Ugo Rosolia

Postdoctoral Scholar
California Institute of Technology

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Education

University of California Berkeley — Berkeley, CA
Ph.D. in Control Engineering, Advisor: Prof. Francesco Borrelli. — Aug 2015 – Dec 2019

- Thesis: "Learning Model Predictive Control: Theory and Applications".
- Developed a theoretical Model-Based RL framework called Learning Model Predictive Control (LMPC).
- Leveraged the LMPC to teach an autonomous full-size car how to race in real-world experiments (video).
- The LMPC paper is among the most frequently accessed journals on IEEE Transaction on Automatic Control.

Politecnico di Milano — Milano, Italy
M.S. in Control Engineering, Grade: 110 Cum Laude/110. — Sept 2012 – Sept 2014

- Thesis: "Nonlinear Model Predictive Control for Autonomous Vehicle".
- Developed a solver for smooth nonlinear programming using continuation methods.
- Results published on the journal IEEE Transaction on Control System Technology.

Politecnico di Milano — Milano, Italy
B.S. in Mechanical Engineering, Grade: 109/110. — Sept 2009 – Sept 2012

- Thesis: "Stress and Strain of a Disk Break: A Finite Element Modelling (FEM) Analysis".
- Developed a FEM solver. Results validated with a commercial solver which costs 20k+/year.

Research And Working Experience

California Institute of Technology — Pasadena, CA
Postdoctoral Scholar. Project: Test and Evaluation of Safety Critical Autonomous Systems. — Jan 2020 – Present

- Developed theory and solvers for constrained mixed observable Markov decision processes (CMOMDPs).
- Designed and tested on hardware an hierarchical framework for safety critical control.
- Mentoring and coordinating students.

University of California Berkeley — Berkeley, CA
Research Assistant. — Jan 2015 – Dec 2019

- Supervised and co-developed the Berkeley Autonomous Racing Car (BARC) platform (barc-project.com).
- Student Member of the Hyundai Center of Excellence. In charge of control design and testing.

École Polytechnique Fédérale de Lausanne (EPFL) — Lausanne, Switzerland
Visiting Scholar. — Nov 2019

Siemens PLM Software — Leuven, Belgium
Research Engineer. Project: Automated Testing. — Jan 2015 – Jun 2015

- Developed C code to automatically synthesizing control policies using approximate dynamic programming.

Siemens PLM Software — Leuven, Belgium
Intern. Project: Automated Driving. — Jun 2014 – Aug 2014

- First researcher to successfully test cooperative autonomous driving on Siemens's testing platform.

University of Illinois at Urbana-Champaign (UIUC) Champaign, IL
Visiting Student, GPA 4/4. Aug 2013 – May 2014

– Attended six grad classes and conducted research at the ARG lab.

MINES ParisTech Paris, France
Athens Student. Project: Plastic deformation of metals Feb 2013

Tonji University Shanghai, China
Double degree student. Sep 2010 – Jun 2011

Teaching and Mentoring

- **Guest Lecturer** at University of California Berkeley Spring 2019 – Fall 2020
  Constrained Optimal Control and Model Predictive Control fundamentals (ME C231A)
  Introduction and advances topics on Learning Model Predictive Control (ME C231B)
  Helped with the preparation of homework and exams
- **PhD Students** at California Institute of Technology Jan 2020 – Present
  - Ivan Jimenez Rodriguez. Topic: "Model Learning for Control"
  - Prithvi Akella. Topic: "Bayesian Optimization for Testing and Evaluation"
- **MS Thesis Students** at University of California Berkeley Aug 2016 – Dec 2019
  - Maximilian Brunner. Topic: "Learning Model Predictive Control for Iterative Tasks"
  - Martin D'Hoffschmidt. Topic: "Deep Model Predictive Control"
  - Michael Garstka. Topic: "Adaptive LMPC"
  - Felix Nobis. Topic: "Obstacle Avoidance in Autonomous Racing"
  - Francesco Ricciuti. Topic: "Dynamic Obstacle Avoidance in Autonomous Racing"
  - Shuqi Xu. Topic: "Comparison of Model Learning Strategies for MPC"
  - Lukas Brunke. Topic: "Multi-agent Autonomous Racing"
- **Undergrad Students** at University of California Berkeley Aug 2016 – Dec 2019
  - Bike Zhang. Project: "Applications of Model Predictive Control"
  - Rohan Shina. Project: "Data-driven control"
  - Thiti Khomin. Project: "Autonomous Skateboard"
  - Paul Hsiao. Project: "Autonomous Skateboard"

Scholarships and Awards

- Graduate Division Block Grant Award (11.4k$) Summer 2019
- The Frank and Margaret Lucas Scholarship Fund (20.3k$) Spring 2019
- Graduate Division Block Grant Award (18.8k$) Spring 2017
- Graduate Division's Non-Resident Supplemental Tuition Award (7.5k$) Spring 2017
- Master Degree Cum Laude (Top 5%) 2014
- Politecnico di Milano Scholarship (2k€/year) 2009 – 2014
- University of Illinois at Urbana-Champaing (UIUC) Scholarship (covered tuition) Spring 2014
- Global E3 Project (covered tuition) Fall 2013
- PoliTong Double Degree Project (1k€ + covered tuition) Fall 2009 – Spring 2010

Programming Skills

Python, C++, Git, MATLAB, Simulink, HTML, LaTeX

Selected Projects

For more details check ugorosolia.com

- Learning How to Race (Python, repo)
  Model-based RL for autonomous car racing
- Planning Under Uncertainty (Python, repo)
  Solver for mixed observable MDPs
- Learning MPC (Python, repo)
  Repo of examples for teaching
- Multi-Rate MPC (C++, repo)
  A control library for safety critical systems

Languages

Italian (mother tongue), **English** (proficient), **French** (basic)

Editorial Roles

Associated Editor: 2021 European Control Conference (ECC)

Reviewer: Transaction on Automatic Control, Automatica, Journal of Nonlinear and Robust Control, Transaction on Robotics, Conference on Robot Learning (CoRL), Conference on Decision and Control (CDC), European Control Conference (ECC), American Control Conference (ACC), Cyber-Physical and Human Systems (CPHS), Optimal Control Applications and Methods, IFAC World Congress

Preprints

[1] M. Ahmadi, **U. Rosolia**, R. M. Murray, and A. D. Ames, *Constrained risk-averse markov decision processes*, 2020.

[2] M. Bujarbaruah, **U. Rosolia***, Y. R. Stürz*, X. Zhang, and F. Borrelli, *Robust mpc for lti systems with parametric and additive uncertainty: A novel constraint tightening approach*, 2020. arXiv: 2007.00930 [eess.SY].

[3] S. H. Nair, **U. Rosolia**, and F. Borrelli, *Output-lifted learning model predictive control for flat systems*, 2020. arXiv: 2004.05173 [math.OC].

[4] **U. Rosolia**, M. Ahmadi, R. M. Murray, and A. D. Ames, *Time-optimal quantitative problems for mixed observable markov decision processes*, 2020.

[5] **U. Rosolia**, Y. Lian, E. T. Maddalena, G. Ferrari-Trecate, and C. N. Jones, *On the optimality and convergence properties of the learning model predictive controller*, 2020.

[6] **U. Rosolia**, X. Zhang, and F. Borrelli, *Robust learning model predictive control for linear systems performing iterative tasks*, 2019. arXiv: 1911.09234 [eess.SY].

Journal Publications

[1] I. Batkovic, **U. Rosolia**, M. Zanon, and P. Falcone, "A robust scenario mpc approach for uncertain multi-modal obstacles", *IEEE Control Systems Letters*, vol. 5, no. 3, pp. 947–952, 2020, URL: https://ieeexplore.ieee.org/document/9133136.

[2] **U. Rosolia** and A. D. Ames, "Multi-rate control design leveraging control barrier functions and model predictive control policies", *IEEE Control Systems Letters*, vol. 5, no. 3, pp. 1007–1012, 2020, URL: https://ieeexplore.ieee.org/document/9137248.

[3] **U. Rosolia** and F. Borrelli, "Minimum time learning model predictive control", *to appear in International Journal of Robust and Nonlinear Control*, 2020, URL: https://arxiv.org/abs/1911.09239.

[4] B. Thananjeyan*, A. Balakrishna*, **U. Rosolia**, F. Li, R. McAllister, J. E. Gonzalez, S. Levine, F. Borrelli, and K. Goldberg, "Safety augmented value estimation from demonstrations (saved): Safe deep model-based rl for sparse cost robotic tasks", *IEEE Robotics and Automation Letters*, vol. 5, no. 2, pp. 3612–3619, 2020, URL: https://ieeexplore.ieee.org/abstract/document/9013084.

[5] **U. Rosolia** and F. Borrelli, "Learning how to autonomously race a car: A predictive control approach", *IEEE Transactions on Control Systems Technology*, 2019, URL: https://ieeexplore.ieee.org/document/8896988.

[6] **U. Rosolia** and F. Borrelli, "Learning model predictive control for iterative tasks. a data-driven control framework", *IEEE Transactions on Automatic Control*, vol. 63, no. 7, pp. 1883–1896, Jul. 2018, URL: https://ieeexplore.ieee.org/abstract/document/8039204.

[7] **U. Rosolia**, X. Zhang, and F. Borrelli, "Data-driven predictive control for autonomous systems", *Annual Review of Control, Robotics, and Autonomous Systems*, vol. 1, pp. 259–286, 2018, URL: https://www.annualreviews.org/doi/abs/10.1146/annurev-control-060117-105215.

[8] **U. Rosolia**, S. De Bruyne, and A. G. Alleyne, "Autonomous vehicle control: A nonconvex approach for obstacle avoidance", *IEEE Transactions on Control Systems Technology*, vol. 25, no. 2, pp. 469–484, 2016, URL: https://ieeexplore.ieee.org/document/7489011.

[9] **U. Rosolia**, F. Braghin, A. Alleyne, and E. Sabbioni, "Nlmpc for real time path following and collision avoidance", *SAE International Journal of Passenger Cars-Electronic and Electrical Systems*, vol. 8, no. 2015-01-0313, pp. 401–405, 2015, URL: https://www.sae.org/publications/technical-papers/content/2015-01-0313/.

Conference Publications

[1] D. Papadimitriou, **U. Rosolia**, and F. Borrelli, "Control of unknown nonlinear systems with linear time-varying mpc", in *to appear in 2020 IEEE Conference on Decision and Control (CDC)*, URL: https://arxiv.org/abs/2004.03041, IEEE, 2020.

[2] N. Scianca, **U. Rosolia**, and F. Borrelli, "Learning model predictive control for periodic repetitive tasks", in *2020 European Control Conference (ECC)*, URL: https://ieeexplore.ieee.org/abstract/document/9143857, IEEE, 2020, pp. 29–34.

[3] Y. R. Stürz, E. L. Zhu, **U. Rosolia**, and F. Borrelli, "Distributed learning model predictive control for linear systems", in *to appear in 2020 IEEE Conference on Decision and Control (CDC)*, URL: https://arxiv.org/abs/2006.13406, IEEE, 2020.

[4] B. Thananjeyan*, A. Balakrishna*, **U. Rosolia**, J. E. Gonzalez, A. D. Ames, and K. Goldberg, "Abc-lmpc: Safe sample-based learning mpc for stochastic nonlinear dynamical systems with adjustable boundary conditions", in *in 2020 Workshop on the Algorithmic Foundations of Robotics (WAFR)*, URL: http://robotics.cs.rutgers.edu/wafr2020/accepted-papers/, WAFR, 2020.

[5] E. L. Zhu, Y. R. Stürz, **U. Rosolia**, and F. Borrelli, "Trajectory optimization for nonlinear multi-agent systems using decentralized learning model predictive control", in *to appear in 2020 IEEE Conference on Decision and Control (CDC)*, URL: https://arxiv.org/abs/2004.01298, IEEE, 2020.

[6] **U. Rosolia** and F. Borrelli, "Sample-based learning model predictive control for linear uncertain systems", in *2019 IEEE Conference on Decision and Control (CDC)*, URL: https://ieeexplore.ieee.org/document/9030270, IEEE, 2019, pp. 2702–2707.

[7] **U. Rosolia**, X. Zhang, and F. Borrelli, "Simple policy evaluation for data-rich iterative tasks", in *2019 IEEE American Control Conference (ACC)*, URL: https://ieeexplore.ieee.org/document/8814765, IEEE, 2019, pp. 2855–2860.

[8] M. Bujarbaruah, X. Zhang, **U. Rosolia**, and F. Borrelli, "Adaptive mpc for iterative tasks", in *2018 IEEE Conference on Decision and Control (CDC)*, URL: https://ieeexplore.ieee.org/document/8618694, IEEE, 2018, pp. 6322–6327.

[9] **U. Rosolia**, X. Zhang, and F. Borrelli, "A stochastic mpc approach with application to iterative learning", in *2018 IEEE Conference on Decision and Control (CDC)*, URL: https://ieeexplore.ieee.org/abstract/document/8619268, IEEE, 2018, pp. 5152–5157.

[10] M. Brunner, **U. Rosolia**, J. Gonzales, and F. Borrelli, "Repetitive learning model predictive control: An autonomous racing example", in *2017 IEEE 56th Annual Conference on Decision and Control (CDC)*, URL: https://ieeexplore.ieee.org/abstract/document/8264027, IEEE, 2017, pp. 2545–2550.

[11] **U. Rosolia** and F. Borrelli, "Learning model predictive control for iterative tasks: A computationally efficient approach for linear system", in *IFAC-PapersOnLine*, URL: https://www.sciencedirect.com/science/article/pii/S2405896317306523, vol. 50, Elsevier, 2017, pp. 3142–3147.

[12] **U. Rosolia**, F. Braghin, A. G. Alleyne, S. De Bruyne, and E. Sabbioni, "A decentralized algorithm for control of autonomous agents coupled by feasibility constraints", in *2017 American Control Conference (ACC)*, URL: https://ieeexplore.ieee.org/document/7963467, IEEE, 2017, pp. 3367–3372.

[13] **U. Rosolia**, A. Carvalho, and F. Borrelli, "Autonomous racing using learning model predictive control", in *2017 American Control Conference (ACC)*, URL: https://ieeexplore.ieee.org/document/7963748, IEEE, 2017, pp. 5115–5120.

[14] **U. Rosolia**, X. Zhang, and F. Borrelli, "Robust learning model predictive control for iterative tasks: Learning from experience", in *2017 IEEE 56th Annual Conference on Decision and Control (CDC)*, URL: https://ieeexplore.ieee.org/document/8263812, IEEE, 2017, pp. 1157–1162.

*indicates equal contribution

Selected Invited Talks

Learning Predictive Control and Dynamic Programming
Mechanical and Civil Engineering (MCE) Seminar Series, Caltech — October 2020

Learning Predictive Control and Dynamic Programming
Yisong Yue Lab, Caltech — September 2020

Learning Predictive Control and Dynamic Programming
IFAC 2020 Workshop "Machine Learning meets Model-based Control", Berlin — August 2020

Learning Predictive Control and Dynamic Programming
Semiautonomous Seminar, Berkeley — May 2020

Learning Model Predictive Control and its Application in Robotics
Dependable Control and Decision (DECODE) group, EPFL — November 2019

Learning Model Predictive Control and its Application in Robotics
Dynamic Design Lab, Stanford — May 2019

Learning Model Predictive Control and its Application in Robotics
AMBER Lab, Caltech — May 2019

Learning Model Predictive Control and its Application in Robotics
Robot Locomotion Group, MIT — May 2019

Learning Model Predictive Control and its Application in Robotics
CITRIS/CPAR Control Theory and Automation Symposium, UC Berkeley — April 2019

Learning Model Predictive Control for Iterative task
Optimization methods in dynamical systems, SIAM Conf. on Applications of Dynamical Systems — May 2017

Learning Model Predictive Control for Autonomous Racing
Baidu — December 2017

Extracurricular Activities

I enjoy cooking and reading historical fiction books, especially from the ancient Greek times.
I have been playing soccer since I was a kid and I love being outdoor hiking, camping and surfing glassy waves.