# Ignacio Contreras

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☆ ignacontreras.github.io

# **Resarch 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)

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

- o 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)

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)

B.Sc. (Licenciatura) in Engineering

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

# Talks & Prsentations

"Recovery of Atomic Measures Supported on the Complex Plane Through Convex	Santiago, Chile
Optimization"	Dec 2024
Universidad de Chile (UCH)	

Poster accepted at "Encuentro Nacional de Ingeniería Matemática 2024" (Mathematical Engineering National Meeting) ENIM 2024. UCH. Webpage here

# **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 *Faculty of Mathematics*, *PUC*

• 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.

Aug 2022- Dec 2024 (Expected)

2017 - 2021

Santiago, Chile Nov 2020 – Jan 2021

2021 - 2022

**Undergraduate Research**, advised by Clémentine Béchet Institute for Mathematical and Computational Engineering, PUC

• 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

Faculty of Physics, PUC

• 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

Institute for Mathematical and Computational Engineering, PUC

- $\circ$  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  $\ell^1$  and nuclear norm with an implementation of an ADMM algorithm with application to separation of components on a surveillance camera.
- $\circ\,$  Fourier Analysis: Studied the  $\ell^1$  reconstruction and the recovery guarantees of compressed sensing with an implementation in Julia

# Work Experience

#### Data Science Final Project Mentor

Institute for Mathematical and Computational Engineering, PUC

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

#### Intern

European Southern Observatory (ESO). Paranal Science Operations. Jan 2

- 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

<b>Teaching Assistant</b> ( <sup>†</sup> denotes graduate courses)	
Institute for Mathematical and Computational Engineering, PUC	
$\circ~{\rm Applications}$ of PDEs and Functional Analysis in Engineering <sup>†</sup>	2023-1st
$\circ$ Advanced Optimization <sup>†</sup>	2023-1st
$\circ~{\rm Topics}$ in Inverse Problems <sup>†</sup>	2022-1st, 2023-1st
• Fourier Analysis	2021-2nd
Teaching Assistant Faculty of Mathematics, PUC	
$\circ~{\rm Topics}$ in Microlocal Analysis and Inverse ${\rm Problems}^{\dagger}~({\rm scribe})$	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

Santiago, Chile Aug 2020 – Dec 2020

Santiago, Chile

June 2020

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Santiago, Chile

Aug 2024 - Now

Antofagasta, Chile Jan 2022 – Mar 2022

Santiago, Chile 2020-2021 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)

 $\circ\,$  For exceptional service to the SIAM-PUC Student Chapter. Interview here (in Spanish)  ${\bf \ensuremath{\mathbb{Z}}}$ 

#### IMC-SIAM Travel Award

Institute for Mathematical and Computational Engineering, PUC

July 2022

April 2023

◦ Travel award to represent the SIAM-PUC Student Chapter at the SIAM Annual Meeting 2022, Pittsburgh, PA. Interview here (in Spanish) ☑

# Skills

 $\label{eq:programming: Python, Julia, MATLAB, R, LATEX$ 

Languages: Spanish (native), English (advanced)

#### Activities

<b>Organizer</b> , SIAM-PUC Summer School. 200 years of Fourier Analysis. Webpage here	Jan 2023
Organizer, Mathematical Engineering National Meeting ENIM 2022. Webpage here $\checkmark$	Aug 2022
President, SIAM-PUC Student Chapter	Aug 2021-Aug 2023
<b>Student Representative</b> , 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