Luis Scoccola

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Education

2016–2020 | **University of Western Ontario**
- PhD Mathematics - Type Theory, Computational Topology

2010–2016 | **Universidad de Buenos Aires**
- BSc + MSc Mathematics (*Licenciatura Mátematicas*)
- BSc Computer Science (*Analista Universitario Computación*)

Research Interests

- *Reinforcement Learning*, *Generative Models*, and *Formal Methods* for *Machine-Assisted Theorem Proving*.
- *Geometric Machine Learning* and *Geometric Data Science*.
- *Computational Topology and Geometry*, *Persistence Theory*, and *Representation Theory of Posets*.
- *Type Theory* and *Formalization*.

Research Experience

(w/ ML projects; for math papers see next page)

2024–curr. | **Université du Québec à Montréal** + **Université de Sherbrooke** – CRM-ISM Fellow

- Reinforcement Learning and Formal Methods for Machine-Assisted Theorem Proving and provably correct reasoning (*in progress*).
- Benchmarking the informal mathematical capabilities of Large Language Models (*in progress*).
- Geometric Optimization and Graph Neural Networks for representation learning of graph and point cloud data. [ICML 2025] [software]

2023–2024 | **University of Oxford** – Research Associate in Mathematics

- Algorithms and theoretical guarantees for differentiability and gradient descent convergence of Geometric and Topological Regularization. Example applications: Graph Vectorization, Graph Classification, Dimensionality Reduction. [ICML 2024]
- Learning representations of geometrically complex data with computational topology. Example applications: Dimensionality Reduction and Pointcloud Vectorization. Software [JOSS 2023a] and theory [Symp. Comp. Geom. 2023].

2020–2023 | **Michigan State University → Northeastern University** – Research Associate in Mathematics

- Interactive density-based clustering with computational topology. Software [JOSS 2023b] and theory [JMLR 2024].
- Vectorization of Graph and Point Cloud data with computational topology. Example applications: Graph, Time Series, and Point Cloud classification. [NeurIPS 2023]

Selected Publications

(∗ first author)

- *Cover learning for large-scale topology representation*
  International Conference on Machine Learning (ICML 2025) *__Scoccola__, Lim, Harrington
- On the bottleneck stability of rank decompositions of multi-parameter persistence modules
  Advances in Mathematics (2024) w/ M. B. Botnan, S. Oppermann, S. Oudot.
- Localization in homotopy type theory
  Higher Structures (2020) w/ D. Christensen, M. Opie, E. Rijke.

Selected Software

- *Persistable: persistent and stable clustering*. *__S.__, Rolle. **Journal of Open Source Software** (JOSS) [Git][PyPI][Docs]
  High performance density-based clustering library for exploratory data analysis, with a web UI for visualization and parameter selection. *Written in:* Python + Cython + Dash (for web UI).
- *DREiMac: dimensionality reduction with Eilenberg–MacLane coordinates*.*{Perea,__S.__,Tralie} **JOSS** [Git][PyPI][Docs]
  Topological data visualization and dimensionality reduction for circularity and (quasi)periodicity in data.
  Written in: Python + Numba. **Used in** [Schneider et al., Nature, 2023].

Service

- *Reviewer:* 20+ math papers (Trans. AMS, Forum. Math. Sigma, . . .), 10+ ML papers (NeurIPS, ICML, . . .).
- (2024) *Supervisor:* Math master thesis at Technical University Munich (w/ Ulrich Bauer).
- (2024) *Organizer:* 5-day BIRS Banff workshop on Representation Theory and Topological Data Analysis.
- (2024) *PhD candidacy committee:* University of Oxford (w/ V. Nanda).
- (2023-2024) *Organizer:* University of Oxford seminar on Topological Persistence in Geometry and Analysis.
- (2023) *Postdoc hiring committee:* Max Planck Inst. of Molecular Cell Biology and Genetics (w/ H. Harrington).
- (2023) *Organizer:* 2-day AMS special session on Topological Persistence: Theory, Algorithms, and Applications.
- (2022-2023) *Organizer:* Persistence, Sheaves, and Homotopy Theory Online Seminar.

Teaching and Talks

- *Speaker:* 55+ invited talks at conferences, workshops, and seminars.
- (2025) *Invited lecturer, minicourse*: Introduction to Persistence, Okinawa Institute of Science and Technology.
- (2021) *Invited lecturer, minicourse*: Applied Topology minicourse, EMALCA 2021, Perú.
- (2019-2021) *Instructor:* Calculus (University of Western Ontario), Calculus II (Michigan State University).
- (2016-2020) *Teaching assistant:* Algebraic Topology, Introduction to Cryptography, Mathematical Structures, Linear Algebra, Methods of Finite Mathematics, and Calculus, at University of Western Ontario.

Articles and Software

Mathematics

- Counts and end-curves in two-parameter persistence.
  w/ T. Brüstle, S. Oudot, H. Thomas (2025)
- Stabilization of the spread-global dimension.
  w/ B. Blanchette, J. Desrochers, E. J. Hanson (2025)
- Decomposing zero-dimensional persistent homology over rooted tree quivers. w/ R. Bindua, T. Brüstle (2024)
- Multi-parameter persistence modules are generically indecomposable. w/ U. Bauer
  International Mathematics Research Notices (2025)
- Computing Betti tables and minimal presentations of zero-dimensional persistent homology. w/ D. Morozov
  Symp. on Computational Geometry (SoCG 2025)
- On the bottleneck stability of rank decompositions of multi-parameter persistence modules. w/ M. B. Botnan, S. Oppermann, S. Oudot. **Advances in Mathematics** (2024)
- On the stability of multigraded Betti numbers and Hilbert functions. w/ S. Oudot.
  SIAM Journal on Applied Algebra and Geometry (2024)
- Approximate and discrete Euclidean vector bundles.
  w/ J. A. Perea. **Forum of Mathematics, Sigma** (2023)
- Rectification of interleavings and a persistent Whitehead theorem. w/ E. Lanari. **Algebraic & Geometric Topology** (2023)
- The Hurewicz theorem in homotopy type theory.
  w/ D. Christensen. **Algebraic & Geometric Topology** (2023)
- Locally persistent categories and metric properties of interleaving distances. **PhD Dissertation, UWO** (2020)
- Nilpotent types and fracture squares in homotopy type theory.
  Mathematical Structures in Computer Science (2020)
- Localization in homotopy type theory.
  w/ D. Christensen, M. Opie, E. Rijke. **Higher Structures** (2020)
- The integers as a higher inductive type. w/ T. Altenkirch
  Symp. on Logic in Computer Science (LICS 2020)

Machine Learning and Data Science

- Cover learning for large-scale topology representation.
  L.S., U. Lim, H. A. Harrington
  International Conference on Machine Learning (ICML 2025)
- Differentiability and optimization of multiparameter persistent homology. L.S., S. Setlur, D. Loiseaux, M. Carrière, S. Oudot
  International Conference on Machine Learning (ICML 2024)
- Stable and consistent density-based clustering via multiparameter persistence. A. Rolle, L.S.
  Journal of Machine Learning Research (2024)
- Stable vectorization of multiparameter persistent homology using signed barcodes as measures. D. Loiseaux, L.S., M. Carrière, M. B. Botnan, S. Oudot
  Adv. Neural Information Processing Systems (NeurIPS 2023)
- Toroidal coordinates: decorrelating circular coordinates with lattice reduction. L.S., H. Gakhar, J. Bush, N. Schonsheck, T. Rask, L. Zhou, J. A. Perea
  Symp. on Computational Geometry (SoCG 2023)
- Fiberwise dimensionality reduction of topologically complex data with vector bundles. L.S., J. A. Perea
  Symp. on Computational Geometry (SoCG 2023)

Software

- ShapeDiscover: cover learning with geometric optimization. L.S., U. Lim. [Git] (2025)
- FufPy: fast union-find in Python. High-performance implementation using Numba. [Git] [Pypi] [Docs] (2025)
- Persistable: clustering with multi-parameter persistence.
  L.S., A. Rolle. [Git] [Pypi] [Docs]
  Journal of Open Source Software (2023)
- DREiMac: dimensionality reduction with Eilenberg-MacLane coordinates. w/ J. A. Perea, C. Tralie. [Git] [Pypi] [Docs]
  Journal of Open Source Software (2023)