

# JOSÉ LUIS LEÓN MEDINA

*Algebraic and Computational Topology, Topological Methods in Machine Learning*

SECIHTI Postdoctoral Researcher, CIMAT-Mérida

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## RESEARCH OVERVIEW

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My research develops algebraic and computational methods for the study of the homotopical and cohomological structure of real subspace arrangement complements. I investigate multiplicative and higher-order operations in their cohomology rings using Poincaré duality and combinatorial models, with an emphasis on explicit and algorithmic constructions. This framework connects topological complexity with computational complexity and provides structural insights into configuration-type spaces and polyhedral models arising in ReLU neural networks. These methods further extend to topological data analysis and geometric machine learning.

## APPOINTMENTS

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- SECIHTI Postdoctoral Researcher - CIMAT-Mérida (2022–Present, Mérida, Mexico)
- Adjunct Lecturer - UPIITA-IPN (2020–2022, Mexico City, Mexico)

## EDUCATION

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- **Ph.D. in Mathematics**, CINVESTAV-IPN (2022). Dissertation: *Homotopical properties of non-k-equal spaces*. Advisor: Prof. Jesús González.
- **M.Sc. in Mathematics**, CINVESTAV-IPN (2018).
- **B.Sc. in Mathematics**, BUAP (2016).

## PUBLICATIONS

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1. Jesús González, **José Luis León-Medina** (2025). The rational (non-)formality of the non-3-equal manifolds. *Mathematical Proceedings of the Cambridge Philosophical Society* 10.1017/S0305004125101680.
2. Jesús González, **José Luis León-Medina** (2022). On Lusternik-Schnirelmann category and topological complexity of non-k-equal manifolds. *Journal of Homotopy and Related Structures* 10.1007/s40062-022-00304-z.
3. Jesús González, **José Luis León-Medina**, Christopher Roque-Márquez (2021). Linear motion planning with controlled collisions and pure planar braids. *Homology, Homotopy and Applications* 10.4310/hha.2021.v23.n1.a15.

4. Jorge Aguilar-Guzmán, Jesús González, **José Luis León-Medina** (2020). Homotopy type of skeleta of the flag complex over a finite vector space and generalized Galois numbers. *Journal of Applied and Computational Topology* 10.1007/s41468-020-00049-9.

## PREPRINTS

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1. José Frías, José Carlos Gómez-Larrañaga, **José Luis León-Medina**, Fabiola Manjarrez-Gutiérrez (2025). 3-manifold polynomials. *arXiv* 10.48550/arXiv.2510.06651.

## GRANTS & DISTINCTIONS

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- 2023-present Principal Investigator, SECIHTI Research Grant CBF2023-2024-4059, “*Interacciones topológico computacionales*”
- 2023-present Candidate Member, Mexican National System of Researchers (SNII)
- 2023-present State Registry of Researchers, Yucatán

## CONFERENCE CONTRIBUTIONS

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- The Cohomology of Real Parabolic Arrangements — Poster presentation, Topology of Arrangements with an Eye to Applications, Sep 2025
- Enhancing Machine Learning with Topological Features — MexSIAM 2025, UNACH, Chiapas, Aug 2025
- The topological complexity of non- $k$ -equal spaces — GEOTOP-A, Jan 2024
- Non- $k$ -equal spaces — Coloquio FMAT-CIMAT Mérida, Mar 2023

## MINI-COURSES

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- Introducción a los Métodos de la Topología Algebraica — CIMAT Mérida Summer School, Jul 2024
- Un Acercamiento al Análisis Topológico de Datos — FCFM-BUAP, Puebla, Jun 2024
- Estudio de 3-variedades usando gráficas en superficies — CIMAT Mérida Spring School, Apr 2024

## SEMINAR ACTIVITY

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- Working Group Leader — CIMAT-Mérida Algebraic Topology Seminar (Feb 2026)
- Participant — CIMAT-Mérida Algebraic Topology Seminar (Participant since 2023)

## TEACHING

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### CIMAT

- Spring 2026 — Graphs on Surfaces, Polynomials and 3-Manifolds (co-taught with José Carlos Gómez Larrañaga).
- Fall 2025 — Modern Algebra. M.Sc. in Basic Mathematics.
- Spring 2025 — Topology 2. M.Sc. in Basic Mathematics.

### CINVESTAV

- Spring 2025 — Singular Homology and Cohomology (co-taught with Jesús González).

### UADY

- Fall 2024 — Applied Topology (co-taught with José Carlos Gómez Larrañaga).

### UPIITA-IPN

- Fall 2021 — Linear Algebra, Probability.
- Spring 2021 — Linear Algebra, Probability, Calculus, Vector Calculus, Differential Equations.
- Fall 2020 — Numerical Analysis, Calculus, Probability and Statistics for Engineering, Introduction to Complex Analysis.
- Spring 2020 — Linear Algebra, Probability, Numerical Analysis.

## STUDENT MENTORING

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### THESIS IN PROGRESS

- Darío Abundis Mendívil — Undergraduate Thesis in Progress, FCFM-BUAP. *Applications of topological invariants associated to time series for analysis and prediction in financial markets.* Co-advised with Dr. Iván Martínez Ruíz

### GRADUATED STUDENTS

- Luis Enrique Aponte Pérez — Master of Sciences (Mathematics), FCFM-BUAP (2025). A study of modal logic with simplicial complexes. Co-advised with Dr. Iván Martínez Ruíz

### SUMMER RESEARCH INTERNSHIPS

- Delfín Program (2025). Host researcher. Students: Juan Sebastian Romero Burgos (Universidad Konrad Lorenz)
- Delfín Program (2024). Host researcher. Students: Abel Salvador Carvajal Escolástico (UDG), Daniel Arturo López Ponce (BUAP), Adán López Villegas (UAS), Cesar Yosgart Mercado Luquin (UDG)
- Pares Ordenados Lecture Program (2023). Mentor. Students: Cristian Fernando León Sierra (Universidad Pedagógica y Tecnológica de Colombia)

- CIMAT-Mérida Summer Internships (2023). Project: Finite reflection groups. Students: Aldair Reyes González (UNAM), José María Castilla Cochegrus (UADY), Ramsés Alejandro García Abascal Ruíz (UNAM)

## THESIS COMMITTEES

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- Raúl David Gorocica Polanco (2025) - Thesis committee member for Bachelor's in Mathematics, UADY. Defense date - August 25, 2025.

## SERVICE & ORGANIZATION

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- 58th National Congress of the SMM (Algebraic and Geometric Topology Session Chair), FCFM-BUAP, Puebla (Oct 2025)
- Applied Topology School, CIMAT-Mérida (Nov 2024)
- Algebraic Topology Session, 11 CIMA, BUAP, Puebla (Sep 2024)
- Summer School in Algebraic Topology, CIMAT-Mérida (Jul 2024)
- GEOTOP-A Conference, CIMAT-Mérida (Jan 2024)
- CIMAT-Mérida Summer School, CIMAT-Mérida (Jul 2023)

## SOFTWARE

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- ParabolicArrangements — Open-source SageMath package for the algorithmic computation of cohomology rings and homotopical invariants of real parabolic arrangement complements. [2025]

## TECHNICAL SKILLS

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**Programming** C/C++, Python, MATLAB, R  
**Topology & TDA** SageMath, giotto-tda, scikit-tda, GUDHI  
**ML & Computing** PyTorch, Hugging Face, CUDA, AWS, Docker

## LANGUAGES

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**Spanish** Native  
**English** C1 Advanced (BULATS)