

Alexandre Capone

The Robotics Institute, Carnegie Mellon University

+1 412-284-3128 | ✉ acapone2@andrew.cmu.edu | 🏠 <https://acapone1.github.io/>

PROFESSIONAL EXPERIENCE

Carnegie Mellon University

Postdoctoral researcher

Mar. 2024 – today
Pittsburgh, PA, USA

- **Research Topic:** Autonomous driving and uncertainty quantification

California Institute of Technology

Visiting student researcher

Oct. 2022 – Jan. 2023
Pasadena, CA, USA

- **Research Topic:** Safe Learning for Control

Technical University of Munich

Research assistant

Oct. 2017 – Nov. 2023
Munich, DE

- **Research Topic:** Safe Learning for Control Using Gaussian Processes

EDUCATION

Technical University of Munich

PhD in Electrical Engineering (Dr.-Ing.)

Oct. 2017 – Nov. 2023
Munich, DE

- **Research Topic:** Safe Learning for Control Using Gaussian Processes

RWTH Aachen University

*Master of Science in Mechanical Engineering, **Best 0.6%***

May 2015 – Oct. 2016
Aachen, DE

- **Thesis topic:** Design and Optimization of a Three-Phase Reactive Batch Distillation Column as an Underdetermined System of Differential-Algebraic Equations with Optimization Criteria
- **Major:** Simulation Sciences

RWTH Aachen University

Bachelor of Science in Mechanical Engineering

Oct. 2011 – May 2015
Aachen, DE

- **Thesis Title:** Modelling and Feedback Control of a 6-Phase Drive System
- **Major:** Energy Engineering

TEACHING EXPERIENCE

Graduate practical course 'Advanced Control and Robotics Laboratory'

- **Semesters:** Spring 2020, Fall 2020, Spring 2021, Fall 2021, Spring 2022, Fall 2022, SPring 2023
- **Role:** Preparing questionnaires and exam, scheduling lessons, supervision of student assistants, communication with the students, grading students
- **Goal:** At the end of the module the students are able to systematically design and configure a modern control concept for different application-oriented control problems, to implement the control concept in an experimental test-bed, and to critically discuss and evaluate the results.

Graduate course 'Selected Topics in Robotics'

- **Semesters:** Spring 2021, Spring 2022
- **Role:** Presenting a lecture on machine learning, Gaussian processes and control. Discussing topic with students and answering questions.

- **Goal:** At the end of the module students should know and understand advanced concepts of robotics and robot control. They should be able to analyse different robotic problems and evaluate solution strategies. In addition, the presented contents are also relevant for industrial application.

Graduate course 'Project Laboratory Networked and Cooperative Control'

- **Semesters:** Fall 2022, Spring 2023
- **Role:** Providing support in technical matters, helping with literature research, and providing feedback for the final report and presentation.
- **Goal:** At the end of the module, the students should be able to independently solve control-oriented problems in the application domain of networked, distributed, and cooperative technical systems. In addition, the students should learn how to work efficiently as a team.

Graduate course 'Scientific seminar Networked Systems and Control'

- **Semesters:** Fall 2022, Spring 2023
- **Role:** Providing support in technical matters, introducing the required tasks, and providing feedback for the final report and presentation. Helping procure software, hardware, and work orders from the workshop.
- **Goal:** To gain knowledge in complex, networked and distributed control systems. Learning and improving scientific writing, learning how to present new findings to an audience of specialists.

RESEARCH INTERESTS

Autonomous Driving, Uncertainty Quantification, Nuclear Fusion, Gaussian Processes, Control Theory, Safe Learning, Bayesian Statistics, Variational Inference, Multi-Agent Systems, Robotics, Energy Systems

SUPERVISING AND MENTORING

Internships

- Lena Heidemann (Mar. 2019), Optimal Power Flow in District Heating Systems
- Julia Ströbel (Dec. 2019), Efficient Information Gain Maximization for Learning Anticipation
- Xuecheng Li (Mar. 2020), Gaussian Processes-Based Model Predictive Control of Overtaking Maneuvers for Autonomous Vehicles

Bachelor Theses

- Johanna Liebl (June 2018), Path Integral Control for Gaussian Processes
- Ekaterina Sedova (Oct. 2018), Machine Learning for Energy Networks
- Alexander Hau (Dec. 2018), Backstepping Control using Gaussian Processes
- Ekin Karabulut (Nov. 2019), Quantifying the Utility of Data for Control Using Gaussian Process Models
- Doruk Özdem (Mar. 2021), Adapting the Risk Parameter in Stochastic Model Predictive Control with Gaussian Processes

Master Theses

- Conrad Helminger (July 2019), Bayesian Neural Network-Based Control of a District Heating Network
- Gerrit Noske (Oct. 2019), Optimized Learning Using Confidence Regions in Safe Model Predictive Control
- Axel Fehr (July 2020), Charge Scheduling of an Energy Storage System with Model-Based Reinforcement Learning under Dynamic Electricity Pricing
- Xuecheng Li (Mar. 2020), Gaussian Processes-Based Model Predictive Control of Overtaking Maneuvers for Autonomous Vehicles
- Simon Petit (July 2020), Anticipating Data Collection in Reinforcement Learning Using Gaussian Processes
- Sebastian Röcken (June 2020), Efficient Exploration for Multi-Task Reinforcement Learning
- Julia Ströbel (Dec. 2020), Efficient Information Gain Maximization for Gaussian Process-Based Model Predictive Control
- Ziqi Zhang (Oct. 2020), Safety Verification of Neural Networks Using Second-Order Derivatives

- Lukas Fichtner (Feb. 2021), Gaussian Process-Based Model Predictive Control for Autonomous Vehicle Overtaking Manoeuvres
- Khalil Messaoudi (June 2022), Sparse Gaussian Processes for Control
- Silke Teuven (June 2022), Localized Curiosity-Driven Reinforcement Learning with Deep Gaussian Processes
- Martin Schuck (September 2022), Dexterous Grasping in Sparse Reward Environments with Full Pose Control

VOLUNTEER EXPERIENCE

Doctoral Candidate Representative, Munich School of Engineering

- Spring 2020 - Fall 2021

ACADEMIC AWARDS AND HONORS

- **Springorum-Denkmünze**, awarded to 10% best students across entire department, Aachen, 2016
- **Dean's list**, awarded to 5% from each course of study, Aachen, 2016
- **Rapid Interactive Keynote, American Control Conference 2019** for "Anticipating the Long-Term Effect of Online Learning in Control"

SKILLS

Languages : Portuguese (native), Italian (native), English (fluent), German (fluent), Spanish (fluent), French (fluent), Chinese (elementary)

Programming : Python, Matlab, Latex, Javascript, C++

HOBBIES

Chess, skateboarding, painting, magic, jogging, board games & role-playing games

PUBLICATIONS

Alexandre Capone, Tim Brdigan, and Sandra Hirche. Online constraint tightening in stochastic model predictive control: A regression approach. *IEEE Transactions on Automatic Control*, 2024

Alexandre Capone, Sandra Hirche, and Geoff Pleiss. Sharp calibrated Gaussian processes. In *Thirty-seventh Conference on Neural Information Processing Systems*. Curran Associates, Inc., 2023

Alexandre Capone, Armin Lederer, and Sandra Hirche. Gaussian process uniform error bounds with unknown hyperparameters for safety-critical applications. In *International Conference on Machine Learning*, pages 2609–2624. PMLR, 2022

Tzu-Yuan Huang, Sihua Zhang, Xiaobing Dai, Alexandre Capone, Velimir Todorovski, Stefan Sosnowski, and Sandra Hirche. Learning-based prescribed-time safety for control of unknown systems with control barrier functions. *IEEE Control Systems Letters*, 2024

Junjie Jiao, Alexandre Capone, and Sandra Hirche. Backstepping tracking control using Gaussian processes with event-triggered online learning. *IEEE Control Systems Letters*, 6:3176–3181, 2022

Alexandre Capone, Armin Lederer, Jonas Umlauf, and Sandra Hirche. Data selection for multi-task learning under dynamic constraints. *IEEE Control Systems Letters*, 5(3):959–964, 2021

Armin Lederer, Alexandre Capone, Jonas Umlauf, and Sandra Hirche. How training data impacts performance in learning-based control. *IEEE Control Systems Letters*, 5(3):905–910, 2021

- Alexandre Capone and Sandra Hirche. Backstepping for partially unknown nonlinear systems using Gaussian processes. *IEEE Control Systems Letters*, 3(2):416–421, 2019
- Neha Das, Jonas Umlauf, Armin Lederer, Alexandre Capone, Thomas Beckers, , and Sandra Hirche. Deep learning based uncertainty decomposition for real-time control. In *The 22nd World Congress of the International Federation of Automatic Control*, 2023
- Alexandre Capone, Junjie Jiao, Mostafa Zarei, Shiqi Zhang, and Sandra Hirche. Robust H_∞ consensus for homogeneous multi-agent systems with parametric uncertainties. In *2023 American Control Conference*, pages 4191–4196. IEEE, 2023
- Martin Schuck, Jan Brüdigam, Alexandre Capone, Stefan Sosnowski, and Sandra Hirche. Dext-gen: Dexterous grasping in sparse reward environments with full orientation control. *arXiv preprint arXiv:2206.13966*, 2022
- Jan Brüdigam, Martin Schuck, Alexandre Capone, Stefan Sosnowski, and Sandra Hirche. Structure-preserving learning using Gaussian processes and variational integrators. In *Proceedings of The 4th Annual Learning for Dynamics and Control Conference*, volume 168, pages 1150–1162. PMLR, 2022
- Tim Brüdigam, Alexandre Capone, Sandra Hirche, Dirk Wollherr, and Marion Leibold. Gaussian process-based stochastic model predictive control for overtaking in autonomous racing. *ICRA 2021 Workshop - Opportunities and Challenges with Autonomous Racing*, 2021
- Armin Lederer, Alexandre Capone, Thomas Beckers, Jonas Umlauf, and Sandra Hirche. The impact of data on the stability of learning-based control. In *Learning for Dynamics and Control*, pages 623–635. PMLR, 2021
- Alexandre Capone, Conrad Helminger, and Sandra Hirche. Day-ahead scheduling of thermal storage systems using bayesian neural networks. *IFAC-PapersOnLine*, 53(2):13281–13286, 2020
- Alexandre Capone, Armin Lederer, and Sandra Hirche. Confidence regions for predictions of online learning-based control. *IFAC-PapersOnLine*, 53(2):1007–1012, 2020
- Alexandre Capone, Gerrit Noske, Jonas Umlauf, Thomas Beckers, Armin Lederer, and Sandra Hirche. Localized active learning of Gaussian process state space models. In *Learning for Dynamics and Control*, pages 490–499. PMLR, 2020
- Alexandre Capone and Sandra Hirche. Anticipating the long-term effect of online learning in control. In *2020 American Control Conference (ACC)*, pages 3865–3872. IEEE, 2020
- Armin Lederer, Alexandre Capone, and Sandra Hirche. Parameter optimization for learning-based control of control-affine systems. In *Learning for Dynamics and Control*, pages 465–475. PMLR, 2020
- Jonas Umlauf, Thomas Beckers, Alexandre Capone, Armin Lederer, and Sandra Hirche. Smart forgetting for safe online learning with Gaussian processes. In *Learning for Dynamics and Control*, pages 160–169. PMLR, 2020
- Alexandre Capone and Sandra Hirche. Interval observers for a class of nonlinear systems using Gaussian process models. In *2019 18th European Control Conference (ECC)*, pages 1350–1355. IEEE, 2019
- Denis Bytschkow, Alexandre Capone, Jan Mayer, Michael Kramer, and Thomas Lickleder. An opc ua-based energy management platform for multi-energy prosumers in districts. In *2019 IEEE PES Innovative Smart Grid Technologies Europe (ISGT-Europe)*, pages 1–5. IEEE, 2019
- Lena Heidemann, Denis Bytschkow, Alexandre Capone, Thomas Lickleder, and Michael Kramer. Sector coupling with optimization: A comparison between single buildings and combined quarters. In *Abstracts from the 8th DACH+ Conference on Energy Informatics*, pages 29–33, 2019

PREPRINTS

Wenhan Cao, Alexandre Capone, Rishabh Yadav, Sandra Hirche, and Wei Pan. Computation-aware learning for stable control with Gaussian process. *arXiv preprint arXiv:2406.02272*, 2024

Wenhan Cao, Alexandre Capone, Sandra Hirche, and Wei Pan. Analyzing the impact of computation in adaptive dynamic programming for stochastic lqr problem. *arXiv preprint arXiv:2402.09575*, 2024

Alexandre Capone, Ryan Cosner, Aaron Ames, and Sandra Hirche. Safe online dynamics learning with initially unknown models and infeasible safety certificates. *arXiv preprint arXiv:2311.02133*, 2023