Lucas Nunes Alegre

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Research Interests

My main research interest is **reinforcement learning** (RL). In my Ph.D., I am tackling the problem of how to design **principled sample-efficient RL algorithms** capable of **learning and combining multiple behaviors** to solve **multi-task** and **multi-objective** sequential decision-making problems.

Education

Doctor of Philosophy — Jan. 2021 – ongoing
Universidade Federal do Rio Grande do Sul (UFRGS) — *Porto Alegre, Brazil*
- Supervisors: Prof. Ana L. C. Bazzan and Prof. Bruno C. da Silva (Univ. of Massachusetts)
- Partial time at Vrije Universiteit Brussel (VUB) — Supervisor: Prof. Ann Nowé

Bachelor of Science *Cum Laude* – Computer Science — Jan. 2016 – Dec. 2020
Universidade Federal do Rio Grande do Sul (UFRGS), Program ranked #1 in the country — *Porto Alegre, Brazil*
- Cumulative GPA: 4.0/4.0
- Supervisor: Prof. Bruno C. da Silva

Experience

Doctoral Researcher — Jan. 2021 – ongoing
Institute of Informatics - UFRGS — *Porto Alegre, Brazil*
- Advisors: Prof. Ana L. C. Bazzan and Prof. Bruno C. da Silva (Univ. of Massachusetts)
- Introduced formal characterizations of connections between multi-task and multi-objective RL, which lead to an algorithm capable of constructing a set of policies with formal guarantees of optimally solving any tasks with linearly-expressible reward functions.
- Introduced a principled method for zero-shot policy transfer that interpolates between model-free policy transfer and fully model-based planning.

Project Manager — Jan. 2023 – ongoing
Farama Foundation — *Remote*
- I am the creator and maintainer of MO-Gymnasium, the main library of multi-objective RL environments. The Farama Foundation is a nonprofit organization that maintains the largest open-source RL libraries in the world.

Doctoral Researcher — Aug. 2022 – Aug. 2023
AI-Lab at Vrije Universiteit Brussel (VUB) — *Brussels, Belgium*
- Advisor: Prof. Ann Nowé
- Introduced the first model-based multi-objective RL algorithm for domains with continuous state spaces.

Research Intern — Winter 2020
Technische Universität Berlin — *Berlin, Germany*
- Advisor: Prof. Dr. Kai Nagel
- Developed a RL traffic signal controller with Fourier basis function approximation that outperformed a state-of-the-art rule-based controller in a real-world multiagent scenario.

Undergraduate Research Assistant — Aug. 2017 – Dec. 2020
Multiagent Systems Lab. (Institute of Informatics - UFRGS) — *Porto Alegre, Brazil*
- Advisors: Prof. Ana L. C. Bazzan and Prof. Bruno C. da Silva
- Developed a model-based RL algorithm able to deal with non-stationarity in high-dimensional domains.

Selected Publications (Full List on Google Scholar)

NeurIPS 2023 — Lucas N. Alegre, Ana L. C. Bazzan, Ann Nowé and Bruno C. da Silva. **Multi-Step Generalized Policy Improvement by Leveraging Approximate Models**. Thirty-seventh Conference on Neural Information Processing Systems, 2023.

NeurIPS 2023 — Florian Felten*, Lucas N. Alegre*, Ann Nowé, Ana L. C. Bazzan, El-Ghazali Talbi, Grégoire Danoy and Bruno C. da Silva. **A Toolkit for Reliable Benchmarking and Research in Multi-Objective Reinforcement Learning**. Thirty-seventh Conference on Neural Information Processing Systems Track on Datasets and Benchmarks, 2023.

AAMAS 2023 Lucas N. Alegre, Diederik M. Roijers, Ann Nowé, Ana L. C. Bazzan and Bruno C. da Silva. **Sample-Efficient Multi-Objective Learning via Generalized Policy Improvement Prioritization**. Proceedings of the 22nd International Conference on Autonomous Agents and Multiagent Systems, 2023.

ICML 2022 Lucas N. Alegre, Ana L. C. Bazzan and Bruno C. da Silva. **Optimistic Linear Support and Successor Features as a Basis for Optimal Policy Transfer**. Proceedings of the Thirty-ninth International Conference on Machine Learning, 2022.

AAMAS 2021 Lucas N. Alegre, Ana L. C. Bazzan and Bruno C. da Silva. **Minimum-Delay Adaptation in Non-Stationary Reinforcement Learning via Online High-Confidence Change-Point Detection**. Proceedings of the 20th International Conference on Autonomous Agents and Multiagent Systems, 2021.

IEEE ITS Lucas N. Alegre, Theresa Ziemke and Ana L. C. Bazzan. **Using Reinforcement Learning to Control Traffic Signals in a Real-World Scenario: an Approach Based on Linear Function Approximation**. IEEE Transactions on Intelligent Transportation Systems, 2021.

SIBGRAPI'20 Lucas N. Alegre and Manuel M. Oliveira. **SelfieArt: Interactive Multi-Style Transfer for Selfies and Videos with Soft Transitions**. Proceedings of the 2020 33rd SIBGRAPI Conference on Graphics, Patterns and Images, 2020.

PeerJ CS Lucas N. Alegre, Ana L. C. Bazzan and Bruno C. da Silva. **Quantifying the Impact of Non-Stationarity in Reinforcement Learning-Based Traffic Signal Control**. PeerJ Computer Science, 2021.

NIME 2019 Aline Weber, Lucas N. Alegre, Jim Torresen and Bruno C. da Silva. **Parameterized Melody Generation with Autoencoders and Temporally-Consistent Noise**. Proceedings of the International Conference on New Interfaces for Musical Expression, 2019.

Open Source Projects

MO-Gymnasium | github.com/Farama-Foundation/MO-Gymnasium | Paper ★+220
- Library of environments for multi-objective reinforcement learning (MORL).
- Provides a standard API for MORL environments, as well as a standard set of over 14 environments.

MORL-Baselines | github.com/LucasAlegre/morl-baselines | ★+210
- Library of MORL algorithms implementations.
- Contains over 10 documented and tested MORL algorithms implementations in PyTorch.

SUMO-RL | github.com/LucasAlegre/sumo-rl ★+590
- Open source repository of reinforcement learning environments for traffic signal control.
- Compatible with Gymnasium, PettingZoo and popular RL libraries such as Stable-Baselines and RLlib.

Vote Network | github.com/LucasAlegre/vote-network | Visualization
- Network analysis and interactive visualization of the Brazilian Chamber of Deputies.

Awards and Honors

- NeurIPS 2023 Scholar Award
- AAMAS 2023 Student Scholarship
- Best Paper Award - LXAI Workshop @ ICML 2021
- Brazilian Computer Society Distinguished Student Award, 2021
- Top Reviewer - NeurIPS 2022
- Highlighted Reviewer - ICLR 2022
- Graduated *cum laude* in Computer Science. Cumulative GPA: 4.0/4.0., 2021
- Ph.D. Scholarship from the Brazilian National Council for Scientific and Technological Development (CNPq) and the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES) (2021–2024)
- Finalist of the City Brain Challenge - KDD Cup 2021
- 1st Place at PUCRS University Entrance Exam - Computer Science, 2016

Teaching

Data Science Specialization Course - Teaching Assistant Aug. 2023 — ongoing
Institute of Informatics - UFRGS *Porto Alegre, Brazil*
- Tutored students in a range of machine learning- and data science-related courses.

Artificial Intelligence - Teaching Assistant Jan. 2022 — Jul. 2022
Institute of Informatics - UFRGS *Porto Alegre, Brazil*
- Tutored students in AI fundamentals and algorithms.

Fundamentals of Algorithms - Teaching Assistant Aug. 2021 — Dec. 2021
Institute of Informatics - UFRGS *Porto Alegre, Brazil*
- Tutored students in fundamental concepts of algorithms and functional programming.

Introduction to Algorithms - Monitor Aug. 2016 — Dec. 2016
Institute of Informatics - UFRGS *Porto Alegre, Brazil*
- Tutored students in fundamental concepts of programming logics and the C language.

Invited Talks

University of Luxembourg. Topic: Sample-Efficient Multi-Objective RL. 2023.
Vrije Universiteit Brussel. Topic: Sample-Efficient Multi-Objective RL. 2023.

Students

Bachelor: • Vicente N. de Almeida (UFRGS - 2022) • Liam Mertens (VUB - 2023).

Service

Reviewer: ICML (2022–2024), NeurIPS (2022–2023), ICLR (2022–2024), AAMAS (2020–2023), AAAI (2023–2024), IJCAI 2024, ALA (2023–2024), ICDL 2021, EUMAS 2021, EWRL 2023, Neural Computing and Applications, IEEE TAI, IEEE TCDS, J. of Supercomputing, MODeM 2023 Workshop, LXAI 2021 Workshop.
Volunteer: AAMAS 2023, AAMAS 2021, LXAI@ICML 2021, NIME 2019.

Technical Skills

Languages: Portuguese (Native), English (Fluent), Spanish (Beginner).
Programming Languages: Python, C/C++, Java, R, MATLAB, Kotlin, SQL.
Tools & Others: Jax, PyTorch, Tensorflow, Gym/Gymnasium, Pandas, NumPy, Matplotlib, i-graph, OpenCV, QT, Git, Unix/Linux, Cplex, LaTeX, SUMO, Network Analysis, Graphistry, VS Code.

Other Academic Activities

- 22nd European Agent Systems Summer School (EASSS), 2021
- Competitive Programming Winter School - Brazilian Computer Society, 2018

Other Interests

- Guitar playing • Music • Travelling • Football/Soccer • Reading