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1 Education

Post Secondary Education

Ph.D. McGill University, Mathematics. 2004-2009
Thesis title: *Systems of equations over free groups: Structures and Complexity*
Supervisor: Olga Kharlampovich

B.Sc. McGill University, Honours Mathematics 2000-2004

Research interests

I am a geometric group theorist. My specialty revolves around hyperbolic groups and their relatives. My primary research interests involve the study of group splittings using low dimensional topology, algorithmic problems in groups, quasi-isometric rigidity, and the computational, algebraic, and logical aspects of equations in groups. More recently I have been interested in the applications of abstract harmonic analysis to group equivariant convolutional neural networks.

2 Employment

Employment History at UNB

Assistant Professor, Department of Mathematics & Statistics 07/2018 - 07/2020
University of New Brunswick

Associate Professor, Department of Mathematics & Statistics 07/2020 - present
University of New Brunswick

Relevant Previous Employment

Stevens Institute of Technology, Teaching Associate Professor, 09/2014 - 06/2018
Department of Mathematical Sciences

Champlain College, Instructor Summer 2014
Continuing Education

Vanier College, Instructor Fall 2013
Continuing Education

Carleton University, Fields postdoctoral fellow, 09/2012 - 09/2013
School of Mathematics and Statistics

Université d'Aix-Marseille, Postdoctoral researcher in the ANR project "Geometric, analytic and algorithmical aspects of groups" 09/2011 - 09/2012

Oxford Mathematical Institute, NSERC postdoctoral fellow 11/2010 - 09/2011
Mathematical Institute

UQÀM, NSERC postdoctoral fellow 09/2009 - 10/2010
Laboratoire CIRGET

Distinctions, Honours, Fellowships, Scholarships

Fields Postdoctoral fellowship 08/2012 - 08/2013

NSERC Postdoctoral fellowship (PDF) 09/2009 - 09/2011

NSERC Alexander Graham Bell fellowship (CGS D2) 09/2007 - 09/2009

Bourse de doctorat en recherche du FQRNT (B2) 05/2007 - 08/2007

Bourse de maîtrise en recherche du FQRNT (B1) 09/2004 - 04/2006

Sigma Xi Excellence in Undergraduate Research Award, 2004
McGill-Montreal Chapter of Sigma Xi.

NSERC Undergraduate research award (USRA) 05/2003 - 08/2003

Bourse d'étude d'été de l'ISM 07/2002 - 08/2002

3 Dissemination of knowledge

Courses Taught in the past 6 years

Instructor for `MATH 3003` (Applied Analysis) Winter 2024
Approximate enrolment: 6
University of New Brunswick

Instructor for `MATH 3033` (Group Theory) Winter 2024
Approximate enrolment: 11
University of New Brunswick

Faculty Mentor for `SCI 1001` (Professional Skills for Science Students) Fall 2023
Approximate enrolment: 15
University of New Brunswick

Instructor for `MATH 3243` (Complex Analysis) Fall 2023
Approximate enrolment: 17
University of New Brunswick

Supervisor for `MATH 4100` (Honours Project) 2022-2023
Student: Rey Blais
University of New Brunswick

Instructor for `MATH 4043/6043` (Advanced Algebra) Fall 2022
Approximate enrolment: 3
University of New Brunswick

Instructor for `MATH 1003` (Calculus 1) Fall 2022
Approxiate enrolment: 200
University of New Brunswick

Instructor for `MATH 3383` (Mathematical Logic) — Winter 2022
Independent Studies Course (1 student)
University of New Brunswick

Instructor for `MATH 3033` (Group Theory) — Winter 2022
Approximate enrolment: 25
University of New Brunswick

Instructor for `MATH 4023/6023` (Functional Analysis) — Fall 2021
Approximate enrolment: 5
University of New Brunswick

Instructor for `MATH 1003` (Calculus 1) — Fall 2021
Approximate enrolment: 200
University of New Brunswick

Supervisor for `MATH 4100` (Honours Project) — 2020-2021
Student: Sam Cookson
University of New Brunswick

Instructor for `MATH 1063` (Enriched Calculus) — Winter 2021
Approximate enrolment: 5
University of New Brunswick

Instructor for `MATH 3343` (Graph Theory) — Winter 2021
Approximate enrolment: 20
University of New Brunswick

Instructor for `MATH 1003` (Calculus 1) — Fall 2020
Approximate enrolment: 300
University of New Brunswick

Instructor for `MATH 6022` (Intro to Geometric Group Theory) — Fall 2020
Approximate enrolment: 5
University of New Brunswick/AARMS Advanced Courses

Supervisor for `MATH 4100` (Honours Project) — 2019-2020
Student: Kaiyu Jiang
University of New Brunswick

Instructor for `MATH 4043` (Advanced Algebra) — Winter 2020
Independent Studies Course
University of New Brunswick

Instructor for `MATH 3343` (Graph Theory) — Winter 2020
Approximate enrolment: 20
University of New Brunswick

Instructor for `MATH 6501` (Analysis for Neural Networks) — Fall 2019
Independent Studies Course
University of New Brunswick

Instructor for `MATH 3213` (Linear Algebra II) — Fall 2019
Approximate enrolment: 25
University of New Brunswick

Instructor for `MATH 4043/6043` (Advanced Algebra) — Fall 2019
Approximate enrolment: 3
University of New Brunswick

Instructor for `MATH 3343` (Graph Theory) Winter 2019
Approximate enrolment: 25
University of New Brunswick University of New Brunswick

Instructor for `MATH 2513` (Multivariable Calculus for Engineers) Winter 2019
Approximate enrolment: 30
University of New Brunswick

Instructor for `MATH 3213` (Linear Algebra II) Fall 2018
Approximate enrolment: 25
University of New Brunswick

Development of New Courses

Representative of Mathematics & Statistics in the development of the interdisciplinary course `Sci1911` (Climate Change Science). To be first offered Winter 2025.

Effective Use or Development of Teaching Aids and Techniques

In Winter 2024, I introduced the use of Jupyter Notebooks hosted on Google Colab. This enabled students to use software such as the `numpy` Python library in order to do numerical computation in the course `MATH 3003` (Applied Analysis) without needing to install anything on their computers.

In Fall 2023, having learned of the damage cell phones can cause to student attention, I instituted an in-class electronic device policy. I also used a physical coloured flashcard-based classroom response system, which had the advantage of being easily integrated into a lecture-based course.

In Winter 2022, I piloted an assessment model where credit was given for fulfilling explicit learning objectives during tests and assignment credit is given solely on the basis of completion in order to support the deeper learning. Improved iterations of this model were successfully used in 3000-level courses in the 2023-2024 academic year.

In Spring 2020, due to the covid-19 pandemic, I successfully pivoted to a fully online course following a flipped classroom model.

At the Stevens Institute of Technology I was part of the *Foundations* program whose goal we to identify best teaching practices as well as favourable institutional cultures to promote deep learning in foundational engineering courses. During four years I participated in the cycle of development, implementation, and assessment of instructional practices. These resulted in a collection of activities and best practices (including TA training) for student problem sessions as well as a method to incorporate "clicker questions" in class.

I wrote `web-crs`: a web-based classroom response system. This open-source webapp is currently in use last in Calculus classes at the Stevens Institute of Technology in Winter 2019.
`https://github.com/LaserTron/web-crs`

Involvement in Curriculum Development

During the 2022-2023 academic year, along with the relevant stakeholders, we started a review of our 3000-level pure mathematics courses. As a result we made modifications to several course calendar descriptions to make them more in line with what was actually taught. We also proposed an update to one of the courses so that it no longer needlessly conflicted with another course. These recommendations were to the curriculum committee in Fall 2023 and have now been implemented in the current official course calendar descriptions.

Direction of Undergraduate Research

Samuel Hawkes, *Neural networks and complex numbers*, Summer 2024, SURE Award

Rey Blais, *The Classification Theorem of Closed Orientable Surfaces*, 2022-2023, Honours Thesis

Ethan O'Connell, *Analog Neural Networks*, Summer 2022, NSERC USRA.

Sam Cookson, *Solving the subgroup membership problem for* $\mathrm{GL}(2,\mathbb{Z})$ *and similar groups*, 2020-2021, Honour's Thesis.

Sam Cookson, *Stallings's foldings in graphs of groups*, Summer 2020, NSERC USRA.

Kaiyu Jiang, *Jordan's Theorem, stochastic matrices and stable distributions*, 2019-2020, Honours Thesis

Graduate supervision

Derrick Kirby (joint with B. Cacic), *TBD*, 2022 - (...) Ph.D.

Benjamin Cook, *Interpolating between splittings over cyclic subgroups*, 2020 - (...) M.Sc.

Cole Dunphy (joint with B. Cacic), *The Topological and Algebraic Picard Groups*, 2020 - 2024 M.Sc.

Matt Brannock, *Kaplansky's Conjectures and Actions on CAT(-1) Spaces*, 2020 - 2023 M.Sc.

Max Hennick, *Group equivariant neural networks*, 2019-2021, M.Sc.

Participation in thesis committees

Mohammed Yasser Ouis, M.Sc in Computer Science at Université de Moncton (Spring 2024).

Mohammed Al-Darwbi, PhD in Computer Science at UNB (Spring 2023).

Shivam Arora, PhD in Mathematics at Memorial University (Spring 2022).

Yavar Abdolmaleki, PhD at UNB in Mathematics (Winter 2022).

Naghmeh Shahverdi, PhD at UNB in Mathematics (Winter 2020).

Participation in supervisory committees (not my students)

Paul Stephan Lissner, PhD in Mathematics (in progress).

Amer Marwan El-Samman, PhD in Chemistry (in progress).

Evan MacTavish, MSc in Mathematics (graduated Summer 2023).

Derrick Kirby, MSc in Mathematics (graduated Winter 2022).

4 Research, scholarly or creative activity

Articles Published or Accepted for Publication in Refereed Journals

A fast algorithm for Stallings foldings over virtually free groups
(with Samuel Cookson) *to appear in IJAC.* `https://arxiv.org/abs/2309.00421`

Panel collapse and its application,
(with Mark F. Hagen) Groups, Geometry, and Dynamics, Volume 13 (2019), Issue 4, 1285-1334.

Deciding Isomorphy using Dehn fillings, the splitting case.
(with François Dahmani) Inventiones Mathematicae, Volume 215 (2019), Issue 1, 81-169.

On geodesic ray bundles in hyperbolic groups,
Proceedings of the American Mathematical Society, Volume 146 (2018), 4165-4173.

Magnus pairs in, and free conjugacy separability of, limit groups
(with Lars Louder), Geometriae Dedicata, Volume 196 (2018), Issue 1, 187-201.

Detecting geometric splittings in finitely presented groups,
Transactions of the American Mathematical Society, Volume 370 (2018), 5635-5704.

Strong accessibility for finitely presented groups,
(with Lars Louder) Geometry & Topology, Volume 21 (2017), 1805-1835.

Multipass automata and group word problems,
(with Tullio Ceccherini-Silberstein, Michel Coornaert, Francesca Fiorenzi, Paul E. Schupp) Theoretical Computer Science, Volume 600 (2015), 19-33.

On the one-endedness of graphs of groups,
Pacific Journal of Mathematics, Volume 278 (2015), Issue 2, 463-478.

Bulitko's Lemma for acylindrical splittings
Journal of Algebra, Volume 406 (2014), 251-271.

The fully residually F quotients of $F * \langle x, y \rangle$,
Groups, Geometry, and Dynamics, Volume 6 (2012), Issue 1, 155-220.

The Solvability Problem for Quadratic Equations over Free Groups is NP-Complete,
(with Igor Lysenok, Olga Kharlampovich, and Alexei Miasnikov) Theory of Computing systems, Volume 47 (2010), Issue 1, 250-258.

The equation $w(x, y) = u$ *over free groups: an algebraic approach*,
Journal of Group Theory, Volume 12 (2009), Issue 4, 611-634.

A Fast Algorithm for Stallings' Folding Process,
International Journal of Algebra and Computation, Volume 16 (2006), Issue 6, 1031-1045.

Preprints

The Conjugacy Problem for $\mathrm{Out}(F_3)$ (submitted)
(with François Dahmani, Stefano Francaviglia, and Armando Martino)
`https://arxiv.org/abs/2311.04010`

Unipotent linear suspensions of free groups (submitted)
(with François Dahmani)
`https://arxiv.org/abs/2305.11274`

Reducing the conjugacy problem for relatively hyperbolic automorphisms to peripheral components (submitted)
(with François Dahmani)
`https://arxiv.org/abs/2103.16602`

Manuscripts in preparation

On the quasi-isometric rigidity of graphs of surface groups
(with Alex Taam)
`https://arxiv.org/abs/1904.10482` (withdrawn due to a mistake and being corrected.)

Panel collapse, wall spaces, and quasi actions on trees

Textbooks

For `MATH6022` I wrote the textbook *An introduction to combinatorial and geometric group theory*, available at `https://ntouikan.ext.unb.ca/MATH6022/IntroCGGT/html_output/frontmatter-1.html/`

Presentation of Seminars, Clinics, Workshops

Invited Presentations and other Visits

Led a research group at the "Geometry in Groups" program at the ICTS-TIFR. Bengaluru, India (July 28 to August 10 2024).

On the structure of mapping tori: towards the conjugacy problem in $\mathrm{Out}(F_n)$. GAGTA 2021. Edinburgh, United Kingdom (online) (June 7 to June 11 2021.)

On the quasi-isometry and commensurability classification of low height constructible groups. LMS Scheme 2 grant. United Kingdom (March 9 to March 18 2018.)

Quasi-isometrically rigid graphs of surface groups. Young GAGTA. Bilbao, Spain (June 2017.)

Free conjugacy separability in limit groups. South Eastern Logic Symposium 2017. Gainesville, Florida (March 2017.)

Makanin-Razborov diagrams for relatively hyperbolic groups. Young Geometric Group Theory V. Karlsruhe, Germany (February 2016.)

Other Presentations (since 2016)

The conjugacy problem in $\mathrm{Out}(F_3)$ *is solvable.* Geometry of Subgroups (Part of the CRM Thematic Program in Geometric Group Theory). Montreal, Québec (May 2023.)

Sur l'utilisation des suspensions pour résoudre le problème de conjugaison dans $\mathrm{Out}(F_n)$. Le séminaire virtuel francophone Groupes et Géométrie. (online) (March 2023.)

Panel collapse and many-ended topological groups. Groups, Rings, Lie and Hopf Algebras IV. St-John's, Newfoundland (June 2022.)

Collapsing cube complexes. New York Group Theory Seminar . New York, New York (February 2018.)

On the set of homomorphisms to a relatively hyperbolic group.. AMS Sectional Meeting, Special Session on Geometric Group Theory. Brunswick, Maine (September 2016.)

Magnus pairs in, and conjugacy separability of, limit groups. Manhattan Algebra Day. New York, New York (December 2016.)

Research retreats

Conjugacy between automorphisms of free groups. Research in Residence. CIRM, Marseile (February 2023.)

Grants

NSERC Discovery Grant: *Constructible groups and ramifications of JSJ theory.* $24,000 per year. 04/2019 - 03/2025

NSERC Early career research supplement. $12,500. 04/2019 - 03/2020

Mitacs Accelerate: *Equivariant Siamese Neural Networks.* $60,000 total award. 09/2019-12/2020

Conferences Organized (past 6 years)

Co-organizer of the *2nd workshop of AARMS CRG on Mathematical Foundations of Scientific Machine Learning* University of New Brunswick August 2023

Co-organizer of the *Geometric Group Theory* scientific session at the 2022 Canadian Mathematical Society (CMS) Summer Meeting. June 2022

5 Service (UNB)

Departmental Committees

Terms are indicated in academic year so, for example, 2020-2022 means 2020-2021 and 2021-2022.

CMS Math Camp.	2023-2024
Calculus Challenge Exam.	2023-2024
Nominating Committee.	2020-2021, then 2022-2024
Engineering Liaison.	2019-2024
Undergraduate Curriculum.	2019-2024
GAU Executive	2019-2024
Putnam and Science East Math competitions.	2018-2024
Science Atlantic Representative.	2019-2022
Data Science search committee (second attempt).	2020-2021
Assessment/Level 1.	2020-2021
Data Science search committee.	2019-2020
Ethics.	2018-2019

Other departmental service

Serving in a 3-year term as the Mathematics & Statistics representative on the S-ROC (science recruitment and outreach committee.) 2023-2026

With Branimir Cacic, I organized the 2019 Inter-Campus Seminar Day of the Mathematics and Statistics GAU. 04/2019

Outreach

Conducted the activity *Building Mathematics* aimed at middle school students June 5$^{\text{th}}$ 2024 UNB Day of STEM for Homeschool Children	06/2024
Presented a talk: *What's the deal with* $0.999999\ldots = 1$*?* New Brunswick Math Competition	05/2024
Presented a talk: *Combing a Sphere, Combing a Doughnut* New Brunswick Math Competition	05/2019
Judge at the Canada-Wide Science Fair	05/2019

6 Service (prior to UNB)

While at the Stevens Institute of Technology I was a member of the following committees:

Mathematical Sciences Website Committee	2015-2018
Graduate Program Committee	2016-2018
Departmental Salary Increase Review Committee	Fall 2017

7 Other Relevant Information

I am the spouse of Charlène Rochefort-Allie. We have a daughter Simone and a son Pierre, both are usually delightful. Here are some other facts.

Spoken Languages: Native speaker of English and French, basic knowledge of Cantonese.

Erdös-Bacon number: 7