# Thomy Phan

## *Curriculum Vitae*

## Contact Information


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## Education

04/2018 – Present **Ph.D. in Computer Science**, *LMU Munich*, Germany.

- Focus on planning and learning in multi-agent systems
- Ph.D. thesis: *"Emergence and Resilience in Multi-Agent Reinforcement Learning"*
  - Thesis committee: Claudia Linnhoff-Popien, Sven Koenig, Long Tran-Thanh
  - Based on work published in AAMAS, AAAI, IJCAI, and NeurIPS
  - Submitted on October 15th, 2022
  - Prospective date of defense: Winter semester 2022/23

10/2015 – 08/2017 **M.Sc. in Computer Science**, *LMU Munich*, Germany.

- Final grade: 1.01 (Excellent – best graduating student in 2017)
- Focus on artificial intelligence, data science, and autonomous systems
- Master thesis: *"EVADE: Emergent Value Function Approximation for Distributed Environments"*
  - Supervision: Claudia Linnhoff-Popien, Lenz Belzner
  - Results published in AAMAS 2018 as full paper

10/2011 – 06/2015 **B.Sc. in Computer Science**, *Munich University of Applied Sciences*, Germany.

- Final grade: 1.09 (Excellent – best graduating student in 2016)
- Collaborative study program with the City of Munich
- Focus on software development and image processing
- Bachelor thesis: *"Quantification and Feature Extraction of 3D Single-Molecule Switching Microscopy Data"*
  - Supervision: Alfred Nischwitz, Joerg Bewersdorf
  - Practical work done at Bewersdorf Lab, Yale School of Medicine
  - Results published in Cell 2016 as journal paper (cover story)

## Research Interests

I am interested in various topics related to artificial intelligence such as multi-agent systems, machine learning, pattern recognition, bio-inspired algorithms, automated planning, optimization, as well as validation and verification of self-learning systems. My current research focuses on *emergence and resilience in multi-agent systems* with industrial applications using planning and reinforcement learning techniques.

## Professional Experience

10/2017 – Present **Research Assistant**, *Mobile and Distributed Systems Chair, LMU Munich*, Germany.

- Research focus on multi-agent systems
  - Over 40 papers published in AAMAS, AAAI, IJCAI, NeurIPS, GECCO, etc.
  - Regularly participating at top conferences as program committee or reviewer
- Teaching more than 100 students per semester about autonomous systems and AI topics
- Acquisition, coordination, and execution of research projects in collaboration with, e.g., Siemens AG and Fraunhofer IKS
- Head of the *Technology and Research on Artificial Intelligence Laboratory (TRAIL)*

06/2015 – 06/2018 **Software Developer**, *it@M, City of Munich*, Germany.
Development, maintainance, and integration of business applications.

## Internships

02/2015 – 05/2015 **Visiting Scholar in Research**, *Bewersdorf Lab, Yale School of Medicine*, New Haven, Connecticut, USA.

- Practical work for the bachelor thesis
- Data analysis and feature extraction of cellular structures in super-resolution microscopy data
- Co-authored publication of methods and experimental results in Cell 2016 (cover story)

02/2012 – 09/2014 **Working Student (Collaborative Study Program)**, *City of Munich*, Germany.
Regular internships focusing on IT architecture, project management, and software development during the semester holidays.

## Teaching

04/2019 – Present **Autonomous Systems**, *LMU Munich*, Germany.

- Practical course of about 20 master students on planning and reinforcement learning
- Primary supervising assistant

04/2019 – Present **Artificial Intelligence**, *LMU Munich*, Germany.

- Working group of over 100 bachelor and master students on current AI topics
- Primary supervising assistant

10/2017 – Present **Thesis Supervision**, *LMU Munich*, Germany.

- 25 master theses
- 21 bachelor theses
- 8 individual research projects

04/2018 – 02/2019 **Mobile and Distributed Systems**, *LMU Munich*, Germany.

- Practical course of about 20 master students on mobile app development and on-device machine learning
- Secondary supervising assistant

## Research Projects

01/2022 – Present **AI-Fusion: Evaluation of Emergence in Distributed Intelligent Systems**, *Bavarian Ministry of Economic Affairs, Regional Development, and Energy*, Munich, Germany.
Research on emergence in multi-agent learning.

04/2022 – 12/2022 **Validation and Verification of Modular Machine Learning Systems**, *Siemens AG*, Munich, Germany.
Research on modular machine learning.

04/2020 – 12/2021 **Federated Learning in Industrial Environments**, *Siemens AG*, Munich, Germany.
Research on adaptive testing of federated learning systems.

01/2019 – 12/2019 **Dependability of Machine Learning in Industrial Environments**, *Siemens AG*, Munich, Germany.
Research on resilient multi-agent reinforcement learning.

08/2018 – 12/2018 **Coevolution in Machine Learning Based Industrial Environments**, *Siemens AG*, Munich, Germany.
Research on coevolutionary reinforcement learning.

10/2017 – 05/2019 **APVEL – Evaluation of Specialized Outpatient Palliative Care**, *Heidelberg University of Education*, Germany.
Development of a mobile and privacy-preserving app helping patients to select a suitable type of palliative care.

## Academic Activities

### Organizing Committee

2019 International Symposium on Applied Artificial Intelligence (ISAAI)

### Program Committee

2023 International Conference on Autonomous Agents and Multiagent Systems (AAMAS Blue Sky Ideas Track)

2021, 2022, 2023 AAAI Conference on Artificial Intelligence (AAAI)

### Reviewer

2022, 2023 International Conference on Machine Learning (ICML)

2023 International Conference on Autonomous Agents and Multiagent Systems (AAMAS Main Track)

2022 Conference on Neural Information Processing Systems (NeurIPS)

2018, 2022 International Symposium On Leveraging Applications of Formal Methods (ISoLA)

2021 PLOS ONE Journal

2020 International Journal on Software Tools for Technology Transfer (STTT)

## Scholarships and Awards

2022 **Top 10% Reviewer**, *International Conference on Machine Learning (ICML)*, Baltimore, MD, USA.

2019 **Travel Grant for AAMAS 2019**, *DAAD*, Montreal, Canada.

2016 **Best Bachelor Award**, *Rohde & Schwarz GmbH & Co. KG*, Munich, Germany.

2016 **Award for an Outstanding Bachelor Thesis in the Field of Image Processing**, *Stemmer Imaging GmbH*, Munich, Germany.

01/2012 – 08/2017 **Scholarship**, *Studienstiftung des Deutschen Volkes*, Munich, Germany.
In Germany, the top 0.5% of university or high school students get selected for funding by the German Academic Scholarship Foundation.

# Publications

## Conferences

2022 [C29] **Emergent Cooperation from Mutual Acknowledgment Exchange**.
Thomy Phan, Felix Sommer, Philipp Altmann, Fabian Ritz, Lenz Belzner, and Claudia Linnhoff-Popien.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 1047-1055, 2022.

[C28] **Towards Anomaly Detection in Reinforcement Learning (Blue Sky Ideas)**.
Robert Müller, Steffen Illium, Thomy Phan, Tom Haider, and Claudia Linnhoff-Popien.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 1799-1803, 2022.

[C27] **Capturing Dependencies within Machine Learning via a Formal Process Model**.
Fabian Ritz, Thomy Phan, Andreas Sedlmeier, Philipp Altmann, Jan Wieghardt, Reiner Schmid, Horst Sauer, Cornel Klein, Claudia Linnhoff-Popien, and Thomas Gabor.
*International Symposium on Leveraging Applications of Formal Methods (ISoLA)*, pages 249-265, 2022.

2021 [C26] **VAST: Value Function Factorization with Variable Agent Sub-Teams**.
Thomy Phan, Fabian Ritz, Lenz Belzner, Philipp Altmann, Thomas Gabor, and Claudia Linnhoff-Popien.
*Advances in Neural Information Processing Systems (NeurIPS)*, pages 24018-24032, 2021.

[C25] **A Sustainable Ecosystem through Emergent Cooperation in Multi-Agent Reinforcement Learning**.
Fabian Ritz, Daniel Ratke, Thomy Phan, Lenz Belzner, and Claudia Linnhoff-Popien.
*Conference on Artificial Life (ALIFE)*, pages 74–83, 2021.

[C24] **SAT-MARL: Specification Aware Training in Multi-Agent Reinforcement Learning**.
Fabian Ritz, Thomy Phan, Robert Müller, Thomas Gabor, Andreas Sedlmeier, Marc Zeller, Jan Wieghardt, Reiner Schmid, Horst Sauer, Cornel Klein, and Claudia Linnhoff-Popien.
*International Conference on Agents and Artificial Intelligence (ICAART)*, pages 28–37, 2021.

[C23] **Resilient Multi-Agent Reinforcement Learning with Adversarial Value Decomposition**.
Thomy Phan, Lenz Belzner, Thomas Gabor, Andreas Sedlmeier, Fabian Ritz, and Claudia Linnhoff-Popien.
*AAAI Conference on Artificial Intelligence (AAAI)*, pages 11308-11316, 2021.

2020 [C22] **Cross Entropy Hyperparameter Optimization for Constrained Problem Hamiltonians Applied to QAOA**.
Christoph Roch, Alexander Impertro, Thomy Phan, Thomas Gabor, Sebastian Feld, and Claudia Linnhoff-Popien.
*International Conference on Rebooting Computing (ICRC)*, pages 50-57, 2020.

[C21] **Towards Ecosystem Management from Greedy Reinforcement Learning in a Predator-Prey Setting**.
Fabian Ritz, Felix Hohnstein, Robert Müller, Thomy Phan, Thomas Gabor, Carsten Hahn, and Claudia Linnhoff-Popien.
*Conference on Artificial Life (ALIFE)*, pages 518-525, 2020.

[C20] **Foraging Swarms using Multi-Agent Reinforcement Learning**.
Carsten Hahn, Fabian Ritz, Paula Wikidal, Thomy Phan, Thomas Gabor, and Claudia Linnhoff-Popien.
*Conference on Artificial Life (ALIFE)*, pages 333-340, 2020.

[C19] **A Quantum Annealing Algorithm for Finding Pure Nash Equilibria in Graphical Games**.
Christoph Roch, Thomy Phan, Sebastian Feld, Robert Müller, Thomas Gabor, Carsten Hahn, and Claudia Linnhoff-Popien.
*International Conference on Computational Science (ICCS)*, pages 488-501, 2020.

[C18] **Learning and Testing Resilience in Cooperative Multi-Agent Systems**.
Thomy Phan, Thomas Gabor, Andreas Sedlmeier, Fabian Ritz, Bernhard Kempter, Cornel Klein, Horst Sauer, Reiner Schmid, Jan Wieghardt, Marc Zeller, and Claudia Linnhoff-Popien.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 1055-1063, 2020.

[C17] **Nash Equilibria in Multi-Agent Swarms**.
Carsten Hahn, Thomy Phan, Sebastian Feld, Christoph Roch, Fabian Ritz, Andreas Sedlmeier, Thomas Gabor, and Claudia Linnhoff-Popien.
*International Conference on Agents and Artificial Intelligence (ICAART)*, pages 234-241, 2020.

[C16] **Multi-Agent Reinforcement Learning for Bargaining under Risk and Asymmetric Information**.
Kyrill Schmid, Lenz Belzner, Thomy Phan, Thomas Gabor, and Claudia Linnhoff-Popien.
*International Conference on Agents and Artificial Intelligence (ICAART)*, pages 144-151, 2020.

[C15] **Uncertainty-Based Out-of-Distribution Classification in Deep Reinforcement Learning**.
Andreas Sedlmeier, Thomas Gabor, Thomy Phan, Lenz Belzner, and Claudia Linnhoff-Popien.
*International Conference on Agents and Artificial Intelligence (ICAART)*, pages 522-529, 2020.

2019 [C15] **Uncertainty-Based Out-of-Distribution Detection in Deep Reinforcement Learning**.
Andreas Sedlmeier, Thomas Gabor, Thomy Phan, Lenz Belzner, and Claudia Linnhoff-Popien.
*International Symposium On Applied Artificial Intelligence (ISAAI)*, pages 74-78, 2019.

[C13] **Adaptive Thompson Sampling Stacks for Memory Bounded Open-Loop Planning**.
Thomy Phan, Thomas Gabor, Robert Müller, Christoph Roch, and Claudia Linnhoff-Popien.
*International Joint Conference on Artificial Intelligence (IJCAI)*, pages 5607-5613, 2019.

[C12] **Subgoal-Based Temporal Abstraction in Monte-Carlo Tree Search**.
Thomas Gabor, Jan Peter, Thomy Phan, Christian Meyer, and Claudia Linnhoff-Popien.
*International Joint Conference on Artificial Intelligence (IJCAI)*, pages 5562-5568, 2019.

[C11] **Scenario Co-Evolution for Reinforcement Learning on a Grid World Smart Factory Domain**.
Thomas Gabor, Andreas Sedlmeier, Marie Kiermeier, Thomy Phan, Marcel Henrich, Monika Pichlmair, Bernhard Kempter, Cornel Klein, Horst Sauer, Reiner Schmid, and Jan Wieghardt.
*Genetic and Evolutionary Computation Conference (GECCO)*, pages 898-906, 2019.

[C10] **Emergent Escape-Based Flocking Behavior using Multi-Agent Reinforcement Learning**.
Carsten Hahn, Thomy Phan, Thomas Gabor, Lenz Belzner, and Claudia Linnhoff-Popien.
*Conference on Artificial Life (ALIFE)*, pages 598-605, 2019.

[C9] **Memory Bounded Open-Loop Planning in Large POMDPs using Thompson Sampling**.
Thomy Phan, Lenz Belzner, Marie Kiermeier, Markus Friedrich, Kyrill Schmid, and Claudia Linnhoff-Popien.
*AAAI Conference on Artificial Intelligence (AAAI)*, pages 7941-7948, 2019.

2018 [C8] **Anomaly Detection in Spatial Layer Models of Autonomous Agents**.
Marie Kiermeier, Sebastian Feld, Thomy Phan, and Claudia Linnhoff-Popien.
*International Conference on Intelligent Data Engineering and Automated Learning (IDEAL)*, pages 156-163, 2018.

[C7] **The Sharer's Dilemma in Collective Adaptive Systems of Self-Interested Agents**.
Lenz Belzner, Kyrill Schmid, Thomy Phan, Thomas Gabor, and Martin Wirsing.
*International Symposium on Leveraging Applications of Formal Methods (ISoLA)*, pages 241-256, 2018.

[C6] **Action Markets in Deep Multi-Agent Reinforcement Learning**.
Kyrill Schmid, Lenz Belzner, Thomas Gabor, and Thomy Phan.
*International Conference on Artificial Neural Networks (ICANN)*, pages 240-249, 2018.

[C5] **Risk-Sensitivity in Simulation Based Online Planning**.
Kyrill Schmid, Lenz Belzner, Marie Kiermeier, Alexander Neitz, Thomy Phan, Thomas Gabor, and Claudia Linnhoff-Popien.
*Joint German/Austrian Conference on Artificial Intelligence (KI)*, pages 229-240, 2018.

[C4] **Preparing for the Unexpected: Diversity Improves Planning Resilience in Evolutionary Algorithms**.
Thomas Gabor, Lenz Belzner, Thomy Phan, and Kyrill Schmid.
*IEEE International Conference on Autonomic Computing (ICAC)*, pages 131-140, 2018.

[C3] **Monitoring Autonomous Agents in Self-Organizing Industrial Systems**.
Marie Kiermeier, Thomy Phan, Horst Sauer, and Jan Wieghardt.
*IEEE International Conference on Industrial Informatics (INDIN)*, pages 653-658, 2018.

[C2] **Accelerating Evolutionary Construction Tree Extraction via Graph Partitioning**.
Markus Friedrich, Sebastian Feld, Thomy Phan, and Pierre-Alain Fayolle.
*International Conference on Computer Graphics, Visualization, and Computer Vision (WSCG)*, 2018.

[C1] **Leveraging Statistical Multi-Agent Online Planning with Emergent Value Function Approximation**.
Thomy Phan, Lenz Belzner, Thomas Gabor, and Kyrill Schmid.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 730-738, 2018.

## Journals

2023 [J5] **Emergent Cooperation from Mutual Acknowledgment Exchange in Multi-Agent Reinforcement Learning**.
Thomy Phan, Felix Sommer, Fabian Ritz, Philipp Altmann, Jonas Nüßlein, Michael Kölle, Lenz Belzner, and Claudia Linnhoff-Popien.
*Journal on Autonomous Agents and Multi-Agent Systems (JAAMAS)*, 2023. Under review.

2022 [J4] **Specification Aware Multi-Agent Reinforcement Learning**.
Fabian Ritz, Thomy Phan, Robert Müller, Thomas Gabor, Andreas Sedlmeier, Marc Zeller, Jan Wieghardt, Reiner Schmid, Horst Sauer, Cornel Klein, and Claudia Linnhoff-Popien.
*Springer Book of ICAART 2021*, pages 3-21, 2022.

2021 [J3] **Productive Fitness in Diversity-Aware Evolutionary Algorithms**.
Thomas Gabor, Thomy Phan, and Claudia Linnhoff-Popien.
*Natural Computing*, 20(3): 363-376, 2021.

2020 [J2] **The Scenario Coevolution Paradigm: Adaptive Quality Assurance for Adaptive Systems**.
Thomas Gabor, Andreas Sedlmeier, Thomy Phan, Fabian Ritz, Marie Kiermeier, Lenz Belzner, Bernhard Kempter, Cornel Klein, Horst Sauer, Reiner Schmid, Jan Wieghardt, Marc Zeller, and Claudia Linnhoff-Popien.
*International Journal on Software Tools for Technology Transfer (STTT)*, 22(4): 457-476, 2020.

2016 [J1] **Ultra-High Resolution 3D Imaging of Whole Cells (Cover Story)**.
Fang Huang, George Sirinakis, Edward S Allgeyer, Lena K Schroeder, Whitney C Duim, Emil B Kromann, Thomy Phan, Felix E Rivera-Molina, Jordan R Myers, Irnov Irnov, Mark Lessard, Yongdeng Zhang, Mary Ann Handel, Christine Jacobs-Wagner, C Patrick Lusk, James E Rothman, Derek Toomre, Martin J Booth, and Joerg Bewersdorf.
*Cell*, 166(4): 1028-1040, 2016.

## Workshops

2020 [W3] **The Holy Grail of Quantum Artificial Intelligence: Major Challenges in Accelerating the Machine Learning Pipeline**.
Thomas Gabor, Leo Sünkel, Fabian Ritz, Thomy Phan, Lenz Belzner, Christoph Roch, Sebastian Feld, and Claudia Linnhoff-Popien.
*International Workshop on Quantum Software Engineering (Q-SE)* at ICSE, pages 456-461, 2020.

[W2] **Insights on Training Neural Networks for QUBO Tasks**.
Thomas Gabor, Sebastian Feld, Hila Safi, Thomy Phan, and Claudia Linnhoff-Popien.
*International Workshop on Quantum Software Engineering (Q-SE)* at ICSE, pages 436-441, 2020.

[W1] **A Distributed Policy Iteration Scheme for Cooperative Multi-Agent Policy Approximation**.
Thomy Phan, Lenz Belzner, Kyrill Schmid, Thomas Gabor, Fabian Ritz, Sebastian Feld, and Claudia Linnhoff-Popien.
*Adaptive and Learning Agents Workshop (ALA)* at AAMAS, 2020.

### Extended Abstracts

Extended abstracts with a conference or journal version are not listed.

2023 [E2] **Attention-Based Recurrence for Multi-Agent Reinforcement Learning under State Uncertainty**.
Thomy Phan, Fabian Ritz, Jonas Nüßlein, Michael Kölle, Thomas Gabor, and Claudia Linnhoff-Popien.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2023. To appear.

2019 [E1] **Distributed Policy Iteration for Scalable Approximation of Cooperative Multi-Agent Policies**.
Thomy Phan, Kyrill Schmid, Lenz Belzner, Thomas Gabor, Sebastian Feld, and Claudia Linnhoff-Popien.
*International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 2162-2164, 2019.

### Other

2020 [O3] **Artificial Intelligence – The New Revolutionary Evolution**.
Thomy Phan, Sebastian Feld, and Claudia Linnhoff-Popien.
*Digitale Welt*, 4(1):7-8, 2020.

2018 [O2] **Bayesian Variational Optimization in Sensor Networks**.
Steffen Illium, Thomas Gabor, and Thomy Phan.
*GI/ITG KuVS Fachgespräch Sensornetze*, page 45, 2018.

[O1] **Reinforcement Learning am Beispiel Schach**.
Thomy Phan.
*Digitale Welt,* 2(4):28-29, 2018.

## Talks

### Invited Talks

07/2022 **Emergent Cooperation from Mutual Acknowledgment Exchange**, Workshop on Ad Hoc Teamwork at IJCAI 2022 (virtual).
Highlight presentation of a paper previously published in AAMAS 2022.

06/2021 **Stability in AI-Systems**, Digitale Stadt München e.V., Germany (virtual).
DigiTalk event on Safe Intelligence of the Digital City Association of Munich.

12/2020 **Artificial Intelligence – How Do Robots Learn?**, Gymnasium Berchtesgaden, Germany (virtual).
P-seminar talk for high school students and the Junior Science Café.

03/2019 **Building Autonomous Systems with AI**, *University of Augsburg*, Germany.
AI workshop for students of the Software Engineering Elite Graduate Program.

### Oral Presentations at Conferences and Workshops

05/2022 **Emergent Cooperation from Mutual Acknowledgment Exchange**, virtual.
International Conference on Autonomous Agents and Multiagent Systems (AAMAS).

12/2021 **VAST: Value Function Factorization with Variable Agent Sub-Teams**, virtual.
Conference on Neural Information Processing Systems (NeurIPS).

02/2021 **Resilient Multi-Agent Reinforcement Learning with Adversarial Value Decomposition**, virtual.
AAAI Conference on Artificial Intelligence (AAAI).

05/2020 **Learning and Testing Resilience in Cooperative Multi-Agent Systems**, virtual.
International Conference on Autonomous Agents and Multiagent Systems (AAMAS).

05/2020 **A Distributed Policy Iteration Scheme for Cooperative Multi-Agent Policy Approximation**, virtual.
Adaptive and Learning Agents Workshop (ALA) at AAMAS.

08/2019 **Adaptive Thompson Sampling Stacks for Memory Bounded Open-Loop Planning**, Macao, China.
International Joint Conference on Artificial Intelligence (IJCAI).

02/2019 **Memory Bounded Open-Loop Planning in Large POMDPs using Thompson Sampling**, *Honolulu*, Hawaii, USA.
AAAI Conference on Artificial Intelligence (AAAI).

07/2018 **Leveraging Statistical Multi-Agent Online Planning with Emergent Value Function Approximation**, Stockholm, Sweden.
International Conference on Autonomous Agents and Multiagent Systems (AAMAS).

### Other Talks

2019 **Unitag: Artificial Intelligence – How Do Robots Learn?**, *LMU Munich*, Germany.
University event for gifted high school students from Upper Bavaria.