Ximena L. Fernández

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Current Position

Lecturer at the Department of Mathematics, **St Georges City University of London**.

Academic appointments

Sep 2023 - Aug 2024 **Postdoctoral Research Associate**, University of Oxford, UK.
Advisor: Prof. Heather Harrington.

Sep 2021 - Aug 2023 **Postdoctoral Research Associate**, Durham University, UK.
Advisor: Prof. Jeffrey Giansiracusa.

Oct 2020 - Aug 2021 **Postdoctoral Research Associate**, Swansea University, UK.
Advisor: Prof. Jeffrey Giansiracusa.

Jan 2020 - Sep 2020 **Research and Teaching Fellow**, University of Buenos Aires, Argentina.

Industrial appointments

May 2019 - Dec 2019 **Data Scientist**, Properati, OLX Group, Argentina.
Machine learning models for predictions in real state and recommendation systems.

Oct 2018 - Apr 2019 **Mathematical Models Specialist**, CAMMESA, Argentina.
Optimization and prediction models for the distribution of electric energy in Argentina.

Education

2011 - 2017 **PhD in Mathematics**, Department of Mathematics, University of Buenos Aires.
Advisor: Prof. Elías Gabriel Minian.
Thesis: Combinatorial methods and algorithms in low dimensional topology and the Andrews-Curtis conjecture.

2005 - 2011 **Licenciate in Mathematical Sciences (equivalent to M.Sc.),** Department of Mathematics, University of Buenos Aires.
Advisor: Prof. Elías Gabriel Minian.
Thesis: Topology of finite spaces: an algorithmic approach.

Research publications and preprints

Authors are listed alphabetic order unless it is marked with * the first (co-) author(s).

2024 X. Fernández* and D. Mateos. *Topological biomarkers for real-time detection of epileptic seizures.* **Submitted.** (2024) `arxiv:2211.02523`.

2024 W. Reise*, X. Fernández*, M. Dominguez. H. A. Harrington and M. Beguerisse-Díaz, *Topological fingerprints for audio identification.* **SIAM Journal on Mathematics of Data Science** Vol. 6 Iss. 3 (2024).

2024 X. Fernández, *Morse theory for group presentations.* **Trans. Amer. Math. Soc.** 377 (2024), 2495-2523

2023 X. Fernández*, E. Borghini, G. Mindlin and P. Groisman. *Intrinsic persistent homology via density-based metric learning.* **Journal of Machine Learning Research**, 24 (2023) no. 75, 1-42.

2023 S. Benas*, X. Fernández* and E. Kropff. *Modeled grid cells aligned by a flexible attractor.* **eLife** 12:RP89851.

2020 X. Fernández and E.G. Minian. *The cylinder of a relation and generalized versions of the Nerve Theorem.* **Discrete Comput. Geom.** 63 (2020), no. 3, 549–559.

2016 X. Fernández and E.G. Minian. *Homotopy colimits of diagrams over posets and variations on a theorem of Thomason.* **Homology Homotopy Appl.** 18 (2016), no. 2, 233–245.

Other Publications

2019 **Book** *Algebra A* (Introduction to Linear Algebra for Engineering, Computer Science and Mathematics). N. Capitelli, R. Escayola, X. Fernández and G. Rossi. Publisher: **EUDEBA.** ISBN 9789502329703. (2019)

Teaching

University of Oxford, UK

Hilary Term 2024 **Tutor**, Mathematical Institute.
Course: Computational Algebraic Topology.

Mich. Term 2023 **Tutor**, Mathematical Institute.
Course: Introduction to Probability.

University of San Andrés, Argentina

Feb 2020 - Aug 2020 **Lecturer**, Department of Mathematics.
Course: Calculus (one variable).

Torcuato DiTella University, Argentina

Mar 2016 - Feb 2018 **Lecturer**, Department of Mathematics.
Courses: Calculus I (one variable) and Calculus II (several variables).

University of Buenos Aires, Argentina

Jan 2020 - Sep 2020 **Graduate Teaching Assistant**, Department of Mathematics.
Course: Probability and Statistics.

Mar 2015 - Sep 2018 **Lead Teaching Assistant**, Department of Mathematics.
Courses: Introduction to Calculus, Introduction to Number Theory, Topology, Advanced Calculus, Probability and Statistics.

Mar 2013 - Feb 2015 **Graduate Teaching Assistant**, Department of Mathematics.
Courses: Introduction to Number Theory, Linear Algebra, Topology, Advanced Calculus.

Mar 2009 - Mar 2011 **Undergraduate Teaching Assistant**, Department of Mathematics.
Courses: Introduction to Calculus, Introduction to Number Theory, Linear Algebra, Topology.

Mar 2007 - Feb 2017 **Instructor**, Course of Admission.
Courses: Introduction to Calculus, Introduction to Linear Algebra.

Invited Lecture Courses

Jul 2022 **EUropean TOPology Interdisciplinary Action** (EUTOPIA) **Summer School** 2022. Paris, France. 27 June - 6 July 2022.
Course: Persistent homology and applications in biology.

Jun 2022 **International Summer School on Modeling Nature** BIOMAT 2022. Multiscale Models and Methods in Life Sciences. Granada, Spain. 6-10 June 2022.
Course: Topological data analysis and applications in dynamics.

Mentoring

2024 **Summer Research Project**, University of Oxford (funded by Balliol College).
Student: Adam Cutts (Mathematical Institute, University of Oxford).
Project: An investigation into classification of initial conditions of dynamical systems using persistent homology.

2023-2024 **Licenciate project** (equiv. Master), Department of Mathematics, University of Buenos Aires.
Student: Lola Lopez Menalled (University of Buenos Aires).
Thesis title: Persistent homology of relations: from Dowker's theorem to topological analysis of neural data.

2022 **Summer Research Internship Project.** Grant URB-2022-07. **Undergraduate Research Bursary**, funded by the **London Mathematical Society**. Joint supervision with Jeffrey Giansiracusa.
Student: Leo Zhang (Imperial College of London).
Project: Reconstruction of surfaces from high dimensional point clouds and applications to data analysis.

Software

2019 **GAP** (System for Computational Discrete Algebra).
Package: `Posets`.
With Iván Sadofschi Costa and Kevin Piterman.
Code: `github.com/isadofschi/posets`
Documentation: `mate.dm.uba.ar/~isadofschi/posets/`

2017 **SageMath** (Open-Source Mathematical Software System).
Module: `Finite Topological Spaces`
Code: `github.com/ximenafernandez/Finite-Spaces`

Latest talks at congresses, conferences and workshops

Aug 2024 *Applying persistent homology in the music industry.*
SPIRES, University of Oxford, UK (**invited**).

June 2024 *Topological fingerprints for audio identification.* **Complexity Workshop, Keble College**, University of Oxford, UK (**invited**).

July 2024 *Topological fingerprints for audio identification.*
9th European Congress of Mathematics, Universidad de Sevilla, Spain (**invited**).

Apr 2024 *Topological fingerprints for audio identification.*
British Applied Mathematics Colloquium, Newcastle University, UK (**invited**).

Dec 2023 *Topological fingerprints for audio identification.*
Colloquium Department of Mathematics, University of Buenos Aires, Argentina (**invited**).

Dec 2023 *Density-based persistent homology and applications to time-series analysis.*
Maths meet Biology Workshop. Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany (**invited**).

Nov 2023 *Topological fingerprints for audio identification.*
Stats meets Math Colloquium, Mathematical Institute, University of Oxford, UK (**invited**).

Oct 2023 *Morse theory for group presentations and applications to persistence*
Ibero-American Colloquium on Algebra and Knot Theory (online, **invited**).

Jul 2023 *Intrinsic persistent homology via density-based metric learning.*
Topological Data Analysis Week, Kyoto University, Japan (poster).

Jul 2023 *Density-based metric learning and applications to TDA.*
Nordic Congress of Mathematicians, Aalborg University, Denmark (**invited**).

Jun 2023 *Intrinsic persistent homology via density-based metric learning.*
Foundations of Computational Mathematics Conference (FoCM 2023), Sorbonne Université, París, France (poster).

Jun 2023 *Topological fingerprints for Audio Identification.*
UK Centre for Topological Data Analysis Meeting, Oxford University, UK (**invited**).

May 2023 *Density-based Riemannian metrics and persistent homology.*
Dagstuhl Schloss, Germany (**invited**).

Jan 2023 — *Topological biomarkers for real-time detection of epileptic seizures.*
UK Centre for Topological Data Analysis Meeting, Oxford University, UK (**invited**).

Nov 2022 — *Morse theory for group presentations.*
3rd International Meeting on Geometric Group Theory and Low Dimensional Topology (online, **invited**).

Jun 2022 — *Topology of the neural connectivity of grid cells.*
Algebraic Topology: Methods, Computation and Science (ATMCS10), Oxford University, UK (poster).

Jun 2022 — *The persistent fundamental group of point clouds.*
11th International Conference on Geometric and Topological Methods in Computer Science (GETCO 2022), EPITA School, Paris, France.

May 2022 — *Morse theory for group presentations.*
Transpennine Topology Triangle Meeting 116, Liverpool University, UK (online, **invited**).

Apr 2022 — *Morse theory for group presentations.*
35th British Topology Meeting, Durham University, UK.

Feb 2022 — *Topological methods for real time detection of epileptic seizures in EEG recordings.*
13th Conference on Dynamical Systems Applied to Biology and Natural Sciences (DSABNS 2022), Basque Center for Applied Mathematics in Bilbao, Spain (online).

Nov 2021 — *Density-based intrinsic persistent homology and applications to time series analysis.*
UK Centre for Topological Data Analysis Meeting, Oxford University, UK (**invited**).

Oct 2021 — *Density-based persistent homology.*
2nd Workshop on Topological Methods in Data Analysis, Heidelberg University, Germany (online).

Jul 2021 — *Morse theory for group presentations.*
Mathematical Congress of the Americas 2021, Buenos Aires, Argentina (online, **invited**).

Jun 2021 — *Intrinsic persistent homology via density-based metric learning.*
The 38th Annual Workshop in Geometric Topology, USA (online).

Apr 2021 — *Intrinsic persistent homology via density-based metric learning.*
IMSI Topological Data Analysis Workshop 2021, Chicago, USA (online).

Apr 2021 — *A density-based metric learning approach to geometric inference.*
37th European Workshop on Computational Geometry (EuroCG 2021), St. Petesburg, Russia (online).

Feb 2021 — *Manifold learning for data analysis.*
V Encuentro de Jóvenes Topólogos, Universidad Distrital Francisco José de Caldas, Colombia (online, **invited**).

Dec 2020 — *Geometric and topological inference for data analysis.*
11th Meeting Applied Algebra and Geometry in the UK, University of York, UK (online, **invited**).

Latest invited seminars

June 2024 — *Morse theory for group presentations and applications.*
Applied Topology Seminar, University of Oxford, UK

Oct 2023 — *Fermat principle in Riemannian geometry.*
GEOTOP-A Seminar (online).

Aug 2023 — *Topological biomarkers for real-time detection of epileptic seizures.*
Systems Medicine Seminar, University of Florida, USA.

May 2023 — *Intrinsic persistent homology via density-based metric learning.*
London Topological Data Analysis Seminar, Queen Mary University, London, UK.

Apr 2023	*Density-based distance learning and applications to topological data analysis.* **Probability & Statistics Seminar**, Universidad de la Republica, Uruguay.
Mar 2023	*Morse theory for group presentations & applications to the persistent fundamental group.* **Applied Topology Seminar**, CIMAT Center for Research in Mathematics, Mexico.
Feb 2023	*Density-based intrinsic persistent homology & applications to time series analysis.* **Applied CATS Seminar**, KTH Royal Institute of Technology, Sweden.
Feb 2023	*Intrinsic persistent homology via density-based metric learning.* **DATASHAPE Seminar**, Université Paris-Saclay, France.
Jul 2022	*Morse theory for group presentations and the persistent fundamental group.* **Applied Algebraic Topology Research Network Seminar** (AATRN) (online).
Jun 2022	*From topological data analysis to computational brain modelling: the case studies of grid cells and epilepsy.* **Oxford Mathematical Brain Modelling Seminar**, Oxford University, UK.
Oct 2021	*Morse theory for group presentations.* **Geometry and Topology Seminar**, Durham University, UK.
Oct 2021	*Topological time series analysis.* **Applied Math Seminar**, Durham University, UK.
Jun 2021	*Morse theory for group presentations.* **Algebraic Topology Seminar**, University of Buenos Aires, Argentina.

Research Projects

2023-2024	**Leverhulme Trust grant**. PI: Dr. Heather Harrington. Role: Postdoctoral researcher.
2020-2023	**EPSRC grant New Approaches to Data Science: Application Driven Topological Data Analysis**, EP/R018472/1. PI: Dr. Ulrike Tillmann. Role: Postdoctoral researcher.
2018	**MTM2016-78647-P, National Program in Math**, Research project in University of Malaga, Spain. PI: Dr. Aniceto Murillo and Dr. Antonio Viruel. Role: Research visitor.
2012-2015	**UBACyT Grant** *Topology, discrete geometry and applications.* PI: Dr. Elías Gabriel Minian. Role: Research student.
2012-2015	**UBACyT Grant** *Combinatorial Topology.* PI: Elías Gabriel Minian. Role: Research student.
2011-2014	**UBACyT Grant** *Homotopy Theory and applications.* PI: Dr. Elías Gabriel Minian. Role: Research student.
2008-2011	**UBACyT Grant** X146 *Algebraic homotopy and combinatorial geometry*, PI: Dr. Elías Gabriel Minian. Role: Research student.

Scholarships, fellowships and grants

2023	**Travel grant** to attend the TDA Week 2023 Conference, Kyoto University, Japan.
2022	**LMS-EPSRC ECR ICM Travel Grant** (obtained by competition) to attend to the International Congress of Mathematicians 2022 in Saint Petersburg. (Cancelled due to Ukraine-Russia war).
2020	**International Travel Scholarship AUIP**, (obtained by competition), provided by the Andalusian and Iberoamerican Universities Program. Funding for a research stay at the Department of Applied Mathematics, University of Sevilla, Spain. (Cancelled due to COVID).
2018	**International Travel Scholarship AUIP**, (obtained by competition) provided by the Andalusian and Iberoamerican Universities Program. Funded a research stay at the Department of Algebra, Geometry and Topology, University of Málaga, Spain.

2011 - 2016	**Doctoral Grant CONICET**, (obtained by competition), provided by the National Scientific and Research Council, Argentina.
2010 - 2011	**M.Sc. Grant UBACyT**, (obtained by competition), provided by the University of Buenos Aires.

Research visits

2024	27 - 3 Aug. Division of Particle and Astrophysical Science, **Nagoya University**, Japan.
2023	27 Feb - 3 Mar. Department of Mathematics, **KTH Royal Institute of Technology**, Sweden.
2023	22 - 24 Feb. Institut de Mathématique d'Orsay, **Université Paris-Saclay**, France.
2018	20 May - 20 Jun. Department of Algebra, Geometry and Topology, **University of Malaga**, Spain.

Service and outreach

2024	**Co-organizer** of the *London-Oxford* TDA Seminar.
2023-2024	**Organizer** of the *Algebraic Systems Biology Seminar*. Mathematical Institute, University of Oxford.
2023	**Outreach** poster **presentation** at the celebration of the 10 years of the Andrew Wiles Building, Mathematical Institute, University of Oxford.
2021 - 2023	**Refereed for international journals**: the International Journal of Computational Geometry and Applications (IJCGA), the Journal of Applied and Computational Topology (JACT) and Journal of Pure and Applied Algebra (JPAA).
2021	**Online research tutorials** *Intrinsic Persistent Homology* and *Morse Theory 2.0*, AATRN Applied Algebraic Topology Research Network YouTube Channel.
2006 - 2021	**Speaker** and collaborator in the following **outreach events** in Argentina: *Math's Week*, *Data Science's Week*, *Matbaires*, *Math Festival*.
2020	**Diversity Panel** *Women in Science*, Swansea Science Festival 2020.
2015 - 2018	**Jury** member at several primary and secondary level national **Math Olympiads** (Argentina) including: *Argentine Mathematical Olympiad* (secondary school), *Ñandú Mathematical Olympiad* (primary school) and **Mateclubes Olympiad** (in groups).
2011	Collaborator of the **Local Organization Committee** at WATACBA *Workshop in Algebraic Topology and Combinatorics*, University of Buenos Aires, Argentina.