Tobia Marcucci

Assistant Professor of Electrical and Computer Engineering
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Research interests

My research lies at the intersection of convex and combinatorial optimization, with applications to robotics, motion planning, and control. I work on optimal decision making in circumstances where discrete and continuous choices have to be made jointly. My work spans both the mathematical formulation and numerical implementation of these problems, focusing on efficient optimization models and fast solution algorithms.

Employment

- **University of California, Santa Barbara** from 3/2025
  Assistant professor of Electrical and Computer Engineering
  Affiliate of the Center for Control, Dynamical Systems, and Computation

- **Amazon Robotics** 6/2024 to 2/2025
  Postdoctoral scientist
  Research focus: development of high-performance optimization algorithms for robot motion planning

Education

- **Massachusetts Institute of Technology** 6/2018 to 5/2024
  Doctoral Degree in Computer Science with minor in Mathematics
  Advisors: Russ Tedrake and Pablo Parrilo
  Thesis: Graphs of Convex Sets with Applications to Optimal Control and Motion Planning

- **University of Pisa** 12/2013 to 9/2015
  Master's Degree in Mechanical Engineering
  Final evaluation: 110/110 cum laude

- **University of Pisa** 11/2010 to 11/2013
  Bachelor's Degree in Mechanical Engineering
  Final evaluation: 110/110

Additional Research Experience

- **Stanford University** 11/2022 to 10/2023
  Visiting Ph.D. student with Stephen Boyd

- **Massachusetts Institute of Technology** 1/2017 to 11/2017
  Visiting Ph.D. student with Russ Tedrake

- **University of Pisa and Istituto Italiano di Tecnologia** 9/2015 to 1/2018
  Ph.D. student with Antonio Bicchi (uncompleted, moved to MIT)

Journal publications

[J1] **Fast Path Planning Through Large Collections of Safe Boxes** 2024
Tobia Marcucci, Parth Nobel, Russ Tedrake, and Stephen Boyd
IEEE Transactions on Robotics (TRO)

[J2] **Shortest Paths in Graphs of Convex Sets** 2024
Tobia Marcucci, Jack Umenberger, Pablo A. Parrilo, and Russ Tedrake
SIAM Journal on Optimization

[J3] **Motion Planning around Obstacles with Convex Optimization** 2023
Tobia Marcucci, Mark Petersen, David von Wrangel, and Russ Tedrake
Science Robotics

- IEEE RAS TC Model Based Optimization for Robotics Best Paper Award
- Cover of November 2023 issue

[J4] **Warm Start of Mixed-Integer Programs for Model Predictive Control of Hybrid Systems** 2020
Tobia Marcucci and Russ Tedrake
IEEE Transactions on Automatic Control (TAC)

[J5] **A Two-Stage Trajectory Optimization Strategy for Articulated Bodies with Unscheduled Contact Sequences** 2017
Tobia Marcucci, Marco Gabiccini, and Alessio Artoni
IEEE Robotics and Automation Letters (RAL)

Conference publications

[C1] **A Biconvex Method for Minimum-Time Motion Planning Through Sequences of Convex Sets** 2025
Tobia Marcucci, Mathew Halm, William Yang, Dongchan Lee, and Andrew Marchese
Robotics: Science and Systems (RSS)

[C2] **A New Semidefinite Relaxation for Linear and Piecewise-Affine Optimal Control with Time Scaling** 2025
Lujie Yang, Tobia Marcucci, Pablo Parrilo, and Russ Tedrake
IEEE International Conference on Robotics and Automation (ICRA)

[C3] **On the Sample Complexity of Imitation Learning for Smoothed Model Predictive Control** 2024
Daniel Pfrommer, Swati Padmanabhan, Kwangjun Ahn, Jack Umenberger, Tobia Marcucci, Zakaria Mhammedi, and Ali Jadbabaie
IEEE Conference on Decision and Control (CDC)

[C4] **Multi-Query Shortest-Path Problem in Graphs of Convex Sets** 2024
Savva Morozov, Tobia Marcucci, Alexandre Amice, Bernhard Paus Graesdal, Rohan Bosworth, Pablo Parrilo, and Russ Tedrake
International Workshop on the Algorithmic Foundations of Robotics (WAFR)

[C5] **Towards Tight Convex Relaxations for Contact-Rich Manipulation** 2024
Bernhard P. Graesdal, Shao Y.C. Chia, Tobia Marcucci, Savva Morozov, Alexandre Amice, Pablo Parrilo,

and Russ Tedrake
Robotics: Science and Systems (RSS)

[C6] **Approximating Robot Configuration Spaces with few Convex Sets using Clique Covers of Visibility Graphs** 2024
Peter Werner, Alexandre Amice, Tobia Marcucci, Daniela Rus, and Russ Tedrake
IEEE International Conference on Robotics and Automation (ICRA)

[C7] **Model-Based Control with Sparse Neural Dynamics** 2023
Ziang Liu, Jeff He, Genggeng Zhou, Tobia Marcucci, Li Fei-Fei, Jiajun Wu, and Yunzhu Li
Conference on Neural Information Processing Systems (NeurIPS)

[C8] **Mixed-Integer Formulations for Optimal Control of Piecewise-Affine Systems** 2019
Tobia Marcucci and Russ Tedrake
ACM International Conference on Hybrid Systems: Computation and Control (HSCC)

[C9] **Approximate Hybrid Model Predictive Control for Multi-Contact Push Recovery in Complex Environments** 2017
Tobia Marcucci, Robin Deits, Marco Gabiccini, Antonio Bicchi, and Russ Tedrake
IEEE International Conference on Humanoid Robots (Humanoids)

[C10] **Parametric Trajectory Libraries for Online Motion Planning with Application to Soft Robots** 2017
Tobia Marcucci, Manolo Garabini, Gian Maria Gasparri, Alessio Artoni, Marco Gabiccini, and Antonio Bicchi
International Symposium on Robotic Research (ISRR)

[C11] **Towards Minimum-Information Adaptive Controllers for Robot Manipulators** 2017
Tobia Marcucci, Cosimo Della Santina, Marco Gabiccini, and Antonio Bicchi
IEEE American Control Conference (ACC)

[C12] **Approximate Explicit Model Predictive Control for Push Recovery Using Mixed-Integer Convex Optimization** 2017
Robin Deits, Tobia Marcucci, Lucas Manuelli, Twan Koolen, and Russ Tedrake
Dynamic Walking

Manuscripts in preparation

[P1] **An Introduction to Certifiably Correct Optimization in Robotics**
Connor Holmes, Frederike Dumbgen, Alan Papalia, Corbinian Scholosser, and Tobia Marcucci

[P2] **Convex-Concave Procedure for Local Optimization of Collision-Free Paths**
Peter Werner, Tobia Marcucci, and Daniela Rus

[P3] **Mixed Discrete and Continuous Planning using Shortest Walks in Graphs of Convex Sets**
Savva Morozov, Tobia Marcucci, Bernhard P. Graesdal, Alexandre Amice, Pablo Parrilo, and Russ Tedrake

Teaching experience

Main instructor:

- *Introduction to Robotics: Planning and Kinematics* Spring 2025
  Undergraduate course at the University of California, Santa Barbara (ECE/ME 179P)

Teaching assistant:

- *Underactuated Robotics* Spring 2020
  Graduate course taught by Russ Tedrake at MIT
  - Gave two lectures (available on the class YouTube channel)
  - Developed the exercises in the class lecture notes
- *Automatic Controls and Robot Mechanics* Fall 2015
  Graduate course taught by Antonio Bicchi and Marco Gabiccini at the University of Pisa
  - Gave multiple lectures

Guest lecturer:

- *Optimal Control: from Calculus of Variations to Numerical Optimization* Summer 2020
  Doctorate course taught by Manolo Garabini at the University of Pisa
  - Lecture material available at https://github.com/TobiaMarcucci/optimal_control_pisa
- *Intelligent Robot Manipulation* Fall 2018
  Graduate course taught by Russ Tedrake and Tomás Lozano-Pérez at MIT

Conference and workshop organization

- **International Workshop on the Algorithmic Foundations of Robotics** 2026
  Co-chair with Stephane Caron, Steven LaValle, Basak Sakcak, Oren Salzman
- **ScaleOPT: GPU-accelerated and Scalable Optimization** 2025
  Workshop proposal at Conference on Neural Information Processing Systems (NeurIPS)
  Organizer with Parth Nobel, Fangzhao Zhang, Maximillian Schaller, Tetiana Parshakova, Stephen Boyd
- **Decision and Control Blending Combinatorial and Continuous Optimization** 2023
  Workshop at SIAM Conference on Optimization
  Main organizer with Jack Umenberger
- **Optimal planning and control fusing offline and online algorithms** 2019
  Workshop at IEEE International Conference on Robotics and Automation
  Main organizer with Manolo Garabini
- **"Robotics I" session** 2017
  IEEE American Control Conference
  Co-chair

Invited talks

Motion Planning around Obstacles with Convex Optimization:

- Stanford University (Interactive Perception and Robot Learning Laboratory) 7/2023
- University of California Berkeley (EECS Seminar) 5/2023
- Stanford University (SystemX Robotics Spotlights) 2/2023
- Cornell University (Verifiable Robotics Group) 10/2022

- Istituto Italiano di Tecnologia (iCub Research Lines) [recording] 9/2022

Graphs of Convex Sets:

- International Conference on Continuous Optimization (ICCOPT) (session on "Optimization for robotics") 7/2025
- INFORMS Annual Meeting (session on "Global optimization") 10/2023
- SIAM Conference on Optimization (session on "Decision and control blending combinatorial and continuous optimization") 6/2023
- Stanford University (Linear Algebra and Optimization Seminars) 1/2023
- Joint Mathematics Meetings (SIAM mini-symposium in combinatorial optimization) 1/2023
- International Conference on Optimization and Decision Science (session on "Path and routing problems in industry") 8/2022
- Université Catholique de Louvain (Cyber-Physical Systems Laboratory) 5/2022
- IMT School for Advanced Studies Lucca 12/2021
- Stanford University (Autonomous Systems Laboratory) 11/2021
- University of California Berkeley (MPC Laboratory) 11/2021
- California Institute of Technology (AMBER Laboratory) 11/2021
- Massachusetts Institute of Technology (Embodied Intelligence Submissions Seminars) 9/2021

Others:

- *Control through Contacts via Approximate Explicit Model Predictive Control* 5/2019
  IEEE International Conference on Robotics and Automation
  Workshop on optimal planning and control fusing offline and online algorithms

Invited posters

Shortest Paths in Graphs of Convex Sets:

- Brown University (ICERM workshop on Linear and Non-Linear Mixed Integer Optimization) 2/2023
- Cornell University (ORIE Young Researchers Workshop) 10/2022

Awards

- IEEE RAS TC Model Based Optimization for Robotics Best Paper Award 2023
- SIAM Student Travel Award 2023
- Grass Instruments Company Fellow 9/2018 to 5/2019

Reviewer

- International journals and conferences, including: Automatica, IEEE Transactions on Automatic Control (TAC), IEEE Transactions on Robotics (TRO), International Journal of Robotics Research (IJRR), Journal of Robust and Nonlinear Control, Journal of Optimization Theory and Applications (JOTA), and Science Robotics.