Guillaume Brouillette

Guillaume.Brouillette@uqtr.ca
ORCID: 0000-0003-2805-4492

Research interests

Computational topology, (discrete) Morse theory, multiparameter persistent homology, topological data analysis, deep learning, large language models

Education

2019 – 2025 **Doctorat en mathématiques**, *PhD in mathematics*
Université de Sherbrooke – Sherbrooke, Canada
Advisors: Tomasz Kaczynski and Madjid Allili
Thesis title: Extension et application de la théorie de Morse-Forman à l'homologie persistante multiparamètre
Extending and Applying Morse-Forman Theory to Multipersistent Homology

2017 – 2019 **Maîtrise en mathématiques et informatique appliquées**
MSc in Applied Mathematics and Computer Science
Université du Québec à Trois-Rivières (UQTR) – Trois-Rivières, Canada
Advisor: Dominic Rochon
Thesis title: Classification des coupes tridimensionnelles principales des Multibrots multicomplexes
Classification of the Principal Tridimensional Slices of the Multicomplex Multibrots

2014 – 2017 **Baccalauréat en mathématiques**, *BSc in Mathematics*
Université du Québec à Trois-Rivières (UQTR) – Trois-Rivières, Canada

Honors and awards

2025 BMO Financial Group Scholarship, Fondation de l'UdeS

2022 – 2025 Canada Graduate Research Scholarship — Doctoral, Natural Sciences and Engineering Research Council of Canada

2020 – 2022 Doctoral Research Scholarship, Fonds de recherche du Québec

2019 National Scholarship, Canada Employment and Immigration Union

2017 – 2019 Master's Research Scholarship, Fonds de recherche du Québec

2017 and 2018 Graduate Scolarships, Institut des sciences mathématiques (ISM)

2017 Admission Award (declined), Université du Québec à Trois-Rivières

2016 and 2017 Undergraduate Student Research Awards, Natural Sciences and Engineering Research Council of Canada

2014 Admission Award, Université du Québec à Trois-Rivières

Publications

G. Brouillette (2025). **Analyzing multifiltering functions using multiparameter Discrete Morse Theory**. *Topological Methods in Nonlinear Analysis* 66.2, pp. 597–645. DOI: 10.12775/TMNA.2025.020

G. Brouillette, M. Allili, and T. Kaczynski (2024). **Multiparameter discrete Morse theory**. *Journal of Applied and Computational Topology* 8, pp. 2155–2196. DOI: 10.1007/s41468-024-00176-7

G. Brouillette and D. Rochon (2019). **Characterization of the Principal 3D Slices Related to the Multicomplex Mandelbrot Set**. *Advances in Applied Clifford Algebras* 29.39. DOI: 10.1007/s00006-019-0956-1

G. Brouillette, P.-O. Parisé, and D. Rochon (2019). **Tricomplex Distance Estimation for Filled-In Julia Sets and Multibrot Sets**. *International Journal of Bifurcation and Chaos* 29.6. DOI: 10.1142/S0218127419500858

Research experience

2025 – Present **Postdoctoral researcher**, département de mathématiques et d'informatique, UQTR
Supervisors : Nadia Ghazzali and Usef Faghihi
- Develop and implement novel methods for the topological analysis of multidimensional data
- Apply these methods to analyze and improve the architecture of a large language model

2019 – 2025 **Doctoral candidate**, Département de mathématiques, Université de Sherbrooke
Advisors: Tomasz Kaczynski and Madjid Allili
- Extend discrete Morse theory to vector-valued functions
- Develop algorithms to derive a vector-valued discrete Morse function from multivariate point data
- Implement algorithms in order to apply the extended discrete Morse theory to the computation of multipersistent homology and the topological analysis of multivariate data

2017 – 2019 **Graduate student**, Département de mathématiques et d'informatique, UQTR
Advisor: Dominic Rochon
- Researched multicomplex fractals
- Gave a characterization of the principal 3D slices of the Multibrots, which are fractal sets generalizing the Mandelbrot set

2016 – 2017 **Undergraduate research intern**, Département de mathématiques et d'informatique, UQTR
Supervisor: Alain Goupil
— Explored various topics of combinatorics
— Examined et enumerated diverse families of polyominoes

Teaching experience

2018 – Present **Instructor**, Département de mathématiques et d'informatique, UQTR
Découvertes mathématiques – Winters 2022, 2023, 2025 and 2026
Using both problem-based and project-based approaches, this undergraduate course introduces various topics in mathematics, notably in the field of combinatorics, and initiates students to the research process
Éléments d'analyse – Fall 2025
Éléments de calcul différentiel – Fall 2018
Éléments de calcul intégral – Fall 2018

2019 – 2021 **Teaching assistant**, Département de mathématiques, Université de Sherbrooke
Notions fondamentales de calcul différentiel – Fall 2021
Géométrie analytique – Winters 2020 and 2021
Analyse II – Fall 2019

2017 – 2019 **Teaching assistant**, Département de mathématiques et d'informatique, UQTR
Analyse à une variable réelle I – Winter 2019
Topologie et analyse à plusieurs variables – Fall 2017
Analyse quantitative de problèmes de gestion – Winter 2017
Vecteurs, calcul matriciel – Winter 2017
Éléments de calcul différentiel – Winter 2017
Éléments de calcul intégral – Winter 2017

Technical skills

Programming languages

Python (expert), Java (intermediate), R (novice)

Software

LaTeX(expert), Excel (intermediate), ParaView (intermediate), Git (intermediate), SAS (novice)

Conferences and posters

February 2026	Les chandails ont trois trous : Une introduction à l'homotopie *Horizons Mathématiques*, Trois-Rivières
May 2025	Toward an Application of Combinatorial Topological Dynamics to Multifiltering Functions *Combinatorial Topological Dynamics*, Kraków
June 2024	Analyzing Multifiltrations Using Multiparameter Discrete Morse Theory *VIII Symposium on Nonlinear Analysis*, Toruń
June 2023	Extending Morse-Forman theory to vector functions *Foundations of Computational Mathematics 2023 conference*, Paris
July 2022	Extending Morse-Forman Theory Through Combinatorial Dynamics *Topological Methods in Nonlinear Analysis: Recent Advances – Professor Andrzej Granas' Memorial Conference*, Montréal
May 2022	Théorie de Morse discrète multidimensionnelle *ISM Graduate Student Conference*, Québec
May 2021	Théorie de Morse-Forman et homologie persistante *ISM Graduate Student Conference*, online
March 2019	Classification des coupes tridimensionnelles de l'ensemble de Mandelbrot généralisé *Concours d'affiches scientifiques de l'UQTR*, Trois-Rivières
October 2018	L'ensemble de Mandelbrot et ses généralisations *Congrès de l'Association Mathématique du Québec*, Montréal
May 2018	Les coupes principales tridimensionnelles des fractales multicomplexes *ISM Graduate Student Conference*, Sherbrooke
March 2018	Sur les serpents deux-côtés *Concours d'affiches scientifiques de l'UQTR*, Trois-Rivières
March 2017	Les polyominos parallélogrammes: réseaux, produit et primalité *Concours d'affiches scientifiques de l'UQTR*, Trois-Rivières
October 2016	Les polyominos parallélogrammes *Congrès de l'Association Mathématique du Québec*, Québec

Academic service

2026	**Co-organizer**, *Horizons Mathématiques* seminar, UQTR
2025 – 2026	**Reviewer**, 42nd International Symposium on Computational Geometry (SoCG 2026)
2023 – 2024	**Reviewer**, Cahiers Mathématiques de l'Université de Sherbrooke (CaMUS)
2017	**Co-organizer**, ISM Graduate Student Conference, Trois-Rivières
2016	**Volunteer**, International Conference on Image and Signal Processing, Trois-Rivières

Involvement

2024 – Present	Treasurer and coordinator, local political party authority, Trois-Rivières
2022 – 2025	Coordinating committee member, regional political party authority, Mauricie
2022	Official agent of a candidate, Quebec general election, Trois-Rivières
2021 – 2022	Board member, InfoLogis Mauricie
2015 – 2017	Student association executive council member, Association des étudiants en mathématiques et informatique de l'UQTR, Trois-Rivières

References

Nadia Ghazzali, professor
Département de mathématiques et d'informatique, Université du Québec à Trois-Rivières
Nadia.Ghazzali@uqtr.ca
1 819 376-5011 (3818)

Usef Faghihi, professor
Département de mathématiques et d'informatique, Université du Québec à Trois-Rivières
Usef.Faghihi@uqtr.ca
1 819 376-5011 (3812)

Tomasz Kaczynski, retired professor
Département de mathématiques, Université de Sherbrooke
Tomasz.Kaczynski@USherbrooke.ca
1 819 821-8000 (62889)

Madjid Allili, professor
Departments of Computer Science and Mathematics, Bishop's University
mallili@UBishops.ca
1 819 822-9600 (2740)