Matías Villagra

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CONTACT INFORMATION

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EDUCATION

Ph.D. in Operations Research, Columbia University — Sept 2020 - May 2026
Advisors: Daniel Bienstock and Yuri Faenza

M.Sc. in Mathematics, Universidad Católica de Chile — Mar 2018 - Sept 2020
Thesis *"An efficient symmetry breaking approach for arbitrary finite groups"* — (Degree awarded Dec 2020)
Advisor: José Verschae
Thesis Committee: José Verschae (UC Chile), Marc Pfetsch (TU Darmstadt), Jan Kiwi (UC Chile)

M.Sc. in Economics, Universidad Católica de Chile — Mar 2015 - July 2016
Thesis *"Divide or Bundle: strategies for a monopolist under asymmetric information"*
Advisor: Nicolás Figueroa

B.Sc. in Economics, Universidad Católica de Chile — Mar 2011 - Dec 2015

B.Sc. in Economics, Universidad de Costa Rica — Mar 2009 - Dec 2010
Transferred to Universidad Católica de Chile

RESEARCH INTERESTS

My research focuses on developing scalable optimization and pricing algorithms for high-impact decision problems, with an emphasis on both practical applications and methodological contributions. My central focus is on energy systems, where I address the fundamental challenge of designing and operating power grids that are economically efficient and adaptable to rapid technological and policy change. A secondary focus is on the structural role of symmetry in optimization, where I investigate its impact on algorithmic performance and the strength of mathematical relaxations, with the goal of developing symmetry-aware algorithms.

AWARDS AND FELLOWSHIPS

Honorable Mention INFORMS Computing Society (ICS) Student Paper Award [J2]
Best Poster Award and **Most Popular Poster Award** for the poster "Symmetries and Lift-and-Project Hierarchies" presented at the Mixed Integer Programming Workshop 2025 [W1]
Deming Doctoral Fellowship 2024 - 2025, W. Edwards Deming Center, Columbia Business School ($ 10,000 stipend)
Lead Teaching Fellow 2022 - 2023, Center for Teaching and Learning (CTL), Columbia University ($ 3,000 stipend)

Pre-doctoral
Master's degree in Mathematics thesis approved with highest distinction (summa cum laude)
Master's degree in Economics thesis approved with highest distinction (summa cum laude)
Graduated with two distinction votes (magna cum laude), *M.Sc. in Economics*

Academic Excellence Scholarship (10% reduction on tuition of Master's degree in Economics)
Graduated with two distinction votes (magna cum laude), *B.Sc. in Economics*

PUBLICATIONS

Journals

[J2] Bienstock, D. and **Villagra, M.**, "Accurate Linear Cutting-Plane Relaxations for ACOPF," Mathematical Programming Computation (2025).

[J1] Verschae, J., **Villagra, M.** and von Niederhäusern, L. "On the Geometry of Symmetry Breaking Inequalities," Mathematical Programming. 197, 693 - 719 (2023).

Conference Proceedings

[C4] Faenza, Y., Vedugo, V., Verschae, J., and **Villagra, M.**, "Linear Programming Hierarchies Collapse under Symmetry," soon to appear in Integer Programming and Combinatorial Optimization: 27th International Conference, IPCO 2026, Padova, Italy. `https://arxiv.org/abs/2511.07766`

[C3] Romero, M., Verástegui, F. and **Villagra, M.**, "A Linear and Scalable Cutting-Plane Algorithm for Electricity Pricing," 2025 IEEE Power & Energy Society General Meeting (PESGM), Austin, TX, USA, 2025

[C2] Bienstock, D. and **Villagra, M.**, "Accurate and Warm-Startable Linear Cutting-Plane Relaxations for ACOPF," 2024 IEEE 63rd Conference on Decision and Control (CDC), Milan, Italy, 2024, pp. 5024 – 5031.

[C1] Verschae, J., **Villagra, M.** and von Niederhäusern, L., "On the Geometry of Symmetry Breaking Inequalities," Integer Programming and Combinatorial Optimization: 22nd International Conference, IPCO 2021, Atlanta, GA, USA, May 19 - 21, 2021, pp. 73 – 88.

WORK IN PROGRESS

[W1] Bienstock, D. and **Villagra, M.**, "Advanced Cutting-Plane Algorithms for ACOPF." `https://arxiv.org/abs/2510.21698`

[W2] Bienstock, D., Qiu, G., Tanneau, M., Verástegui, F. and **Villagra, M.**, "Dual proxies and OPF pricing."

[W3] Bienstock, D. and **Villagra, M.**, "On the Feasibility of Convex QCQPs". Early stage.

[W4] Anunrojwong, J. Romero, M., Verástegui, F. and **Villagra, M.**. "A study of pricing schemes for nonconvex electricity markets". Early stage.

TALKS

2025 INFORMS Annual Meeting, Oct 20-23, Atlanta; *2025 Berkeley - Columbia Meeting in Engineering and Statistics* [slides], Oct 3rd 2025, Berkeley; *Discrete Optimization Talk (DOTs)* [video], Sept 5th 2025; *Symmetry Handling for Satisfiability and Optimization Workshop* at TU Eindhoven, March 23-24, 2025; 2024 Conference on Decision and Control (CDC), December 16-19, 2024, Milan, Italy; 2024 INFORMS Annual Meeting, Oct 20-23, Seattle; ISMP 2024, July 21-26, Montreal; IPCO XXII, 2021 [video], May 19th 2021, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology; *Discrete Optimization Reading Group*, Oct. 2020, IEOR Department, Columbia University;*Research Seminar, Mathematical Optimization Methods Group*,

Feb. 2020, AI in Society, Science and Technology Department, Zuse Institute Berlin; *Research Seminar*, Feb. 2020, Department of Mathematics and Computer Science, Technische Eindhoven University of Technology; *Research Seminar, Optimization Group*,Feb. 2020, Department of Mathematics, Technische Universität Darmstadt; *OR Research Seminar*, Jan. 2020, Department of Mathematics and School of Management, Technische Universität München; *Seminar der Arbeitsgruppen Diskrete Mathematik*, Jan. 2020, Geometrie & Diskrete Geometrie, Faculty of Mathematics, Technische Universität Berlin; *Workshop on Extended Formulations and Symmetries in Integer Programming*, Dec. 2019, Faculty of Engineering, University of O'Higgins; *Algorithms, Combinatorics, Game Theory and Optimization Seminar*, Dec. 2019, Faculty of Engineering, Universidad de Chile; *Computational Group Theory Seminar*, Oct. 2017, Faculty of Mathematics, P. Universidad Católica de Chile.

TEACHING EXPERIENCE

Lecturer

Faculty of Engineering and Science, Universidad Adolfo Ibañez 2016 - July 2020

- *Microeconomics* (x5)
- *Principles of Economics* (x2)
- *Industrial Organization* (x6)

My 2018 teaching evaluations (Spanish and English) are available here: Teaching Evaluations

Faculty of Economics and Business, P. Universidad Católica de Chile

- *Mathematical Applications in Economics and Business* 2020 - July 2020
- *Introduction to Economics* (x2) 2017 - 2018

Teaching Assistant

IEOR Department, Columbia University

- *Optimization Models and Methods for Financial Engineering, MSc. level course (Fall 2025, Lecturer Tianyi Li)*
- *Integer Programming, PhD course (Fall 2023, Lecturer Daniel Bienstock)*
- *Optimization II, Core PhD course (Spring 2022, Lecturer Daniel Bienstock)*
- *Optimization Models and Methods, MSc. level course (Spring 2021, Lecturer Donald Goldfarb)*

Teaching evaluations for Optimization Models and Methods (Spring 2021) and Optimization II (Spring 2022) can be accessed here: Teaching Evaluations.

Faculty of Mathematics, P. Universidad Católica de Chile

- *Linear Algebra; Calculus I (x2); Introductory Mathematics mini course (PIMU); Mathematics Workshop for 1st year BSc. Mathematics students*

Institute of Economics, P. Universidad Católica de Chile

- *Probability and Statistics; Algebra; Real Analysis for Economics (graduate course), Social Projects Evaluation, Mathematical Economics (x2) (graduate course)*

OTHER ACTIVITIES

Professional Service

Journal Reviewer: *Mathematics of Operations Research*, *INFORMS Journal on Computing*, *INFORMS Journal on Optimization*.

Conference Reviewer: *Integer Programming and Combinatorial Optimization (IPCO)*, *Power Systems Computation Conference (PSCC)*.

Internships

Research Internship with Prof. Michael Joswig — Jan - Feb 2020
"A symmetric height function for a regular unimodular triangulation"
Arbeitsgruppen Diskrete Mathematik Geometrie & Diskrete Geometrie
Faculty of Mathematics, Technische Universität Berlin

Outreach

Lecturer at Instituto de Formación y Capacitación Popular (INFOCAP). This is a technical school for vulnerable people in Chile. I taught courses for future sewing professionals.

- Basic Mathematics — Fourth trimester 2017
- Financial Planning and Budgeting — First trimester 2018
- Finance for Entrepreneurs — Second trimester 2018

Mathematics tutor for mathematical reasoning workshops — Aug 2017 – Aug 2019
Program UC Math - Juvenile Temporary Detention Center (CIP SENAME)
Reference: Duvan Henao, duvan.henao@uoh.cl

COMPUTATIONAL TOOLS

Proficient in LaTeX and Python; basic knowledge of C; experienced with optimization solvers including Gurobi, Mosek, and Knitro.

REFERENCES

Prof. Daniel Bienstock
Email: dano@columbia.edu
Department of Industrial Engineering and Operations Research
Columbia University

Prof. Yuri Faenza
Email: yf2414@columbia.edu
Department of Industrial Engineering and Operations Research
Columbia University

Prof. Santanu S. Dey
Email: santanu.dey@isye.gatech.edu
H. Milton Stewart School of Industrial and Systems Engineering
Georgia Institute of Technology

Prof. José Verschae
Email: jverschae@uc.cl
Institute of Computational and Mathematical Engineering
UC Chile