Tobia Marcucci

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I am a PhD student at the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT, working under the supervision of Russ Tedrake and Pablo Parrilo. Since November 2022 I am visiting Stanford University to collaborate with Stephen Boyd. My research sits at the intersection of control theory and optimization (convex and combinatorial). Specifically, I study optimal decision making in circumstances where discrete and continuous choices have to be taken simultaneously. I work on these problems on a mathematical and numerical level: I devise efficient problem formulations and I design fast solution algorithms. Motion planning and control of robotic systems is the main application of my research.

Education

- **Massachusetts Institute of Technology** 06/2018 to 09/2023 (estimated)
  PhD student with Russ Tedrake and Pablo Parrilo
  Major: Computer science (System Science and Control Engineering)
  Minor: Mathematics (Abstract Algebra)
  GPA: 4.8/5
- **Stanford University** 11/2022 to 07/2023
  Visiting PhD student with Stephen Boyd
- **Massachusetts Institute of Technology** 01/2017 to 11/2017
  Visiting PhD student at the Robot Locomotion Group (CSAIL)
- **Research Center "E. Piaggio" and Istituto Italiano di Tecnologia** 09/2015 to 1/2018
  PhD student with Antonio Bicchi (uncompleted, moved to MIT)
- **University of Pisa** 12/2013 to 09/2015
  Master's Degree in Mechanical Engineering
  Overall graduation grade: 110/110 cum laude
  GPA: 30.0/30
- **University of Pisa** 11/2010 to 11/2013
  Bachelor's Degree in Mechanical Engineering
  Overall graduation grade: 110/110
  GPA: 27.2/30

Publications Under Review

- **Motion Planning around Obstacles with Convex Optimization** 2022
  Tobia Marcucci, Mark Petersen, David von Wrangel, and Russ Tedrake
  Under review in Science Robotics (preprint arXiv:2205.04422)
- **Shortest Paths in Graphs of Convex Sets** 2021
  Tobia Marcucci, Jack Umenberger, Pablo A. Parrilo, and Russ Tedrake
  Under review in SIAM Journal on Optimization (preprint arXiv:2101.11565)

Journal Publications

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

Conference Publications

- **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
- **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
- **Parametric Trajectory Libraries for Online Motion Planning with Application to Soft Robots** 2017
  Tobia Marcucci, Manolo Garabini, Gian Maria Gasparri, Alessio Artoni, Marco Gabiccini, Antonio Bicchi
  International Symposium on Robotic Research
- **Towards Minimum-Information Adaptive Controllers for Robot Manipulators** 2017
  Tobia Marcucci, Cosimo Della Santina, Marco Gabiccini, and Antonio Bicchi
  IEEE American Control Conference

Extended Abstracts

- **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

Invited Talks

Motion Planning around Obstacles with Convex Optimization:

- Cornell University (Verifiable Robotics Group) October 2022
- Istituto Italiano di Tecnologia (iCub Research Lines) [recording] September 2022
- Presented by Russ Tedrake:
  - Keynote at WAFR 2022 [recording]
  - Seminar at Contextual Robotics Institute (UCSD)
  - Seminar at GRASP on Robotics (University of Pennsylvania) [recording]

Shortest Paths in Graphs of Convex Sets:

- Joint Mathematics Meetings (JMM) (SIAM mini-symposium in combinatorial optimization) January 2023
- International Conference on Optimization and Decision Science (ODS) (Session on "Path and routing problems in industry") August 2022
- Université Catholique de Louvain (Cyber-Physical Systems Laboratory) May 2022
- IMT School for Advanced Studies Lucca December 2021
- Stanford University (Autonomous Systems Laboratory) November 2021
- University of California Berkeley (MPC Laboratory) November 2021
- California Institute of Technology (AMBER Laboratory) November 2021
- Massachusetts Institute of Technology (Embodied Intelligence Seminars) September 2021
- Presented by Pablo Parrilo:
  - Semi-Plenary at ICCOPT 2022

Others:

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

Workshops Invitations

- ICERM Linear and Non-Linear Mixed Integer Optimization (Brown University) — February 2023
- ORIE Young Researchers Workshop (Cornell University) — October 2022
  - Poster presentation on "Shortest Paths in Graphs of Convex Sets"

Teaching Experience

- **Guest lecturer** — Summer 2020
  Optimal Control: from Calculus of Variations to Numerical Optimization
  PhD course taught by Manolo Garabini at the University of Pisa
  - Lecture material available at https://github.com/TobiaMarcucci/optimal_control_pisa
- **Teaching assistant** — Spring 2020
  Underactuated Robotics
  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
- **Guest lecturer** — Fall 2018
  Intelligent Robot Manipulation
  Graduate course taught by Russ Tedrake and Tomás Lozano-Pérez at MIT
- **Contributor to the lecture notes** — Spring 2016
  Robot Control
  Graduate course taught by Antonio Bicchi at the University of Pisa
- **Author of the final exam** — Fall 2015
  Fundamentals of Automatic Control
  Undergraduate course taught by Lucia Pallottino at the University of Pisa
- **Teaching assistant** — Fall 2015
  Robot Mechanics
  Graduate course taught by Marco Gabiccini at University of Pisa
  - Gave multiple lectures

Awards

- Grass Instruments Company Fellow from 9/2018 to 5/2019.

Service

- **Workshop organizer** — 2019
  Optimal planning and control fusing offline and online algorithms
  IEEE International Conference on Robotics and Automation
- **Co-chair** — 2017
  Session "Robotics I"
  IEEE American Control Conference
- **Reviewer**
  International journals and conferences, including: IEEE Transactions on Automatic Control (TAC), IEEE Control Systems Letters (CSS), International Journal of Robotics Research (IJRR), IEEE Transactions on Robotics (TRO), IEEE Robotics and Automation Letters (RAL), and Journal of Optimization Theory and Applications (JOTA)

Miscellaneous Academic Achievements

- Grade of A+ in half the classes taken in the PhD at MIT
- Grade of A+ in all the classes taken for the minor in mathematics in the PhD at MIT
- Highest GPA among the students enrolled in 2013 in the master program in Mechanical Engineering at the University of Pisa

- Only student enrolled in 2010 in Mechanical Engineering at the University of Pisa to complete bachelor and master within 5 years (approximately 90% of the students take more than 6 years)