\tau)u(t - \Delta\tau) + f'(2\tau)u(t - 2\Delta\tau) + \dots + f'(n\tau)u(t - \Delta n\tau)) \times \Delta\tau, \quad (1)$$

where $\Delta\tau$ is the time increment, and $u(t - \tau)$ is a Heaviside step function. Observe that in (1), we have addition (superposition) of elements with the time delay which is represented by the translation kernel in the step function. In a more compact form, (1) is written as:

$$f(t) = f(0) + \sum_{i=0}^n f'(i\tau)u(t - i\Delta\tau)\Delta\tau, \quad (2)$$

and if we take the limit when $\Delta\tau$ goes to zero, we obtain the convolution integral:

$$f(t) = f(0) + \int_0^t f'(\tau)u(t - \tau)d\tau. \quad (3)$$

In his research, Fourier truly mastered the convolution integrals. We have found more than forty convolution integrals in his *Théorie analytique de la chaleur*, published in 1822 [3]. Also, his article [4], published in 1818, concerned the equation of a vibrating membrane

and its solution as a convolution. In the same article Fourier made a comparison with the wave equation and the heat equation and their solutions under the structure of convolution integrals. Fourier's objectives were ultimately to prove that these convolution integrals could describe complex natural effects. Struck by the similarities between the solutions, such as that in each equation the initial state and time were included, Fourier remarked:

The analogy from which we speak does not result from the physical nature of causes; it resides altogether in the mathematical analysis that lends common forms to most diverse phenomena.

The secret was a hidden property of convolution integrals. The present state of the temperature of an infinite prism, of the position of an elastic blade, or of the state of a wave, all depended upon their past values.

In the late 18th and the 19th centuries, the cooling of the earth became the object of intense study. For Fourier, the problem of the terrestrial temperature presented one of the most beautiful applications of the theory of heat. In 1821–1822, he published an astonishing article about terrestrial temperatures, and about the diffusion of heat inside a spherical solid, subject to periodic temperature changes at its surface [5]. Fourier admitted that the examination of this problem would require multiple observations, which were yet lacking. In 1825, he wrote a new memoir [6] on the analytical theory of heat, in which he changed again the boundary conditions at the surface of a solid. Fourier proposed to study the effect when the temperature V at both extremities of a prism of length ℓ was subject to two time-dependent functions that may be periodic or not. His mathematical model was a non-dimensional heat conduction equation:

$$\frac{\partial V}{\partial t} = \frac{\partial^2 V}{\partial x^2}; \quad 0 < x < \ell; t > 0, \quad (4)$$

with the boundary conditions:

$$\begin{aligned} V(0, t) &= \varphi(t), \\ V(\ell, t) &= f(t), \end{aligned} \quad (5)$$

and the initial value:

$$V(x, 0) = \psi(x). \quad (6)$$

Here V is the temperature, t the time, x the distance from the first extremity; the distance from the second extremity will be represented by the variable ϖ .

With time-dependent boundary conditions, Fourier realized that if the time variable was made discrete, the solid did not have enough time to reach a permanent regime at each stage of discretization. If t is the total time, he would divide the time t into a “multitude of parts” t_1, t_2, t_3, \dots . Then it became clear that a temperature at time t_i affected the temperature at time t and that this influence depended upon the difference $t - t_i$. At each of these times, Fourier supposed, a progressive increase of the temperature of one extremity, for example $f(t_i)$, is infinitely small, and the value of the increase is $f'(t_i)dt$. Thus he stated the solution to this question as follows:

$$V(x, t) = \frac{x}{\varpi} f(t) + \frac{2}{\varpi} \sum_{i=1}^{\infty} \frac{1}{i} \sin(ix) \cos(i\varpi) \left\{ f(0) + \int_0^t f'(r) e^{-i^2(t-r)} dr \right\} \\ + \frac{(\varpi - x)}{\varpi} \varphi(t) - \frac{2}{\varpi} \sum_{i=1}^{\infty} \frac{1}{i} \sin(ix) \left\{ \varphi(0) + \int_0^t \varphi'(r) e^{-i^2(t-r)} dr \right\} \quad (7) \\ + \frac{2}{\varpi} \sum_{i=1}^{\infty} \sin(ix) \int_0^{\varpi} \psi(r) \sin(ir) dr.$$

Like the geometers of the 18th century, Fourier verified that his solution obeys a non-dimensional heat conduction equation and the boundary conditions. He emphasized that the solution has three distinct parts. The first row represents the state where the point zero is restricted to having a zero temperature and the temperature of the other extremity varies as $f(t)$. We can see the analogy with Eq. (3). Conversely, in the second row the extremity zero has a variable temperature $\varphi(t)$ and the other extremity is restricted to a zero temperature. In the third row, the boundary conditions are both fixed at zero and the initial temperature of the solid has a distribution $\psi(x)$. In rows one and two, he obtained a solution in the form of convolution integrals $\int_0^t f'(r) e^{-i^2(t-r)} dr$ and $\int_0^t \varphi'(r) e^{-i^2(t-r)} dr$

Thus the memory effect and the superposition principle were established through these two convolution integrals. Note that the boundary conditions appear under the form of their derivatives $f'(r)$ and $\varphi'(r)$. This is due to the discretization and the quadrature of $f(r)$ and $\varphi(r)$.

Fourier was an extremely clever mathematical modeler. Because of the linearity of the partial differential equation he utilized the principle of superposition for the boundary conditions and the initial value, and thus was able to decompose his problem into smaller parts. Fourier’s memoir was read at the Academy of Sciences in 1825, but was not published until 1829, just one year before his death. In the meantime, Poisson’s memoir on the same type of approach was read at the same Academy in 1826. His work concerned the theory of magnetism in motion. He was followed by Liouville in 1832 and Duhamel in 1833 [2] and 1834, particularly on the heat conduction equation with, again, time-dependent boundary conditions. In his article published in 1833, Duhamel

provided more details about the superposition principle. Note that in the Anglo-German world, this principle of superposition is known as the Boltzmann-Hopkinson principle. Boltzmann’s article *Zur Theorie der elastischen Nachwirkung* (the after-effect of elasticity), was a brilliant exposition of the superposition principle, memory effects, and convolutions [1]. Published in 1874, this article seems very modern.

Finally, we have noticed that in 1830 Lejeune-Dirichlet [8] published his own solution to Fourier’s problem, Eqs. 4–6. His approach was more mathematically oriented, with no physical considerations, but he missed the convolution effects. However, he presented his method step by step, and at the end he found Fourier’s answer.

In conclusion, Fourier is often considered the father of modern mathematical physics because of his contribution to parabolic partial differential equations. If the Dirichlet conditions correspond to values of the function at the boundary of the domain of integration, and if the Neumann conditions are named for the values of its normal derivative at the frontier of the domain, we suggest, in order to honor Fourier, the name “Fourier condition” for a periodic condition at the border of the domain.

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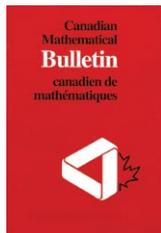
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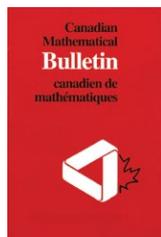
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| Ailana Fraser (UBC Vancouver) | 12/2020 | Rédactrice associée |
| Alexander Furman (Illinois Chicago) | 12/2021 | Rédacteur associé |
| Wee Teck Gan (National University of Singapore) | 12/2021 | Rédacteur associé |
| Dragos Ghioca (UBC Vancouver) | 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 (Universita 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 |
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| 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 (Universita 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 |
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| Juncheng Wei (UBC Vancouver) | 12/2018 | Rédacteur associé |
| Daniel Wise (McGill) | 12/2018 | Rédacteur associé |

Canadian Mathematical Society SUMMER MEETING

Fredericton | June 1-4, 2018



2018 CMS Summer Meeting

June 1 – 4, 2018

University of New Brunswick, New Brunswick, Fredericton

Scientific Directors:

Colin Ingalls (University of New Brunswick)
cingall@unb.ca

Alexandre Girouard (Université Laval)
alexandre.girouard@mat.ulaval.ca

Scientific Sessions

All scientific sessions will take place at the University of New Brunswick.

Advances in Harmonic Analysis and PDEs

Org: **David Cruz-Uribe** (University of Alabama), **Galia Dafni** (Concordia University) and **Scott Rodney** (Cape Breton University)

Algebraic groups and related topics

Org: **Eddy Campbell** (University of New Brunswick) and **David Wehlau** (Royal Military College of Canada)

Categories and Topology

Org: **Darien DeWolf** (St. Francis Xavier University), **Pieter Hofstra** (University of Ottawa) and **Dorette Pronk** (Dalhousie University)

Cohomology – a link between numbers and geometry

Org: **Stefan Gille** (University of Alberta), **Jan Minac** (Western University) and **Kirill Zainoulline** (University of Ottawa)

Combinatorial Game Theory

Org: **Svenja Huntemann** (Dalhousie University), **Neil McKay** (University of New Brunswick, St. John) and **Rebecca Milley** (Memorial University)

Computational and Diophantine Number Theory

Org: **Michael Bennett** (University of British Columbia), **Keith Johnson** (Dalhousie University) and **Gary Walsh** (University of Ottawa)



Réunion d'été de la SMC 2018

1 – 4 juin, 2018

l'Université du Nouveau Brunswick, Nouveau-Brunswick, Fredericton

Directeur scientifique :

Colin Ingalls (l'Université du Nouveau Brunswick)
cingall@unb.ca

Alexandre Girouard (Université Laval)
alexandre.girouard@mat.ulaval.ca

Contributed Papers

Dynamical systems and spatial models in ecology

Org: **Amy Hurford** (Memorial University)

Ergodic Theory, Dynamical systems, Fractals and Applications

Org: **Shafiqul Islam** (University of Prince Edward island) and **Franklin Mendivil** (Acadia University)

Geometric Potential Theory

Org: **Jie Xiao** (Memorial University)

Graph Searching & Pursuit-Evasion Games on Graphs

Org: **Dr. Danielle Cox** (Mt. St. Vincent University) and **Dr. Christopher Duffy** (University of Saskatchewan)

Mathematical Aspects of Quantum Information Theory

Org: **Nathaniel Johnston** (Mount Allison University) and **Sarah Plosker** (Brandon University)

Mathematical Epidemiology

Org: **Lin Wang** and **James Watmough** (University of New Brunswick)

Noncommutative Geometry and Topology

Org: **Branimir Ćaćić** (University of New Brunswick), **Dan Kucerovsky** (University of New Brunswick) and **Martin Mathieu** (Queen's University Belfast)

Number Theory

Org: **Alia Hamieh** (University of Northern British Columbia) and **Matilde Lalin** (University of Montreal)

Partial Differential Equations and Variational Problems

Org: **Mohammad El Smaily** (University of New Brunswick)

Prize Lectures

Reesentation theory of algebras and related topics

Org: **Colin Ingalls** (University of New Brunswick) and **Charles Paquette** (Royal Military College of Canada)

Singularities and Phase transitions in Nonlinear PDE's

Org: **L. Bronsard** (McMaster University), **T. Giorgi** (New Mexico State University) and **I. Topaloglu** (Virginia Commonwealth University)

Schedule to be determined

Thomas Bellsky (University of Maine)
Rohit Jain (McGill University)
Maxime Laborde (McGill University)
Xin Yang Lu (Lakehead University)
Guanying Peng (The University of Arizona)
Scott Rodney (Cape Breton University)

Stude Student Research Session

Org: **Aram Demenjian** (UQAM) and **Jean Lagacé** (University of Montreal)

CALL FOR NOMINATIONS - EDITOR-IN-CHIEF

A Taste of Mathematics (ATOM)

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 15, 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

Frédéric Gourdeau (Laval), Associate Editor to 8/2019

Miroslav Lovric (McMaster), Associate Editor to 12/2020

Jamie Mulholland (Simon Fraser), Associate Editor to 12/2020

Denise Charron (CMS), Managing Editor

APPEL DE MISES EN CANDIDATURE - RÉDACTEUR-EN-CHEF

Aime-T-On les Mathématiques (ATOM)

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 15 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 :

- une lettre formelle;
- un curriculum vitae;
- l'expression de votre opinion sur la publication; et
- une inclusion d'un soutien de leur département universitaire.

Veuillez soumettre votre mise en candidature par voie électronique, de préférence en format PDF, à : ATOM-REC-2018@smc.math.ca

Conseil de rédaction ATOM à présent

Kseniya Garaschuk (Fraser Valley),
Rédactrice associée à 12/2020

Frédéric Gourdeau (Laval), Rédacteur associé à 8/2019

Miroslav Lovric (McMaster), Rédacteur associé à 12/2020

Jamie Mulholland (Simon Fraser),
Rédacteur associé à 12/2020

Denise Charron (CMS), Rédactrice-gérante

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.

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^e 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 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.

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

If undelivered, please return to:
Si NON-LIVRÉ, veuillez retourner à :

CMS Notes / Notes de la SMC

209 - 1725 St. Laurent Blvd Ottawa, ON K1G 3V4 Canada