Daniel López-Castaño

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RESEARCH INTERESTS

Optimal Transport and Applications, Manifold Learning, Optimization on Manifolds, Geometric Deep Learning

EDUCATION

Johns Hopkins University, Baltimore MD, USA — August 2021 — Present
Ph.D. in Applied Mathematics and Statistics
Supervisors: Mateo Díaz, Soledad Villar

Johns Hopkins University, Baltimore MD, USA — August 2021 — May 2023
M.Eng. in Applied Mathematics and Statistics
Relevant Coursework: Machine Learning 1, Machine Learning 2, Optimal Transport, Equivariant Machine Learning, Riemannian Geometry, Software Engineering for Data Science, Topics in Computer Graphics

National University of Colombia, Bogotá, Colombia — January 2018 — May 2020
M.Sc. in Mathematics
Supervisors: Sylvie Paycha (University of Postdam), Carolina Neira Jiménez

National University of Colombia, Bogotá, Colombia — January 2013 — December 2017
B.Sc. in Mathematics
Supervisor: Carolina Neira Jiménez

RELEVANT EXPERIENCE

The Johns Hopkins University - Applied Physics Laboratory — Baltimore MD, USA
WSE-APL Assistant Research Intern — May 2023 — August 2023

Developed research for density estimation, focusing on advancing theory, algorithms, and practical applications. Led the development of a transformative approach that converts density estimation into supervised learning, optimizing computational efficiency for real-time inference. Proved two pivotal universal approximation theorems, laying the foundation for an innovative algorithm surpassing Gaussian mixture models in modeling complex densities. Achieved lightweight model scalability for rapid inference.

Vozy — Bogotá, Colombia
Machine Learning Engineer — September 2020 — July 2021

In charge of developing and implementing a Voice Biometrics Authentication System through deep learning based on PyTorch and TensorFlow. This model outperformed the state-of-the-art in voice authentication when it was trained and became one of the first developed in Latin America launched for corporate marketing. Conversational AI projects were deployed through APIs and Docker containers from collecting and posting data to production. Mentored research interns from Holberton School in NLP projects.

Universität Potsdam — Potsdam, Germany
Graduate Research Intern — August 2019 — November 2019

Developed research for master's thesis focusing on the Cesàro theory of distributions and its asymptotic analysis, exploring the asymptotic expansion of the spectral action for a commutative spectral triple.

TEACHING EXPERIENCE

The Johns Hopkins University — Baltimore MD, USA
Graduate Teaching Assistant — August 2023 — May 2025

Created lecture notes and instructional materials for Machine Learning 1 and Machine Learning 2 courses. Served as Teaching Assistant for Nonlinear Optimization 2, as well as for both Machine Learning courses. Delivered supplementary lectures and provided personalized feedback to students. Conducted review sessions and held office hours.

Instituto Universitario de Las Américas y El Caribe — Colima, Mexico
Visiting Lecturer (Remote) — November 2019 — April 2020

Developed the syllabus and served as an instructor for (i) Arithmetic, Trigonometry, and its Concept Development, and (ii) Linear Algebra courses in the master's program in Mathematical Education.

Universidad Nacional de Colombia — Bogotá, Colombia
Lecturer and Graduate Assistant — August 2018 — December 2019

Instructor for the Calculus 1 course (Cálculo Diferencial 1000004-B) covering four groups of 40-60 students over 18 months.

Fundación Círculo de Excelencia Académica — Bogotá, Colombia
Mathematics Teacher — March 2013 — July 2018

Traveled to various regions of Colombia to teach and provide academic advising in placement programs for students from vulnerable populations. Designed school curricula and prepared educational materials for the courses.

PROJECTS

Vision Guided Drone Baltimore MD, USA
Mentor Feb 2025 — May 2025

Mentored a team of three high school interns at Johns Hopkins University, where we developed an autonomous drone navigation system that utilizes computer vision and optimization techniques for safe and efficient flight. My contributions included implementing optimization algorithms for path planning and image detection, as well as providing hands-on development of technical skills for the interns.

Qudost Baltimore MD, USA
Research Assistant May 2023 — May 2024

Repository for a project developed during a summer research internship at The Johns Hopkins University Applied Physics Laboratory. This project advances density estimation research and introduces a transformative supervised learning approach for real-time inference.

VoBio Bogotá, Colombia
Machine Learning Engineer September 2020 — July 2021

This project successfully integrated voice biometrics into the client's authentication framework, achieving a balance between cost efficiency, user satisfaction, and streamlined processes.

LILI-STT Bogotá, Colombia
Machine Learning Engineer September 2020 — July 2021

Trained domain-specific automatic speech recognition models on GPUs with NVIDIA NeMo framework.

RESEARCH & PUBLICATIONS

Working Papers & Research in Progress
Estimating Morse Information from Samples (In preparation) - Developed provably consistent estimators for critical points and Morse indices of generic height functions on manifolds from random samples. Established rigorous mathematical framework connecting Morse theory to topological learning with minimal regularity assumptions, proving asymptotic convergence guarantees. Implemented open-source numerical methods and validated theoretical findings through computational experiments. Presented at Statistics and Data Science Workshop, Universidad de Los Andes (December 2025).

Geometric Factor Analysis (In preparation) - Developed rigorous theoretical framework for Wasserstein Factor Analysis with provable convergence guarantees. Applied optimal transport and Riemannian optimization to address rotational ambiguity in high-dimensional factor models. Established formal mathematical foundations using advanced non-smooth optimization techniques. Presented at SIAM Mathematics of Data Science (2024), runner-up for Best Poster Award at Universidad de Los Andes Optimization Workshop (2024).

Inference-Fast Density Estimation via Universal Approximators (In preparation) - Established mathematical foundations through universal approximation theorems, transforming density estimation into supervised learning framework. Research conducted at Johns Hopkins Applied Physics Laboratory.

Master's Thesis
A distributional approach to Asympotics of the Spectral Action (2020) - Developed rigorous asymptotic analysis using Cesàro theory of distributions. Research conducted at Universität Potsdam under supervision of Prof. Sylvie Paycha.

Undergraduate Thesis
Complex Powers of Elliptic Pseudodifferential Operators (2017) - Rigorous mathematical treatment of operator theory with applications to spectral geometry.

SKILLS

Programming: Python (NumPy, Pandas, Scikit-learn, PyTorch, JAX), version control (Git), containerization (Docker), backend (Flask), frontend (HTML, Javascript), SQL, bash shell scripting

Data visualization: Plotly, Seaborn, Matplotlib, MANIM, Tableau

Software: Postman, LaTeX, GeoGebra, Microsoft Excel

Languages: English (proficient), Spanish (native)

HONORS

Fulbright Scholarship Minciencias Baltimore MD, USA
Doctoral scholarship for studies in the U.S. August 2020

Beca Asistente Docente Bogota, Colombia
Graduate Teaching Assistantship at Universidad Nacional de Colombia. August 2018 - February 2020

Honors Tuition Bogotá, Colombia
Scholarship awarded for the highest entrance exam score (2013-1) and top grade point average (2013-2) at the National University of Colombia. February 2013 - December 2013

VOLUNTEER ACTIVITIES

Whiting Internships in Science and Engineering (WISE) - Johns Hopkins Baltimore MD, USA
Mentor February 2025 — May 2025

Mentored high school interns, encouraging STEM interest and skill development through hands-on guidance and collaborative problem-solving.

Directed Reading Program - Johns Hopkins Chapter Baltimore MD, USA
Mentor September 2023 — December 2024

Fall 2024 - Geometry of the Space of Probability Distributions (Mentee: Shayaan Emran).
Spring 2024 - Symmetries and Representations (Mentee: Minjae Kim).
Fall 2023 - Spectral Geometry on Triangles (Mentee: Sukriti Gupta).

FUNAMJE Cota, Colombia
Cultural Promoter 2008 — July 2021

Volunteer work with the elderly. Collection and delivery of essential items and food.

FELLOWSHIPS

Acheson J. Duncan Research Fund Baltimore MD, USA
Travel grant to attend the Summer School on Optimal Transport, Stochastic Analysis, and Applications to Machine Learning in Daejeon, South Korea. June 2024

UNM-NSF Guanajuato, Mexico
Financial assistance for attendance at the 2023 Workshop on Potential Theory at CIMAT-Guanajuato. September 2023

INMAS Baltimore MD, USA
Internship training and exploring career prospects for students in the field of mathematical sciences. May 2023

IAMP Scalea, Italy
Financial assistance for attendance at the Summer School Noncommutative Manifolds and their symmetries. September 2019

UNI-GOTTINGEN Göttingen, Germany
Funding to present a contributed talk at the Summer School on L2-Torsion and Symmetric Spaces. October 2019

CIMPA Mérida, Mexico
Funding to present a contributed talk at the CIMPA Research School on Noncommutative Geometry and Index Theory hosted at CIMAT-Mérida. November 2018

UNIANDES Villa de Leyva, Colombia
Funding to present a contributed talk at the Villa de Leyva Summer School 2017 on Geometric, Algebraic and Topological Methods for Quantum Field Theory. July 2017

ACADEMIC TALKS

Statistics and Data Science Workshop - Universidad de Los Andes Bogotá, Colombia
Poster: *Estimating Morse Information from Samples* December 2025

Optimization Workshop - Universidad de Los Andes Bogotá, Colombia
Poster: *Geometric Factor Analysis* - **Runner-up for Best Poster Award** December 2024

SIAM Mathematics of Data Science Atlanta GA, USA
Poster: *Geometric Factor Analysis* October 2024

Johns Hopkins AI-X Foundry Fall 2023 Symposium Baltimore MD, USA
Poster: *Inference Fast Density Estimation via Universal Approximators* September 2023

Colloquium Mathematics Department - Universidad Nacional de Colombia Bogotá, Colombia
Conference: *On vibrating strings, drums and what can and cannot be heard* December 2019

Analysis Group Seminar - Universität Potsdam Potsdam, Germany
Conference: *On the distributional asymptotic expansion of the Spectral Action* November 2019

Summer School on L2-Torsion and Symmetric Spaces - Universität Göttingen Göttingen, Germany
Short Communication: *Sunada's Technique for Constructing Isospectral Manifolds* October 2019

Analysis Group Seminar - Universität Potsdam Potsdam, Germany
Conference: *A Space of Symbols and the Cesàro Behaviour at Infinity* September 2019

Uniandes SRI-2019 on Geometry and Theoretical Physics Villa de Leyva, Colombia
Short Communication: *Notions of Spectral Action* July 2019

CIMPA School on Noncommutative Geometry and Index Theory - CIMAT Mérida Mérida, Mexico
Short Communication: *Spectral Geometry and Spectral Action* December 2018

School on Geometric, Algebraic and Topological Methods for Quantum Field Theory Villa de Leyva, Colombia
Short Communication: *Index Formulas of an Elliptic Operator* July 2017

TOP3-UD - Universidad Distrital Francisco José de Caldas Bogotá, Colombia
Short Communication: *The Weak* Topology on Distributions and Calculation Rules* May 2017

VII Encuentro Nacional de Matemáticas y Estadística - Universidad del Tolima Ibagué, Colombia
Short Communication: *Radon Measures: An Approximation of Topological Dual of* L^{∞} May 2017