

Mathieu Carrière

Topological Data Analysis
Statistical Machine Learning

☎ +33(0) 4 92 38 77 57
✉ mathieu.carriere@inria.fr
Address: Antibes, France
French/American

Short Bio

I did my PhD at Inria Saclay in the DataShape team, under the supervision of Steve Oudot, and a postdoc of two years in the Rabadán Lab, at the Department of Systems Biology of Columbia University, under the supervision of Raúl Rabadán. In between, I spent a few months at Fujitsu Laboratories in Japan, as part of a collaborative project between Inria and Fujitsu, see <https://www.inria.fr/en/datashape-project-team-work-fujitsu>. My research focuses on topological data analysis and statistical machine learning, with applications in, e.g., bioinformatics. I contributed to the analysis of topological descriptors and their use in machine learning tools such as kernel methods and deep learning. All details can be found on my website: <https://www-sop.inria.fr/members/Mathieu.Carriere/>.

Education

- 2024-Present **Chairholder**, 3IA Côte d'Azur, Sophia Antipolis, France.
- 2020-Present **Research Scientist (CRCN)**, DataShape team, Centre Inria d'Université Côte d'Azur, Sophia Antipolis, France.
- 2018-2020 **Postdoc. Research Fellow**, Rabadán Lab, Columbia University, New York, USA.
- 2014-2018 **Ph.D. in Computer Science**, EDSTIC (Saclay), Inria Saclay, Palaiseau, France.
Title: On metric and statistical properties of topological descriptors for geometric data.
- 2011-2014 **Engineering Degree**, Ecole Centrale Paris, Châtenay-Malabry, France.
- 2013-2014 **M.Sc. in Mathematics, Vision and Learning (MVA)**, ENS Cachan, Cachan, France.

Selected Publications

I am mostly working at the intersection of topological data analysis and statistical machine learning, as well as their applications. Below, I provide a curated list of some of my most representative publications, in computational geometry and topology, as well as artificial intelligence proceedings and journals. My full list of publications is available at: <https://www-sop.inria.fr/members/Mathieu.Carriere/publis/publis.html>, and my Google scholar is available at: <https://scholar.google.com/citations?user=K4B97dMAAAAJ&hl=fr>.

Structure and stability of the one-dimensional Mapper.

Mathieu Carrière and Steve Oudot.

Foundations of Computational Mathematics (FoCM), 18(6):1333–1396, 2017.

Sliced Wasserstein kernel for persistence diagrams.

Mathieu Carrière, Marco Cuturi, and Steve Oudot.

In 34th International Conference on Machine Learning (ICML 2017), volume 70, pages 664–673, PMLR, 2017.

Statistical analysis and parameter selection for Mapper.

Mathieu Carrière, Bertrand Michel, and Steve Oudot.

Journal of Machine Learning Research (JMLR), 19(12):1–39, 2018.

PersLay: a neural network layer for persistence diagrams and new graph topological signatures.

Mathieu Carrière, Frédéric Chazal, Yuichi Ike, Théo Lacombe, Martin Royer, and Yuhei Umeda.

In 23rd International Conference on Artificial Intelligence and Statistics (AISTATS 2020), pages 2786–2796, 2020.

Optimizing persistent homology based functions.

Mathieu Carrière, Frédéric Chazal, Marc Glisse, Yuichi Ike, Hariprasad Kannan, and Yuhei Umeda.

In 38th International Conference on Machine Learning (ICML 2021), volume 139, pages 1294–1303, 2021.

Persistent homology based characterization of the breast cancer immune microenvironment: a feasibility study.

Andrew Aukerman, Mathieu Carrière, Chao Chen, Kevin Gardner, Raúl Rabadán, and Rami Vanguri.

Journal of Computational Geometry (JoCG), 12(2), 2022.

A gradient sampling algorithm for stratified maps with applications to topological data analysis.

Jacob Leygonie, Mathieu Carrière, Théo Lacombe, and Steve Oudot.
Mathematical Programming, 2023.

Differentiability and convergence of filtration learning with multiparameter persistence.

Luis Scoccola, Siddharth Setlur, David Loiseaux, Mathieu Carrière, and Steve Oudot.
In 41st International Conference on Machine Learning (ICML 2024), 2024.

Multi-parameter Module Approximation: an efficient and interpretable invariant for multi-parameter persistence modules with guarantees

David Loiseaux, Mathieu Carrière and Andrew J. Blumberg
Journal of Applied and Computational Topology (JACT), 2025.

Selected Invited Talks and Courses

I have participated to many different seminars and conferences in computational topology and machine learning. Below, I provide a curated list of recent scientific events for which I was invited and funded by the organizers for giving a talk/keynote/introductory course. My full list of talks is available at: <https://www-sop.inria.fr/members/Mathieu.Carriere/talk/talk.html>

Talk: "Probabilistic and Statistical Analysis of the Mapper algorithm in Topological Data Analysis".

Symposium on Probabilistic Methods in Biological Sciences, March 6th 2020,
Columbia University, New-York, USA.

Keynote: "An introduction to Topological Data Analysis".

Le Monde des Mathématiques Industrielles, March 8th–9th 2021,
Centre Inria d'Université Côte d'Azur (online), Sophia Antipolis, France.

Talk: "Topology identifies emerging adaptive mutations in SARS-CoV-2".

When AI meets Biology: a workshop, October 1st 2021,
Université de Lyon (online), Lyon, France.

Talk: "An introduction to Topological Machine Learning".

Interpretable and higher-order statistics for late-time cosmology, June 27th–July 1st 2022,
Institute for Fundamental Physics of the Universe, Trieste, Italy.

Talk: "Topological Machine Learning with applications in Computational Biology".

ml4geo : Machine Learning for Geometry Workshop, October 26th 2023,
Institut Henri Poincaré, Paris, France.

Introductory Lecture: "A Statistical Perspective on Multiparameter Persistent Homology".

Dagstuhl Seminar on Applied and Combinatorial Topology, Feb. 25th–March 1st 2024,
Schloss Dagstuhl, Dagstuhl, Germany.

Course: "Basic concepts in topological data analysis".

Introductory School to IHP's thematic quarter on Geometry and Statistics in Data Sciences, Sept. 5th–9th 2022,
IESC Cargèse, Corsica, France.

Course: "Topological Data Analysis".

École d'hiver Statski, February 1st–3rd 2023,
Université de Franche Comté, Metabief, France.

Course: "Analyse topologique de données".

Journées Mathématiques X-UPS, April 22nd–23rd 2024,
École Polytechnique, Palaiseau, France.

Code Contributions

I am part of the editorial board of the Gudhi library for topological data analysis, to which I am heavily involved in the development and maintenance. I have created several Python submodules (with backend in C++) of the Gudhi library, with Scikit-Learn- and TensorFlow-based APIs for easy integration with these libraries and better accessibility to machine learning practitioners. More precisely, I have developed the following modules:

Representations module: Scikit-Learn-like classes for persistence diagram representations in ML pipelines.

<https://gudhi.inria.fr/python/latest/representations.html>.

Cover complex module: Scikit-Learn-like classes for cover complexes computation in data visualization.
https://gudhi.inria.fr/python/latest/cover_complex_sklearn_user.html.

PersLay module: TensorFlow layer for optimizing representations of persistence diagrams.
https://gudhi.inria.fr/python/latest/representations_tflow_itf_ref.html.

Differentiation module: TensorFlow models for computing and optimizing persistence diagrams.
https://gudhi.inria.fr/python/latest/cubical_complex_tflow_itf_ref.html.
https://gudhi.inria.fr/python/latest/rips_complex_tflow_itf_ref.html
https://gudhi.inria.fr/python/latest/ls_simplex_tree_tflow_itf_ref.html

I have also been involved in the development of tutorials for the Gudhi library, which concretely describe how to implement machine learning pipelines on real-world data sets with topological tools. See <https://github.com/GUDHI/TDA-tutorial> and the tutorials therein corresponding to the modules described above.

Other coding projects outside of Gudhi can be accessed there: <https://www-sop.inria.fr/members/Mathieu.Carriere/code/code.html>.

Grants and Prizes

I received the following prizes for my work:

- 2017 Best Scientific Contribution 2017 (2nd Prize – 600 euros) from the STIC doctoral school.
- 2018 Thiessé de Rosemont / Schneider Prize (10,000 euros) from Chancellerie des Universités de Paris.

I have been awarded the following grants:

- 2016 Mobility Grant (1000 euros) from the DAAD exchange program.
- 2023 ANR JCJC TopModel (213,993 euros) on multiparameter topological data analysis methods for cosmology and single-cell data.
- 2023 PEPR SN AI4scMed (141,181 euros) on topological data analysis methods for spatial transcriptomics data.

Teaching Activities

I am supervising the following Ph.D. students:

- 2025–on co-advisor of Théo Prosper.
- 2025–on co-advisor of Tony Zaayer.
- 2023–2026 co-advisor of Ziyad Oulhaj, *Statistical contributions to the Mapper algorithm*.
- 2021–2024 supervisor of David Loiseaux, *Multiparameter topological persistence for machine learning*.

I am currently teaching M2 classes on topological data analysis and its interactions with machine learning and applications. More precisely, I am in charge of the following courses:

- 2021–2026 *Geometric and Topological Methods in Data Analysis, with Applications in Biology and Medicine*, M2, MSc. Data Science and Artificial Intelligence (MScDSAI), Université Côte d'Azur, Nice, France.
<http://www-sop.inria.fr/abs/teaching/uca-master-data-science-GTML/uca-master-data-science-GTML--cazals-boissonnat-carriere.html>
- 2024–2026 *Statistical Learning Theory*, M2, MSc. Data Science and Artificial Intelligence (MScDSAI), Université Côte d'Azur, Nice, France.
- 2024–2026 *Basic Algebra for Data Analysis*, M1, MSc. Data Science and Artificial Intelligence (MScDSAI), Université Côte d'Azur, Nice, France.
- 2020–2024 *Foundations of Geometric Methods in Data Analysis*, 3rd Year of Engineering Program, CentraleSupélec, Gif-sur-Yvette, France.
<http://www-sop.inria.fr/abs/teaching/centrale-FGMDA/centrale-FGMDA--cazals-carriere.html>

As a Ph.D. student, I was a teaching assistant for the following courses:

- 2015–2017 *Topological Data Analysis*, Ecole Polytechnique, Palaiseau, France.
<https://www.enseignement.polytechnique.fr/informatique/INF556/>
- 2016–2017 *Basics of Algorithmic and Programming*, Ecole Polytechnique, Palaiseau, France.
<https://www.enseignement.polytechnique.fr/informatique/INF411/>

Outreach Activities

I have been a reviewer for many different journals and conferences in computational topology and machine learning. For instance, I have regularly participated to the reviewing process of:

ML/AI ICML, ICLR, NeurIPS, JMLR, TMLR.

Comp. Topo. SoCG (PC in 2026), DCG, JACT, JoCG, Proc. AMS.

I have been a jury member for the Gilles Kahn Ph.D. prize between 2022–2024:

<https://www.societe-informatique-de-france.fr/recherche/prix-de-these-gilles-kahn/>

I was part of the organizing committee of the following scientific events:

May 2022 *Computational Geometry Days 2022*, Online.

<https://project.inria.fr/jga2022/>

2019–2020 *New-York Applied Topology Meeting Group*, Columbia University, New-York, USA.

<https://psoc.c2b2.columbia.edu/index.php/new-york-applied-topology-meeting-group/>

Nov. 2019 *Symposium on Random Matrix Theory*, Columbia University, New-York, USA.

<http://mc4660-projects.s3-website-us-east-1.amazonaws.com/rmtsymp2019/index.html>

Moreover, I wrote a few Medium blog posts about topological data analysis and its usefulness in data science, available at: <https://medium.com/@mathieu.carriere3>

References

Steve Oudot

GeomeriX team

Inria Saclay

91120 Palaiseau, France

steve.oudot@inria.fr

+33(0) 1 74 85 42 16

Marco Cuturi

CREST - ENSAE

Université Paris-Saclay

91120 Palaiseau, France

marco.cuturi@ensae.fr

+33(0) 1 70 26 69 31

Raúl Rabadán

Systems Biology Department

Columbia University

New-York, USA

rr2579@columbia.edu