Ximena L. Fernández

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Current Position

- Postdoctoral Research Associate at the Department of Mathematical Sciences, Durham University.
- Member of the UK Centre for Topological Data Analysis.

Academic appointments

Sep 2021 - Present   **Postdoctoral Research Associate**, Grade 7, Durham University, UK.
Advisor: Prof. Jeffrey Giansiracusa.

Oct 2020 - Aug 2021   **Postdoctoral Research Associate**, Grade 7, Swansea University, UK.
Advisor: Prof. Jeffrey Giansiracusa.

Jan 2020 - Sep 2020   **Research Assistant**, University of Buenos Aires, 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 Mathematics (equivalent to Bachelor + 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 in alphabetical order unless it is marked with * the first (co-) author(s).

2023   X. Fernández, *Morse theory for group presentations.* Transactions of the AMS (accepted).

2023   X. Fernández*, E. Borghini, G. Mindlin and P. Groisman. *Intrinsic persistent homology via density-based metric learning.* Journal of Machine Learning Research (to appear).

2022   X. Fernández*, D. Mateos. *Topological biomarkers for real-time detection of epileptic seizures.* Preprint. `arxiv:2211.02523`.

2022   S. Benas*, X. Fernández* and E. Kropff. *Modeled grid cells aligned by a flexible attractor.* Preprint. `bioRxiv 2022.06.13.495956`.

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.

Industrial appointments

May 2019 - Dec 2019   **Data Scientist**, Properati, OLX Group, Argentina.

I developed models for: prediction of the price of properties, recommender systems, statistical reports and data analysis. I used machine learning, deep learning and statistical tools, using as input for the models the historical data of advertisements published in the web page, and the interaction of users with the web platform. I developed software in Python and I deployed the models using Google Cloud tools.

Oct 2018 - Apr 2019 **Mathematical Models Specialist**, CAMMESA, Argentina.

I was part of the project of optimization of energetic resources, developing mixed linear programming models and stochastic dynamical programming models. I also designed a model for prediction of demand of electric energy in Argentina. I used machine learning, combinatorial optimization and statistical tools. I developed software in Python, Fortran and Visual Basic. I used as input the historical data of electric production and demand, as well as external meteorological and economical features that had latent predictive qualities for this problem.

Software

2023   Contributor of `Giotto-tda`. Developer of the method `Fermat distance` and a tutorial *Intrinsic Persistent Homology* within the module `graphs` *(in progress)*.

2019   GAP package `Posets`. With Iván Sadofschi Costa and Kevin Piterman.

Code: `github.com/isadofschi/posets`

Documentation: `mate.dm.uba.ar/~isadofschi/posets/`

2017   SAGE Module `Finite Topological Spaces`

Code: `github.com/ximenafernandez/Finite-Spaces`

Recent Talks

Mar 2023   *Morse theory for group presentations & applications to the persistent fundamental group.*
Applied Topology Seminar, CIMAT Center for Research in Mathematics, Mexico (online, **invited**).

Feb 2023   *Density-based intrinsic persistent homology & applications to time series analysis.*
Applied CATS Seminar, KTH Royal Institute of Technology, Sweden (**invited**).

Feb 2023   *Intrinsic persistent homology via density-based metric learning.*
DATASHAPE Seminar, Université Paris-Saclay, France (**invited**).

Jan 2023   *Topological biomarkers for real-time detection of epileptic seizures.*
Centre for Topological Data Analysis Group 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**).

Jul 2022   *Morse theory for group presentations and the persistent fundamental group.*
Applied Algebraic Topology Research Network Seminar (online, **invited**).

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 (**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 of Engineering and Computer Science, 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, Basque Country, Spain (online).

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

Oct 2021	*Morse theory for group presentations.*
	Geometry and Topology Seminar, Durham University, UK (**invited**).
Oct 2021	*Topological time series analysis.*
	Applied Math Seminar, Durham 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**).

Invited Lectures

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.

Project Supervision

Summer 2022	Grant URB-2022-07. Undergraduate Research Bursary, funded by the London Mathematical Society. Joint supervision with Jeffrey Giansiracusa. *Student:* Leo Zhang. *Project:* Reconstruction of surfaces from high dimensional point clouds and applications to data analysis. *Code:* github.com/shesturnedtheweansagainstus/quotient_rml

Scholarships, fellowships and grants

2022	*LMS-EPSRC ECR ICM Travel Grant* to attend to the International Congress of Mathematicians 2022 in Saint Petersburg. (Cancelled due to Ukraine-Russia war).
2020	*International Travel Scholarship AUIP - Andalusian and Iberoamerican Universities Program.* Research stay at the Department of Applied Mathematics, University of Sevilla, Spain. (Cancelled due to COVID). *Mentor:* Prof. Rocio Gonzalez Diaz.
2018	*International Travel Scholarship AUIP - Andalusian and Iberoamerican Universities Program.* Research stay at the Department of Algebra, Geometry and Topology, University of Málaga, Spain. *Mentor:* Prof. Aniceto Murillo.
2011-2016	*CONICET PhD Fellowship. Advisor:* Prof. Elías Gabriel Minian.
2010-2011	*UBACyT Scholarship for finalization of career. Advisor:* Prof. Elías Gabriel Minian.

Research Projects

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

Research visits

2023	*Research visit.* 27 Feb - 3 Mar. Department of Mathematics and Digital Futures Faculty, KTH Royal Institute of Technology, Sweden.
2023	*Research visit.* 22-24 Feb. Department of Mathematics and Statistics, Institut de Mathématique d'Orsay, Université Paris-Saclay, France.
2022	*Research visit.* 14 Jul. Department of Mathematics and Statistics, University of Sheffield, UK.
2018	*Research stay.* 20 May - 20 Jun. Department of Algebra, Geometry and Topology, University of Malaga, Spain.

Teaching

- **University of Buenos Aires, Argentina**

Jan 2020 - Sept 2020 & Mar 2013 - Sep 2018.	*Lead Teaching Assistant* (requires PhD), Department of Mathematics.
Mar 2009 - Feb 2013.	*Teaching Assistant*, Department of Mathematics.
Mar 2012 - Feb 2017 & Mar 2007 - Jun 2010.	*Instructor*, Course of Admission.

Courses: Introduction to Calculus, Introduction to Algebra, Linear Algebra, Topology, Advanced Calculus, Elementary Numerical Analysis, Probability and Statistics.

- **University of San Andrés, Argentina**

Mar 2020 - Jul 2020. *Lecturer*, Department of Mathematics.

Course: Calculus.

- **Torcuato DiTella University, Argentina**

Mar 2016 - Feb 2018. *Lecturer*, Department of Mathematics.

Courses: Calculus I (one variable) and Calculus II (several variables).

Technical Skills

- **Programming languages**: Python, R, Matlab, C++, Sage, Html, SQL, Latex.
- **TDA tools**: Ripser, Giotto-TDA, Gudhi, Eirene.
- **Data science tools**: Jupyter, NumPy, Pandas, SciKit-Learn, NetworkX, Statsmodels, Keras, PyTorch.
- **OS**: Linux, Windows, OSX.

SERVICE AND OUTREACH

2021	Tutorials *Intrinsic Persistent Homology* and *Morse Theory 2.0*, AATRN Applied Algebraic Topology Research Network YouTube Channel.
2006 - 2021	Speaker and collaborator in several outreach events at the University of Buenos Aires: *Math's Week*, *Data Science's Week*, *Matbaires*, *Math Festival*.
2020	Panel *Women in Science*, Swansea Science Festival 2020.
2015 - 2018	Jury member at several primary and secondary math level national competitions (Argentina) including: Olimpiada Matemática Argentina, Olimpiada Matemática Ñandú and Olimpiada de los Mateclubes.
2011	Collaborator in the organization of WATACBA *Workshop in Algebraic Topology and Combinatorics*, University of Buenos Aires, Argentina.

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