KIMBERLY VILLALOBOS CARBALLO

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EDUCATION

Massachusetts Institute of Technology *Cambridge, MA, USA*
Ph.D. candidate in Operations Research. GPA: 5.0/5.0 *2019 - Exp. 2024*
- Advisor: Prof. Dimitris Bertsimas
- Thesis: *Integrating Optimization and Machine Learning: Theory, Computation and Healthcare Applications*

Massachusetts Institute of Technology *Cambridge, MA, USA*
Bachelor of Science in Mathematics. GPA: 5.0/5.0 *2015 - 2019*
Bachelor of Science in Computer Science. GPA: 5.0/5.0
Minor in Statistics and Data Science

RESEARCH INTERESTS

Methodology: Optimization (Robust, Stochastic, Convex and Non-convex, Discrete and Continuous, Multistage), Machine Learning, Data Multimodality.

Applications: Healthcare Analytics, Applications in Medicine.

PAPERS

Published Papers

(P1) Holistic Deep Learning
Dimitris Bertsimas, **Kimberly Villalobos Carballo**, Léonard Boussioux, Michael Lingzhi Li, et al.
Machine Learning (MACH), 2023

(P2) Integrated multimodal artificial intelligence framework for healthcare applications
Luis R Soenksen, Yu Ma, Cynthia Zeng, Leonard Boussioux, **Kimberly Villalobos Carballo**, Liangyuan Na, et al.
NPJ Digital Medicine (NPJDIGITALMED), 2022

(P3) From predictions to prescriptions: A data-driven response to COVID-19
Dimitris Bertsimas, Leonard Boussioux, Ryan Cory-Wright, Arthur Delarue, ..., **Kimberly Villalobos Carballo**, et al.
Health Care Management Science, 2021

(P4) Do neural networks for segmentation understand insideness?
Kimberly Villalobos Carballo, Vilim Štih, Amineh Ahmadinejad, Shobhita Sundaram, Jamell Dozier, et al.
Neural Computation, 2021

Papers Under Review

(U1) TabText: A Flexible and Contextual Approach to Tabular Data Representation
Kimberly Villalobos Carballo, Irra Na, Yu Ma, Léonard Boussioux, Cynthia Zeng, Luis Soenksen, Dimitris Bertsimas
Submitted to Nature Machine Intelligence

(U2) Robust Upper Bounds for Adversarial Training
Dimitris Bertsimas, **Kimberly Villalobos Carballo**, Xavier Boix, Dick den Hertog
Submitted to Operations Research, 2023

(U3) Patient Outcome Predictions Improve Operations at a Large Hospital Network
Liangyuan Na, **Kimberly Villalobos Carballo**, Jean Pauphilet, Dimitris Bertsimas, Ali Haddad-Sisakht, et al.
Submitted to Manufacturing & Service Operations Management (M&SOM), 2023

(U4) Multistage Stochastic Optimization via Kernels
Dimitris Bertsimas, **Kimberly Villalobos Carballo**
Submitted to Mathematical Programming (MAPR), 2023

RESEARCH AND INDUSTRY EXPERIENCE

MIT Operations Research Center *September 2019 - Present*
Doctoral Research Assistant *Cambridge, MA, USA*

Theory and Methodology

- Built a flexible representation framework to extract contextual information from tabular structures using Large Language Models (U1).
- Developed a new algorithm for training robust Neural Networks and provided theoretical guarantees for the nonexistence of adversarial attacks (U2).
- Developed a new methodology to train neural networks that simultaneously optimize for sparsity, robustness and stability (P1).
- Formulated a novel algorithm to solve multistage stochastic optimization problems via sparsification of universal kernels, and proved asymptotic optimality (U4).
- Co-designed a novel framework for solving medical prediction tasks by combining multiple data modalities (P2).

Healthcare Applications

- Helped designing analytics tools that support decision makers to combat the COVID-19 pandemic (P3).
- Improved hospital operations with patient outcome predictions at Hartford Healthcare and UMass Memorial Center, resulting in length of stay reduction (U3).
- Co-developed a machine learning model to identify life-threatening events for early dispatch of Rapid Response Teams at Hartford Healthcare (*in preparation*).
- Co-designed an optimization algorithm for assignment of elective surgeries at Hartford Healthcare (*in preparation*).
- Applied multi-modal machine learning algorithms at Brigham And Women's Hospital for early detection of victims of domestic violence (*in preparation*).

MIT Neuroscience Department *June 2017 - June 2019*
Undergraduate Research Assistant *Cambridge, MA, USA*

- Demonstrated mathematically that state-of-the art Neural Networks can solve the problem of finding if an object lies inside or outside a closed path (P4).

Microsoft Research *January 2017 - April 2018*
Research Intern *Cambridge, MA, USA*

- Analyzed the conditions under which a set of points on a sphere universally locally minimize total potential energy.
- Formulated a representation of the isometry group for the octacube and decomposed it into irreducible representations.

SPUR - MIT Math Department Summer Program *June 2017 - August 2017*
Undergraduate Researcher *Cambridge, MA*

- Explored connections between theoretical physics and machine learning through random walk models on Ising spin systems.

Singapore University of Technology and Design *June 2017 - August 2017*
Undergraduate Researcher *Changi, SG*

- Developed a 3D virtual map of the SUTD campus to facilitate navigation for students.

TEACHING EXPERIENCE

Teaching Assistant for Machine Learning via a Modern Optimization Lens (MIT 15.095) Fall 2022
- Graduate level course on ML tools via robust, convex and mixed integer optimization.
- Led recitations and weekly office hours, developed and graded assignments, supervised final projects.
- Designed class content for robust and sparse classification, median, convex and holistic regression, optimal trees, data imputations, sparse principal component analysis, matrix completion, kernel methods.
- Class Size: 105; Student Evaluation Score: 6.9/7.0

Teaching Assistant for Analytics Capstone (MIT 15.089) Summer 2022
- Master of Business Analytics course on using analytical tools to solve key business challenges.
- Evaluated project presentations, provided feedback and graded final project reports.
- Class Size: 78; Student Evaluation Score: Not Applicable.

Teaching Assistant for Robust Modeling, Optimization, and Computation (MIT 15.094) Spring 2022
- Graduate level course on theory, modeling, algorithms, and applications of robust optimization.
- Led recitations and weekly office hours, developed and graded assignments, supervised final projects.
- Designed class content for robust convex and concave optimization, distributionally robust optimization, probabilistic guarantees in robust optimization, robust machine learning.
- Class Size: 21; Student Evaluation Score: 6.7/7.0

Instructor for Analytics Software Tools (MIT 15.003) Fall 2021, 2022, 2023
- Master of Business Analytics course on software tools such as R, Python, Julia and Git.
- Taught and assisted students for 3-hour classes during 6 days.
- Designed curriculum and created software workshops on data wrangling, visualization, machine learning, deep learning, version control, optimization.
- Average Class Size: 80; Student Evaluation Score: 7.0/7.0

Teaching Assistant for The Analytics Edge (MIT 15.727) Spring 2021
- Executive Master of Business Analytics course on quantitative methods.
- Led recitations and weekly office hours, developed and graded assignments, supervised final projects.
- Designed class content for regression and classification methods, text analytics, prescriptive methods.
- Class Size: 46; Student Evaluation Score: 7.0/7.0

Teaching Assistant for The Analytics Edge (MIT 15.071x) Fall 2020
- Online course on Analytics methods.
- Answered student questions on regression and classification methods, text analytics, prescriptive methods.
- Class Size: 844; Student Evaluation Score: Not Applicable.

TALKS

Robust Upper Bounds for Adversarial Training (U2)
- Robust Optimization (MIT 15.094) - Invited Speaker 2023
- MIT Operations Research Student Seminar 2022
- INFORMS Annual Meeting 2022
- International Conference on Continuous Optimization (ICCOPT) 2022
- Biological Learning in Silico MIT Meeting Group 2022

Modern Optimization for Deep Learning (P1, U2)
- INFORMS Annual Meeting - SC54 2023
- Young Researchers Workshop, Cornell University 2023
- *Upcoming:* Operations Management Seminar, MIT 2023

Patient Outcome Predictions Improve Operations at a Large Hospital Network (U3)
- INFORMS Annual Meeting - SB79 2023
- MIT MIMO Symposium Poster Competition 2023
- AI Cures Conference 2023

TabText: A Flexible and Contextual Approach to Tabular Data Representation (U1)
- INFORMS Healthcare Conference 2023
- AI Cures Conference 2023
- INFORMS Annual Meeting Workshop: the Future of Analytics and OR 2022

Multistage Stochastic Optimization via Kernels (U4)
- Machine Learning Under a Modern Optimization Lens (MIT 15.095) Guest Lecture 2023
- MIT Operations Research Center General Exam Research Presentation 2023

Integrated multimodal artificial intelligence framework for healthcare applications (P2)
- INFORMS Annual Meeting 2022
- AI Cures Conference 2022

Do neural networks for segmentation understand insideness? (P4)
- Center for Brains, Minds and Machines, EIT Research Presentations 2019

HONORS AND AWARDS

INFORMS' William Pierskalla Best Paper Award - Winner 2020
INFORMS Doing Good with Good OR Student Paper Competition - Finalist 2023
MIT-Pillar AI Collective Prize - Winner 2023
MIT Cognex Poster Competition - Winner 2022
Operations Research Center's Common Experience Deep Learning Challenge - 1st Place 2021
Tau Beta Pi Honor Society 2018
Eta Kappa Nu Honor Society 2018
Young Talent Costa Rican Presidency Award 2014
55th International Mathematical Olympiad - Bronze Medal 2014
54th International Mathematical Olympiad - Honorable Mention 2013
Asian Pacific Mathematics Olympiad - Bronze medal 2013
Iberoamerican Mathematical Olympiad - Bronze medal 2013
Iberoamerican Mathematical Olympiad - Bronze medal 2012

SERVICE AND OUTREACH

INFORMS Annual Meeting Session Chair 2023

INFORMS Healthcare Session Chair 2023

MIT Operations Research Center Seminar Series Coordinator 2023

MIT Operations Research Center IAP Seminar Series Coordinator 2022

Reviewer for INFORMS Journal on Optimization, International Conference on Computer Vision 2020-Present

SKILLS

Programming Languages: Python, Julia, R, Java, JavaScript, HTML, CSS, SQL, C++

Software Tools: TensorFlow, PyTorch, MATLAB, JuMP, Gurobi, MOSEK, IPOPT

OTHERS

Languages: Spanish (native), English (fluent)

Activities: Singing, Dancing, Sports

Citizenship: Costa Rica