

Ignacio Contreras

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Research Interests

I am interested in convex optimization and analysis with applications to science and engineering, like inverse problems/signal reconstruction, computational harmonic analysis, foundations of data science, compressed sensing, (quantum) information theory, and others.

Education

Pontificia Universidad Católica de Chile (PUC)

Aug 2022- Dec 2024

M.Sc. in Engineering, advised by Carlos Sing Long

(Expected)

- Thesis: *Lifting to Measure Spaces Techniques for Nonlinear Inverse Problems*
- We investigated a general class of inverse problems that are linear in one parameter and nonlinear in another, and the solution by posing it as recovering an atomic measure through the minimization of the total variation norm of measures. We make the connection and investigate recovery guarantees through reproducing kernel Hilbert spaces (RKHS) and extend the method and algorithms to measures supported in the complex plane with imaging applications.

Pontificia Universidad Católica de Chile (PUC)

2021 – 2022

Mathematical and Computational Engineering (Professional Degree)

- Coursework: Functional Analysis, PDEs, Advanced Optimization, Applications of Functional Analysis and PDEs to Engineering, Probability Theory, Topics in Inverse Problems, High-Dimensional Probability, Regression Analysis, Parallel Algorithms in Scientific Computing, Biomedical Image Formation, Mathematical Foundations of Machine Learning, etc.

Pontificia Universidad Católica de Chile (PUC)

2017 – 2021

B.Sc. (Licenciatura) in Engineering

- **Major in Engineering Physics**
- Coursework: Quantum Mechanics, Electromagnetic Theory, Statistical Mechanics, Mathematics Methods, Waves and Optics, etc.
- **Minor in Applied Mathematics**
- Coursework: Real Analysis, Measure Theory, Fourier Analysis, Scientific Computing, Statistical Inference, Discrete Mathematics, Optimization.

Research Experience

Undergraduate Research, advised by Carlos Sing Long

Santiago, Chile

Institute for Mathematical and Computational Engineering, PUC

April 2021 – Sept 2021

- Studied the atomic norm minimization for super-resolution of point sources and implemented an SDP approach in Julia using `Convex.jl`.

Summer Research in Mathematics, advised by Carlos Pérez-Arancibia

Santiago, Chile

Faculty of Mathematics, PUC

Nov 2020 – Jan 2021

- Studied Boundary Integral Equations (BIE) for 2D scattering for the Helmholtz equation and implemented in Julia an adjoint-based method for shape optimization with BIE constraints.

Undergraduate Research, advised by Clémentine Béchet

Santiago, Chile

Institute for Mathematical and Computational Engineering, PUC

Aug 2020 – Dec 2020

- Studied statistical model selection and implemented in OpenCV different distortion models for close-range photogrammetry for the MOONS project of the European Southern Observatory.

Summer Research in Physics, advised by Rafael Benguria

Santiago, Chile

Faculty of Physics, PUC

June 2020

- Studied three classic inverse problems in mathematical & physics. Inversion of the Radon Transform, “Can one hear the shape of a drum?” problem (non-isometric shape can have the same Laplacian eigenvalues)

and electrical impedance tomography.

Other Relevant Course Projects

Santiago, Chile

Institute for Mathematical and Computational Engineering, PUC

2020-2021

- Topics in Inverse Problems: Studied Robust Principal Component Analysis (recovery of a matrix with a sparse component and a low-rank component) through the minimization of the ℓ^1 and nuclear norm with an implementation of an ADMM algorithm with application to separation of components on a surveillance camera.
- Fourier Analysis: Studied the ℓ^1 reconstruction and the recovery guarantees of compressed sensing with an implementation in Julia

Work Experience

Data Science Final Project Mentor

Santiago, Chile

Institute for Mathematical and Computational Engineering, PUC

Aug 2024 – Now

- Mentor for the final project (Actividad Final de Graduación) of the Master of Data Science PUC (Coursera)
- Mentored 3+ groups with weekly feedback on projects.

Intern

Antofagasta, Chile

European Southern Observatory (ESO). Paranal Science Operations.

Jan 2022 – Mar 2022

- Professional Internship at Paranal Observatory, ESO (remote due to Covid Pandemic)
- Studied and implemented the detrended fluctuation analysis and other statistical methods for cloud and precipitation detection from the observatory's time series weather data in Python.

Teaching

Teaching Assistant ([†] denotes graduate courses)

Institute for Mathematical and Computational Engineering, PUC

- Applications of PDEs and Functional Analysis in Engineering[†] 2023-1st
- Advanced Optimization[†] 2023-1st
- Topics in Inverse Problems[†] 2022-1st, 2023-1st
- Fourier Analysis 2021-2nd

Teaching Assistant *Faculty of Mathematics, PUC*

- Topics in Microlocal Analysis and Inverse Problems[†] (scribe) 2023-2nd
- Scientific Computing I 2020-1st, 2022-2nd
- Calculus III 2021-1st

Teaching Assistant

Faculty of Engineering, PUC

- Biomedical Imaging 2022-2nd
- Electricity & Magnetism Lab (grader) 2021-Summer
- Electricity & Magnetism 2020-1st

Grants & Awards

HackSciML - Hackathon on Scientific Machine Learning

Santiago, Chile

National Center for Artificial Intelligence (CENIA)

Oct 2023

- Our team (3 people) got 1st place at the HackSciML organized by the National Center for Artificial Intelligence (Graduate challenge). [HackSciML webpage](#) & [Picture of the award \(Instagram\)](#)

SIAM Student Chapter Certificate of Recognition

Society for Industrial and Applied Mathematics (SIAM)

April 2023

- For exceptional service to the SIAM-PUC Student Chapter. [Interview here \(in Spanish\)](#)

IMC-SIAM Travel Award

Institute for Mathematical and Computational Engineering, PUC

July 2022

- Travel award to represent the SIAM-PUC Student Chapter at the SIAM Annual Meeting 2022, Pittsburgh,

PA. [Interview here \(in Spanish\)](#) 


Skills

Programming: Python, Julia, MATLAB, R, \LaTeX

Languages: Spanish (native), English (advanced)

Activities

Organizer, SIAM-PUC Summer School. 200 years of Fourier Analysis. [Webpage here](#)  *Jan 2023*

Organizer, Mathematical Engineering National Meeting ENIM 2022. [Webpage here](#)  *Aug 2022*

President, SIAM-PUC Student Chapter *Aug 2021-Aug 2023*

Student Representative, Institute for Mathematical and Computational Engineering *April 2021-April 2024*

Vice President, SIAM-PUC Student Chapter *Aug 2020-Aug 2021*

Student Representative, Engineering Physics Major *April 2020-Aug 2021*