Lukas Schäfer

lukaschaefer.com github.com/LukasSchaefer luki.schaefer96@gmail.com

RESEARCH FOCUS

Reinforcement learning is sample inefficient, and prone to overfitting, leading to brittle behaviour which often does not generalise across tasks. These challenges are further exacerbated in **multi-agent systems** in which multiple agents interact with each other in a shared environment. Guided by these challenges, my PhD research focuses on **efficient** and **robust** reinforcement learning in multi-agent systems.

EDUCATION

PhD Data Science & Artificial Intelligence — 12/2019 - Expected 08/2024

University of Edinburgh — Edinburgh, United Kingdom

- Supervisors: **Stefano V. Albrecht** (primary) and **Amos Storkey** (secondary)
- Thesis: **Sample Efficiency and Generalisation in Multi-Agent Reinforcement Learning**
- Awarded **Principal's Career Development Scholarship** from the University of Edinburgh
- Organisation and hosting of **RL reading group** with speakers from industry (DeepMind, MSR, Google Brain, FAIR) and academia (Oxford University, McGill University, Georgia Institute of Technology, National University of Singapore)

M.Sc. Informatics — 09/2018 - 08/2019

University of Edinburgh - Grade: Distinction — Edinburgh, United Kingdom

- Thesis: Curiosity in Multi-Agent Reinforcement Learning, advised by Stefano V. Albrecht
- Awarded **DAAD graduate scholarship** and **Stevenson Exchange Scholarship**

B.Sc. Computer Science, minor subject Japanese — 10/2015 - 09/2018

Saarland University - within top 5% of year — Saarbrücken, Germany

- Thesis: Domain-Dependent Policy Learning using Neural Networks in Classical Planning, advised by Jörg Hoffmann

EXPERIENCE

Textbook Author — 03/2022 - 10/2023

Designed and wrote an introductory **textbook on multi-agent reinforcement learning** with **Stefano V. Albrecht** and **Filippos Christianos** (equal contributions). The book will be published with **MIT Press** in 2024 [1].

Research Scientist Intern — 04/2023 - 10/2023

Microsoft Research — Cambridge, United Kingdom

- Mentored by **Sam Devlin** and **Tabish Rashid**
- Conducted an empirical study on the effectiveness of various **visual encoders**, including pre-trained **vision foundation models**, for **imitation learning in modern video games** [11]
- Developed **novel platform** for imitation learning in Minecraft Dungeons **from scratch**, including human gameplay recorder, imitation learning framework using **PyTorch Lightning**, and programmatic interface for online evaluation

Young Research Attendee — 09/2022 - 09/2022

Heidelberg Laureate Forum — Heidelberg, Germany

- Selected as one of 100 international young researchers in computer science to network and discuss research

Research Scientist Intern — 07/2022 - 12/2022

Huawei Noah's Ark Lab — London, United Kingdom

- Researched the application of **ensemble models** to guide exploration and improve training stability of **multi-agent reinforcement learning** under the supervision of **David Mguni** [9]

Research Intern — 11/2020 - 03/2021

Dematic - Technology and Innovation — Remote

- Applied multi-agent reinforcement learning to automate **robotic warehouse logistics** and **scale to real-world settings** [12]
- My internship led to four further internship projects and a **fellowship-funded research collaboration**

SKILLS

Machine Learning & Data Science
Python: PyTorch • PyTorch Lightning • NumPy • Pandas • Scikit-Learn • Matplotlib • Jupyter • Anaconda

Software Engineering
C++ • C • Bash • Git • Docker • HTML • CSS • JavaScript

Natural Languages
German (native) • English (fluent) • Chinese (beginner)

Soft Skills
Teamwork • Teaching • Communication • Organisation

SELECTED PUBLICATIONS

Textbook

[1] S. V. Albrecht, F. Christianos, and **Lukas Schäfer** (equal contributions), *Multi-Agent Reinforcement Learning: Foundations and Modern Approaches*. To be published with **MIT press**, 2024.

Conferences and Journals

[2] T. McInroe, **Lukas Schäfer**, and S. V. Albrecht, "Learning representations for control with hierarchical forward models," ***TMLR***, 2023.

[3] **Lukas Schäfer**, F. Christianos, J. P. Hanna, and S. V. Albrecht, "Decoupled reinforcement learning to stabilise intrinsically-motivated exploration," in ***AAMAS***, 2022.

[4] **Lukas Schäfer**, "Task generalisation in multi-agent reinforcement learning," in ***AAMAS***, *Doctoral Consortium*, 2022.

[5] R. Zhong, D. Zhang, **Lukas Schäfer**, S. V. Albrecht, and J. P. Hanna, "Robust on-policy data collection for data efficient policy evaluation," in ***NeurIPS***, 2022.

[6] G. Papoudakis, F. Christianos, **Lukas Schäfer**, and S. V. Albrecht, "Benchmarking multi-agent deep reinforcement learning algorithms in cooperative tasks," in ***NeurIPS***, *Datasets and Benchmarks Track*, 2021.

[7] F. Christianos, **Lukas Schäfer**, and S. V. Albrecht, "Shared experience actor-critic for multi-agent reinforcement learning," in ***NeurIPS***, 2020.

Workshops

[8] **Lukas Schäfer**, F. Christianos, A. Storkey, and S. V. Albrecht, "Learning task embeddings for teamwork adaptation in multi-agent reinforcement learning," in *Generalization in Planning Workshop at* ***NeurIPS***, 2023.

[9] **Lukas Schäfer**, O. Slumbers, S. McAleer, Y. Du, S. V. Albrecht, and D. Mguni, "Ensemble value functions for efficient exploration in multi-agent reinforcement learning," in *Adaptive and Learning Agents Workshop at* ***AAMAS***, 2023.

[10] A. A. Fernandez, **Lukas Schäfer**, E. Villar-Rodriguez, S. V. Albrecht, and J. Del Ser, "Using offline data to speed-up reinforcement learning in procedurally generated environments," in *Adaptive and Learning Agents Workshop at* ***AAMAS***, 2023.

Pre-prints

[11] **Lukas Schäfer**, L. Jones, A. Kanervisto, Y. Cao, T. Rashid, R. Georgescu, D. Bignell, S. Sen, A. T. Gavito, and S. Devlin, "Visual encoders for data-efficient imitation learning in modern video games," *arXiv*, 2023.

[12] A. Krnjaic, R. D. Steleac, J. D. Thomas, G. Papoudakis, **Lukas Schäfer**, A. W. K. To, K.-H. Lao, M. Cubuktepe, M. Haley, P. Börsting, and S. V. Albrecht, "Scalable multi-agent reinforcement learning for warehouse logistics with robotic and human co-workers," *arXiv*, 2023.

Theses

[13] **Lukas Schäfer**, *Curiosity in multi-agent reinforcement learning*, Master's Thesis, 2019.

[14] **Lukas Schäfer**, *Domain-dependent policy learning using neural networks in classical planning*, Bachelor's Thesis, 2018.

REVIEWING

- 2024: ICML (**best reviewer award**), RLC, AAMAS, TMLR
- 2023: NeurIPS, NeurIPS Datasets and Benchmark Track, ICML, AAMAS
- 2022: NeurIPS, NeurIPS Datasets and Benchmark Track, ICML (**top 10% outstanding reviewer award**), AAMAS
- 2021: NeurIPS
- 2020: Pre-registration experiment workshop at NeurIPS

TEACHING AND SUPERVISION EXPERIENCE

Visiting PhD Student Supervision, University of Edinburgh — 05/2022 - 05/2023

- Supervised Alain Andres Fernandez from Tecnalia, Spain, during his 3-month research visit and subsequent collaboration
- Jointly developed and executed research project investigating the efficacy of imitation learning for pre-training and concurrent training of reinforcement learning agents in procedurally generated environments [10]

Teaching Assistant, University of Edinburgh — 10/2019 - 06/2022

Reinforcement Learning, School of Informatics

- **Delivered lectures** and **designed coursework** on reinforcement learning (including deep and multi-agent RL) for last year undergraduate and M.Sc. students
- **Supervised and marked coursework** and **exam scripts** for 100+ students

M.Sc. Student Supervision, University of Edinburgh — 02/2021 - 08/2021

- Co-supervised two M.Sc. students through project proposal, refinement and execution towards final thesis
- Rujie Zhong: Data Collection for Policy Evaluation in Reinforcement Learning
  Revised paper accepted at Workshop on Offline Reinforcement Learning at NeurIPS 2021, and later as a **main conference paper at NeurIPS 2022** [5]
- Panagiotis Kyriakou: Reinforcement Learning with Function Approximation in Continuing Tasks: Discounted Return or Average Reward?

Voluntary Lecturer and Coach, Saarland University — 09/2017 - 10/2017

Mathematics Preparation Course

- Delivered daily **lectures** on formal languages and predicate logic **to 250 participants** in first week
- The course received **BESTE-award** for special student commitment 2017 of Saarland University

Teaching Assistant, Saarland University — 10/2016 - 03/2017

Programming 1, Dependable Systems and Software Group

- Taught functional programming, basic complexity theory, and inductive proofs to first-year undergraduate students in weekly tutorials and office hours
- Collectively created learning materials and discussed student progress as part of the whole teaching team
- Marked weekly tests, mid-term and final exams

AWARDS

- Best reviewer award at ICML 2024 — 07/2024
- Principal's Career Development Scholarship — 12/2019 – 06/2024
- Top 10% outstanding reviewer award at ICML 2022 — 07/2022
- DAAD graduate scholarship — 09/2018 - 08/2019
- Stevenson Exchange Scholarship — 09/2018 - 08/2019
- BESTE-award for special student commitment 2017 of Saarland University — 10/2017

[References available on request]