

Licio Romao

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RESEARCH INTERESTS

I am currently interested in bridging the gap between learning and control, using data-driven methods to the design of feedback controllers for safety-critical applications. More specifically, my research interest includes sequential decision-making problems and the role of feedback and adaptation to produce safe and reliable systems. I focus on establishing rigorous mathematical frameworks to study continuous- and discrete-time stochastic processes by means of discrete models and sampling techniques, and leveraging these discrete models to perform feedback controller design.

One of my works has won a distinguished paper award on the 2022 AAAI conference. My PhD thesis won the 2021 IET Control and Automation Doctoral Dissertation Prize for its significant contributions to the area of control engineering.

EMPLOYMENT

- **Stanford University, Department of Aeronautics & Astronautics** Stanford, United States
Postdoctoral fellow *January 2024 - present*
 - Working with Prof. Mykel Kochenderfer and Prof. Jef Caers
 - Sequential decision-making, Partially observable Markov decision process (POMDP), Applications to mineral exploration and carbon sequestration

- **University of Oxford, Computer Science Department** Oxford, United Kingdom
Postdoctoral fellow *April 2021 - December 2023*
 - Working with Prof. Alessandro Abate
 - Abstraction of stochastic systems. Formal verification. Reinforcement learning. Discrete-time stochastic systems.

EDUCATION

- **University of Oxford, Engineering Science Department** Oxford, United Kingdom
DPhil in Engineering Science *October 2017 - August 2021*
Title: Scalable and data-driven approaches to convex programming
CAPES, Ministry of Education, Brazil (2000 applicants to 120 scholarships for all areas)
Supervisors: Prof. Antonis Papachristodoulou and Prof. Kostas Margellos

- **University of Campinas, School of Electrical and Computer Engineering** Sao Paulo, Brazil
MSc in Control Engineering, GPA:4/4 *September 2014 - February 2017*
Title: Filter design for linear systems with $H-2$, H -infinity and H -infinity
in frequency interval criteria by means of matrix inequalities
Supervisor: Prof. Pedro Luis Dias Peres

- **UFCG (Federal University of Campina Grande)** Campina Grande, Brazil
BSc in Electrical Engineering, GPA: 9.08/10 (top 2% of cohort) *April 2008 - July 2014*

RESEARCH MOBILITY

- **Stanford University** Stanford, United States
Visiting scholar *April 2023*
 - Research visit to the group of Prof. Mykel Kochenderfer
 - Theoretical foundations of reinforcement learning. Distributed sampling techniques. Reachability computation.

- **University of Bologna** Bologna, Italy
Visiting scholar *July 2019*
 - Working with Prof. Giuseppe Notarstefano
 - Multi-agent optimisation.

- **University of California San Diego, UCSD**

Visiting scholar

- Working with Prof. Mauricio de Oliveira
- Generalized Kalman-Yakubovich-Popov (KYP) lemma.

San Diego, United States

November 2015 - April 2016

AWARDS

- **IET Control and Automation Doctoral Dissertation Prize 2021.** A prestigious award from *the Institution of Engineering and Technology* (IET) that recognises significant achievements in the area of control engineering.
- **2022 AAI distinguished paper award.** For the results in the paper T. Badings, L. Romao, A. Abate, D. Parker, H. Poonawala, N. Jensen. Robust Control for Dynamical Systems with Non-Gaussian Noise via Formal Abstractions. *Journal of Artificial Intelligence Research*, Volume 76. 341-391. 2023.

FUNDING

- **CAPES graduate scholarship** (*August 2017*) Prestigious scholarship awarded by the Brazilian Ministry of Education to pursue a PhD at the University of Oxford.
- **FAPESP scholarship** (*April 2014*) Competitive scholarship awarded by the Sao Paulo Research Foundation (FAPESP), Brazil, to pursue a Masters at the University of Campinas, SP, Brazil.
- **FAPESP research internships abroad** (*September 2015*) To spend six months as a visiting scholar at the University of California, San Diego.

TEACHING EXPERIENCE

- **Modern Control Theory**

Graduate course, Department of Engineering Science, University of Oxford

- Organisers: Prof. Kostas Margellos & Prof. Alessandro Abate
- Lecturer. Delivering lectures on optimisation, duality theory, LMIs, S-procedure, dynamic programming, and controller design using SDPs.
- Students' feedback: "Licio in particular was an amazing teaching assistant, he went out of his way to explain concepts thoroughly and did a great job lecturing when the other lecturer fell ill"; "Licio was a great TA and explained in lots of detail."

- **Probabilistic Model Checking**

Graduate course, Department of Computer Science, University of Oxford

- Organiser: Prof. Alessandro Abate
- Holding tutorial sessions with the students. Preparing the final exam.
- Students' feedback: "Always prepared; Punctual; Knowledgeable about everything; Explains questions on assignments very well; Patient on answering all questions"; "It is clear that he had a very good understanding of the material and also a very strong intuition regarding potential issues we may have. He provided alternative solutions and interpretations for most problems and really enhanced our understanding of the material."

- **Modern Control Theory**

Graduate course, Department of Engineering Science, University of Oxford

- Organisers: Prof. Kostas Margellos, Prof. Paul Goulart & Prof. Alessandro Abate
- Producing a set exercises and assisting the students with the problem set solution.

- **B15: Control Systems**

3rd-year undergraduate course, Department of Engineering Science, University of Oxford

- Teaching assistant. Solving exercise sets with the students, and helping them solidifying concepts learned during the lectures.
- Students' feedback: "Licio's been a brilliant tutor this year. I found B15 quite challenging overall but Licio was incredibly supportive and provided good explanations, and extra little resources during the tutorial which were also very helpful."; "Very good tutor. Even provided his own notes on the subject so as to give us another explanation/description of the topics which was very helpful. Good explainer. He would sometimes ask us to run through a problem on the board which would keep us on our toes, but it's good to try these out as a student, as you can show him step-by-step what you're doing which is good for learning."

- **C20: Linear Matrix Inequalities & Robust Control**

4th-year undergraduate course, Department of Engineering Science, University of Oxford

- Course organiser: Prof. Kostas Margellos
- Producing and solving a set of exercises on duality theory.
- **LEGO Football Coursework Module**
2nd-year undergraduate course, Department of Engineering Science
 - Course organiser: Prof. Kostas Margellos
 - **Lead tutor** for two consecutive years in a week-long lab. Main topics: root locus and state-feedback design to stabilise a model of an inverted pendulum.
- **EA614: Signal Analysis**
3rd-year undergraduate course, University of Campinas
 - Course organiser: Prof. Pedro Luis Dias Peres
 - **Lead tutor.** Main topics: convolution, continuous- and discrete-time Fourier transform. Laplace transform.

SUPERVISION

- **Adrian Capraru** (with Prof. Alessandro Abate) MSc. in Computer Science, University of Oxford. Developing a computational toolbox to perform distributionally robust PCTL model checking.
- **Catalin Dumitru** (with Prof. Alessandro Abate) MSc. in Computer Science, University of Oxford. Exploring connections between a recent paper of mine about RL robustness and a two-player game setting.
- **Luke Rickard** (with Prof. Alessandro Abate) Ph.D. student at the AIMS program, University of Oxford. Extending an abstraction technique that leverages the scenario approach theory to the design of reach-avoid controllers for Markov jump linear systems.
- **John Ryan** (with Prof. Alessandro Abate) MSc. in Computer Science, University of Oxford. Applying reinforcement learning techniques for controlling the OPS-SAT satellite. In collaboration with the European Space Agency (ESA).
- **Thomas Koeck** (with Prof. Alessandro Abate) MSc. in Computer Science, University of Oxford. Combining reinforcement learning algorithms and robust control to space applications. In collaboration with Airbus.
- **Ming Ow** (with Prof. Kostas Margellos) MSc. in Engineering Science, University of Oxford. Studying chance-constrained optimisation. Applying the results developed in one of the chapters of my PhD thesis to the optimal power flow problem.

PUBLICATIONS

Technical reports

- A. Banse, **L. Romao**, A. Abate, R. Jungers. Smart data-driven abstractions of dynamical systems via a Cantor-Kantorovich distance. 2024. *Control journal draft*.
- R. Coppola, A. Peruffo, **L. Romao**, A. Abate, M. Mazo Jr. Probably Approximately Correct Alternating Stochastic Simulation Relations. 2024. *Control journal draft*.
- F. Mathiesen, **L. Romao**, A. Abate, L. Laurenti. Chance-constrained approximations for safety certification of discrete-time, non-linear stochastic systems. 2023. *Control journal draft*.
- A. Tsikas, **L. Romao**, M. Pilanci, A. Abate, M. Kochenderfer. Distributed Markov Chain Monte Carlo Sampling based on the Alternating Direction Methods of Multipliers. 2024. *Machine learning journal draft*.
- T. Badings, **L. Romao**, A. Abate, N. Jensen. Exploiting stability for abstraction of stochastic dynamical systems. 2024. *Control conference submission*.
- D. Jarne Ornia, **L. Romao**, M. Mazo Jr, A. Abate. Observational Robustness and Invariances in Reinforcement Learning via Lexicographic Objectives. 2024. *Control conference submission*.
- X. Zhang, Y. Gao, **L. Romao**, A. Abate, M. Kwiatkowska. Reachability of Bayesian Neural Network: a Sampling-based Approach. 2024. *Formal methods conference submission*.

Journal papers

- T. Badings, **L. Romao**, A. Abate, D. Parker, H. Poonawala, N. Jensen. Robust Control for Dynamical Systems with Non-Gaussian Noise via Formal Abstractions. *Award-winning 2022 AAAI paper*. Journal of Artificial Intelligence Research (JAIR), Vol. 76, 341-391. 2023.
- **L. Romao**, K. Margellos, A. Papachristodoulou. Probabilistic feasibility guarantees for convex scenario programs with an arbitrary number of discarded constraints. *Automatica*, 148, 1–9. 2023.
- **L. Romao**, K. Margellos, A. Papachristodoulou. On the exact feasibility of convex scenario programs with discarded constraints. *IEEE Transaction on Automatic Control*. Vol. 68. No. 4. 1986-2001. 2023.
- **L. Romao**, K. Margellos, G. Notarstefano, A. Papachristodoulou. Subgradient averaging for multi-agent optimisation with different constraint sets. *Automatica*. Vol. 131. 109738. 2021.
- **L. Romao**, K. Margellos, A. Papachristodoulou. Distributed Actuator Selection: Achieving Optimality via a Primal-Dual Algorithm. *IEEE Control Systems Letters*. Vol. 2. No. 4. 779–784. 2019.

Conference papers

- **L. Romao**, A. Hota, A. Abate. Distributionally Robust Optimal and Safe Control of Stochastic Systems via Kernel Conditional Mean Embedding. 62-nd Conference on Decision and Control. 2023.
- F. Mathiesen, **L. Romao**, S. Calvert, A. Abate, L. Laurenti. Inner approximations of stochastic programs for data-driven stochastic barrier function design. 62-nd Conference on Decision and Control. 2023.
- A. Banse, **L. Romao**, A. Abate, R. Jungers. Data-driven abstractions via adaptive refinements and a Kantorovich metric. 62-nd Conference on Decision and Control. 2023.
- M. Engelaar, **L. Romao**, Y. Gao, L. Lazar, A. Abate, S. Haesaert. Model Reduction of Linear Stochastic Systems with Preservation of sc-LTL Specifications. 62-nd Conference on Decision and Control. 2023.
- L. Rickard, T. Badings, **L. Romao**, N. Jansen, A. Abate. Formal Controller Synthesis for Markov Jump Linear Systems with Uncertain Dynamics. International Conference on Quantitative Evaluation of Systems. 2023.
- A. Banse, **L. Romao**, A. Abate, R. Jungers. Data-driven memory-dependent abstractions of dynamical systems. 5th Annual Learning for Dynamics & Control Conference (L4DC). 2023.
- T. Badings, **L. Romao**, N. Jensen, A. Abate. Probabilities Are Not Enough: Formal Synthesis for Stochastic Dynamical Models with Epistemic Uncertainty. 37th AAAI Conference on Artificial Intelligence. 2023.
- **L. Romao**, K. Margellos, A. Papachristodoulou. Tight sampling and discarding bounds for scenario programs with an arbitrary number of removed samples. 3rd Annual Learning for Dynamics & Control Conference (L4DC). 2021.
- **L. Romao**, K. Margellos, A. Papachristodoulou. Tight generalization guarantees for the sampling and discarding approach to scenario optimization. 59-th Conference on Decision and Control. 2020.
- **L. Romao**, K. Margellos, G. Notarstefano, A. Papachristodoulou. Convergence rate analysis of a subgradient averaging algorithm for distributed optimisation with different constraint sets. 58-th Conference on Decision and Control. 2019.
- **L. B. R. R. Romao**, M. C. de Oliveira, P. L. D. Peres, R. C. L. F. Oliveira. H-infinity filter design with low- and middle-frequency specifications for continuous-time linear systems: LMI conditions derived from two different extensions of the KYP lemma. 2018 American Control Conference. 2018.
- **L. B. R. R. Romao**, Luciano Frezzatto, M. C. de Oliveira, R. C. L. F. Oliveira, P. L. D. Peres. Non-minimal order low-frequency H-inf filtering for uncertain discrete-time systems. IFAC International Federation on Automatic Control. 2017.
- **L. B. R. R. Romao**, M. C. de Oliveira, P. L. D. Peres, R. C. L. F. Oliveira. State-Feedback and Filtering Problems using the Generalized KYP Lemma, IEEE Multi-Conference on Systems and Control. 2016.
- **L. B. R. R. Romao**, R. C. L. F. Oliveira, P. L. D. Peres. Projeto de Filtros Robustos H2 usando LMIs com Escalares, XII SBAI Simpósio Brasileiro de Automação Inteligente. 2015.
- **L. B. R. R. Romao**, P. L. D. Peres, R. C. L. F. Oliveira. H-infinity Robust Filter Design for Continuous-Time Linear Systems Using LMIs with a Scalar Parameter, XXI Congresso Brasileiro de Automática, 2016.