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# Ingrid Amaranta Membrillo Solis

## Contact information

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## Employment

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August    2023–present      **Lecturer (Artificial Intelligence)**, School of Computer Science and Engineering, University of Westminster.

August    2023–present      **Visiting Researcher**, Mathematical Sciences, University of Southampton.

Sept.      2022–August 2023      **Lecturer (Data Analytics)**, School of Computing and Digital Media, London Metropolitan University.

Sept.    2018–July 2023      **Research Fellow (Topological Data Analysis)**, Mathematical Sciences, University of Southampton.

Supported by the Leverhulme research grant “*DiG for the Future: Taming disorder in self-assembled materials with topology*”, 2019-2023.

Supported by the EPSRC research grant “*Joining the Dots: from Data to Insight*”, 2018-2019.

2013–2018      **Teaching Assistant (Mathematics)**, Mathematical Sciences, University of Southampton.

2007–2013      **Associate Lecturer (Chemistry)**, Faculty of Sciences and Faculty of Chemistry, National Autonomous University of Mexico.

## Education

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2018              **PhD Mathematics**, University of Southampton. Doctoral Thesis “Homotopy theory of the gauge groups over certain 7-manifolds” supervised by Stephen Theriault.

2014              **BSc Mathematics**, National Autonomous University of Mexico. BSc Thesis “Discrete model of gravity”, supervised by Juan Manuel García Islas.

2008              **MSc Chemistry**, National Autonomous University of Mexico. MSc Thesis “Synthesis and kinetic and electrochemical characterisation of mononuclear Cu(II) complexes analogous to dinuclear systems”, supervised by Laura Gasque Silva.

2006 **BSc Chemistry**, National Autonomous University of Mexico. BSc Thesis “Kinetic and electrochemical studies of dinuclear Cu(II) complexes”, supervised by Laura Gasque Silva.

### Publications and preprints

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- Mathematics K. Gittins, C. Gordon, M. Khalile, I. Membrillo Solis, J.P. Rossetti, M. Sandoval and E. Stanhope. *Do the Hodge spectra distinguish orbifolds from manifolds? Part 2*. Preprint.
- K. Gittins, C. Gordon, M. Khalile, I. Membrillo Solis, M. Sandoval and E. Stanhope. *Do the Hodge spectra distinguish orbifolds from manifolds? Part 1*. Mich. Math. J, 1(1), (2023),1-28.
- D. Kishimoto, I. Membrillo-Solis and S. Theriault. *The homotopy types of  $SO(4)$ -gauge groups*. Eur. J. Math. (2021), 1245-1252.
- I. Membrillo-Solis and S. Theriault. *The homotopy types of  $U(n)$ -gauge groups over lens spaces*. Bol. Soc. Mat. Mex. 27 (2021), no. 2, Article No. 40.
- I. Membrillo-Solis. *Homotopy types of gauge groups related to  $S^3$ -bundles over  $S^4$* . Topol. Appl., 255 (2019), 56–85.
- I. Membrillo-Solis. *On gauge groups over high dimensional manifolds and self-equivalences of  $H$ -spaces*. Preprint.
- Data Science T. Madeleine, N. Podoliak, O. Buchnev, I. Membrillo Solis, T. Orlova, Maria van Rossem, J. Brodzki, G. D’Alessandro, M. Kaczmarek. *Topology for the classification of disorder: an application to the design of metasurfaces*. Accepted for publication by ACS Nano. DOI: 10.1021/acsnano.3c08776
- M. Che, F. Galaz-García, L. Guijarro, I. Membrillo Solis, M. Valiunas. *Basic metric geometry of the bottleneck distance* <https://arxiv.org/abs/2205.09718>. Accepted for publication by Proceedings of the American Mathematical Society.
- I. Membrillo Solis, M. Van Rossem, T. Orlova, T. Madeleine, J. Brodzki, G. D’Alessandro, M. Kaczmarek. *Learning complex systems dynamics from vector fields over discrete measure spaces*. Preprint. DOI:10.21203/rs.3.rs-3011267/v2
- I. Membrillo Solis, T. Orlova, K. Bednarska, P. Lesiak, T. Wolinski, J. Brodzki, G. D’Alessandro and Malgosia Kaczmarek. *Tracking the time evolution of soft matter systems via topological structural heterogeneity*. Communications Materials (2022) 3(1), 1-11.
- M. Che, F. Galaz-García, L. Guijarro, I. Membrillo Solis. *Metric geometry of spaces of persistence diagrams*. <http://arxiv.org/pdf/2109.14697/pdf>. Submitted.
- I. Membrillo-Solis, M. Pirashvili, L. Steinberg, J. Brodzki, J. G. Frey. *The topology and geometry of molecular conformational spaces and energy landscapes*. <https://arxiv.org/pdf/1907.07770.pdf>. Preprint
- Chemistry A. Martínez, I. Membrillo, V.M. Ugalde-Saldívar, L. Gasque. *Dinuclear copper complexes with imidazole derivative ligands: a theoretical study related to catechol oxidase activity*. J. Phys. Chem. B **116** (2012), no. 28, 8038–8044.

L. Gasque, V.M. Ugalde-Saldívar, I. Membrillo, J. Olguín, E. Mijangos, S. Bernés, I. González. *A dicopper complex with distant metal centers. Structure, magnetic properties, electrochemistry and catecholase activity.* J. Inorg. Biochem. **102** (2008), no. 5–6, 1227–1235.

### In preparation

Mathematics *Topology of moduli spaces of flat Riemannian metrics.* Joint with A. K. Garcia and M. Valiunas.

Data Science *Identification of Periodic Processes and Structure Transformations in Dynamic Soft Matter Systems.* Joint with T. Orlova, H. Sohn, I. Smalyukh, J. Brodzki, G. D’Alessandro and M. Kaczmarek.

*Fully reversible assembly and topological analysis of gold nanoparticle networks in liquid crystals.* Joint with N. Podoliak, T. Madeleine, T. Orlova, J. Brodzki, G. D’Alessandro and M. Kaczmarek.

### Other publications

I. Membrillo Solis. *Homotopy theory of gauge groups over certain 7-manifolds*, PhD thesis, University of Southampton, 2018, 129 pp.

I. Membrillo Solis. *Discrete model of gravity*, BSc thesis, UNAM, 2014, 69 pp.

I. Membrillo Solis. *Synthesis and kinetic and electrochemical characterisation of mononuclear copper (II) complexes analogous to dinuclear systems* MSc thesis, UNAM, 2008, 133 pp.

I. Membrillo Solis. *Kinetic and electrochemical studies of dinuclear copper (II) complexes*, BSc thesis, UNAM, 2006, 89 pp.

### Grants and Fellowships

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2022 LMS Scheme 5 Grant ‘Collaborations with Developing Countries’.

2018 LMS Grace Chisholm Young Fellowship.

2013–2017 Fellowship of the National Council of Science and Technology (CONACyT), Mexico.

2013–2014,  
2015–2017 Fellowship of Excellence, Mexican Secretariat of Public Education.

2005–2007 Fellowship of the National Council of Science and Technology (CONACyT), Mexico.

2005–2007 Fundación Telmex Fellowship, Mexico.

### A selection of invited talks for conferences

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January 2024 Data-driven applications of geometry and topology in complex systems dynamics. Seminar GEOTOP-A International Conference, Mérida, Mexico.

July 2023 Spaces of discrete vector fields and their applications to complex systems dynamics. Early Career Researchers in Mathematics, Durham, UK.

July 2022	Rank Prize Funds Symposium on Liquid Crystal Technology for Light, Grasermer, UK.
April 2022	Do the Hodge spectra distinguish orbifolds from manifolds? Part 2, Joint Mathematics Meeting, Special Session, Women in Geometry II (Online due to pandemic).
September 2021	Do the Hodge spectra distinguish orbifolds from manifolds? Part 2, Meeting on Spectral Theory and Partial Differential Equations, Durham University, UK.
August 2020	Hearing 2 and 3-orbifolds with heat invariants, Young researchers in spectral geometry 2020 (online).
July 2019	The homotopy types of gauge groups over lens spaces, Transpennine Topology Triangle, University of Sheffield, UK.
June 2019	The geometry and topology of configuration spaces of molecules, Geometry, Topology and Computations, Heidelberg University, Germany.
August 2017	Homotopy types of gauge groups related to certain 7-manifolds, Young Researchers in Homotopy Theory and Toric Topology, Kyoto University, Japan.

#### A selection of invited talks in seminars

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February 2023	Applications of spaces of vector fields over discrete measure spaces, Seminar GEOTOP-A, online.
August 2022	Inverse problems in the spectral theory of orbifolds (in Spanish), Online Seminar DIVAGEO, UNAM, Mexico.
February 2021	The dynamics of the phase transition in liquid crystals: what persistent homology reveals, Applied Algebraic Topology Network (online).
February 2021	Detecting the singular points of an orbifold via its Hodge Laplace spectrum, Differential Geometry and Topology Seminar (online), University of Wrocław, Poland.
January 2021	Heat invariants of the Hodge Laplace operator on Riemannian orbifolds, Geometry and Topology Seminar (online), Durham University, UK.
November 2020	New theoretical and data-driven approaches to the study of molecular conformational spaces and energy landscapes, AI3SD Winter Seminar Series: Topology and Applications in Chemistry.
January 2020	The topology and geometry of molecular conformational spaces and energy landscapes, Oxford TDA Seminar, University of Oxford, UK.
August 2018	Homotopy decompositions of gauge groups over connected sums of sphere bundles over spheres, Topology Seminar, Kyushu University, Japan.
May 2018	Homotopy decomposition of gauge groups, International Seminar on Toric Topology and Homotopy Theory, Steklov Mathematical Institute, Russia.
April 2017	The shape of matter seen through the lens of algebraic topology, Physical chemistry seminar, National Autonomous University of Mexico, Mexico.

### Contributed talks

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- August 2022 Topological and geometric properties of the spaces of persistence diagrams, Nordic Topology Conference 2022, NTNU, Trondheim, Norway.
- March 2019 Homotopy decompositions of gauge groups over connected sums of sphere bundles over spheres, Women in Homotopy Theory and Algebraic Geometry II, Freie Universitat Berlin, Germany.
- August 2016 Homotopy theory of gauge groups, Mexican Mathematicians Abroad, CIMAT, Mexico.

### Other academic workshops attended

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- August 2022 Metric measure Spaces with Symmetry and Lower Ricci Curvature Bounds (Online), BIRS.
- September 2020 Workshop on Topological Complexity and Motion Planning (Online), BIRS.
- June 2020 Workshop on Topological Data Analysis (Online), The Fields Institute.
- June 2019 Women in Geometry 2. Casa Matemática Oaxaca, Mexico.
- August 2017 Applied Algebraic Topology 2017, Hokkaido University, Japan.
- August 2015 Workshop on Applied Topology, Institute for Mathematical Sciences, NUS, Singapore.

### Academic visits

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- September 2021 Visiting Dr Fernando Galaz García, Durham University, UK.
- August 2018 Visiting Professor Shizuo Kaji, Kyushu University, Japan.

### Teaching Experience

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#### University of Westminster

- Autumn 2023 Data Engineering. Module leader.
- Autumn 2023 Applied AI. Workshop tutor.

#### London Metropolitan University

- Spring 2023 Data Mining and Machine Learning. Module leader.
- Spring 2023 Programming for Data Analytics. Workshop tutor.
- Spring 2023 Statistical modelling and forecasting. Workshop tutor.
- Autumn 2022 Data Warehousing and Big Data. Workshop tutor.
- Autumn 2022 Data Analytics and Data Visualization. Workshop tutor.

### University of Southampton

2018-2022	Geometry and topology. Teaching Assistant.
2017	Foundations of Computer Science. Teaching Assistant.
2013-2017	Calculus I. Teaching assistant. Calculus II. Teaching assistant. Linear Algebra I. Teaching assistant. Linear Algebra II. Teaching assistant.

### National Autonomous University of Mexico

2011-2013	Calculus I. Teaching Assistant.
2011-2013	Calculus II. Teaching Assistant.
2011-2012	General Relativity. Teaching Assistant.
2007-2013	General Chemistry. Module leader.
2007-2013	Organic Chemistry. Module leader.
2007-2012	Analytic Chemistry. Workshop tutor.

### Supervision

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2023	Hind El Ghazouani, <i>Enhancing financial decision making: a comparative analysis of RNN variants for US banking equities forecasting</i> (London Metropolitan University, MSc Thesis).
2023	Elina Andriianova, <i>Analytical and reporting system for a tyre company: demand forecast and inventory classification</i> (London Metropolitan University, MSc Thesis).
In progress	Max Benson, <i>Improving the classification and algorithmic approach for tornado weather detection systems in Florida, USA</i> (University of Westminster, BSc Thesis). Jawharah Hosseinian, <i>Building a machine learning-based book recommendation system</i> (University of Westminster, BSc Thesis). Joshua Nwachukwu, <i>SignLink: A deep learning application for sign language recognition</i> (University of Westminster, BSc Thesis).
Tutoring	Tristan Madelein, PhD student (Mathematics, University of Southampton). Maria Van Rossem, PhD student (Physics, University of Southampton).

### Service

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2023	Co-organiser of the GEOTOP-A International Conference, Yucatan, Mexico 2024.
2022	Co-organiser of the online seminar MateM-App: Young Seminar of Applied and Multidisciplinary Mathematics.

2020 Co-organiser of the Equality, Diversity and Inclusion discussion group for PGR students and Early Career Staff, Mathematical Sciences, University of Southampton.

### **Computer skills**

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Programming languages: Python, Matlab, SQL, Fortran.

Software: GUDHI, Ripser, ImageJ, MongoDB, Power BI, Excel, Origin.

I have produced code for the Leverhulme Trust project DiG for the Future: Taming disorder in self-assembled materials with topology. The code uses the software package GUDHI. The code is available at <https://tinyurl.com/2kack8kz>.

### **Languages**

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Spanish: Native

English: Fluent

French: Intermediate