Aalto Science Institute (AScI)

International Summer Research Programme

2025 project list

(updated, 7.1.2025)

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Contents

SCHOOL OF ELECTRICAL ENGINEERING 3

Department of Electrical Engineering and Automation **3**
2101 - Learning and Control for Networked Multi-agent Systems 3
2102 - Assistive Systems for Autonomous Vehicle 4
2103 - Optimal preference selection in multi-objective reinforcement learning 5
2104 - Multi-Agent Coordination for Bimanual Manipulation 6

Department of Information and Communications Engineering **7**
2301 - Optimization of Reinforcement Learning Agents for Design 7
2302 - Modeling interactions on visualizations 8
2303 - Simulating medical doctors' decision-making in anesthesiology 9
2304 - Generating Interactive 3D Objects for Cross-Reality Applications 10
2305 - Simulating human behaviour in traffic 11
2306 - Multi-Agent Reinforcement Learning for Adaptive Cooperative Interfaces 12
2307 - Modeling Human Collaboration Behaviors with AI 13
2308 - Modeling Human Creativity with Generative Agents 14
2309 - Carbon-aware cloud computing 15

SCHOOL OF ENGINEERING 16

Department of Civil Engineering **16**
3201 - Digitization of construction - Digital twins (1) 16
3202 - Digitization of construction - Digital twins (2) 17

SCHOOL OF SCIENCE 18

Department of Applied Physics **18**
4101 - Replacing plastics by functionalizing biodegradable foams 18
4102 - Noise spectroscopy of edge states in graphene confined geometry 19
4103 - Superconducting field effect transistor in Si-based Josephson junctions 20
4104 - Extracting many-body correlation from strongly correlated systems with machine learning 21
4105 - Quantum States in Moiré Complex Oxides 22
4106 - Radiation damage modelled with two-temperature molecular dynamics 23
4107 - Macroscopic Quantum Optics 24

Department of Computer Science **25**
4201 - Toward Robust and Reliable Algorithmic Recourse 25

4202 - Legal Network Science 26
4203 - Computational Perspectives on Democracy 27
4204 - Machine Learning: Foundations and New Frontiers 28
4205 - Building Game Prototype(s) to Explore Game Feel Design for Emotional Experiences 29
4206 - Learning Movement Plans with Generative Models 30
4207 - Modelling weak signals in high-dimensional neuroscientific data 31
4208 - The leaky Pipeline in Academia 32
4209 - Distances in geometric (intersection) graphs 33
4210 - Approaching exascale using physics simulations with the help of machine learning 34
4211 - The DNAforge design tool for nucleic acid nanostructures 35
4212 - Positions in Probabilistic Machine Learning 36
4213 - Theory of distributed and parallel computing 37
4214 - Bayesian workflow 38
4215 - Distributed training of LLMs with reinforcement learning from human feedback (RLHF) 39

Department of Industrial Engineering and Management 40
4301 - Incentivizing globally sustainable production in the local environment 40
4302 - Digital transformation of manufacturing and operations 41
4303 - A system dynamic model for analyzing dynamics of technology markets 42

Department of Neuroscience and Biomedical Engineering 43
4501 - Cognitive Neuroimaging with naturalistic stimuli 43

School of Electrical Engineering

Department of Electrical Engineering and Automation

2101 - Learning and Control for Networked Multi-agent Systems

Field of study:	Automatic control, machine learning	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Electrical Engineering and Automation	
Professor:	Dominik Baumann	dominik.baumann@aalto.fi
Academic contact person:	Dominik Baumann	dominik.baumann@aalto.fi

In the next generation of control systems, we will see multiple smart agents that collaborate to reach a joint goal. For instance, autonomous cars will exchange their planned routes to increase traffic throughput, drone swarms will coordinate to increase efficiency in precision agriculture, and mobile robots will collaborate with factory automation machinery to manufacture products jointly. To achieve this level of collaboration, the agents need to be able to (i) autonomously act in and learn from interactions with their environment, and (ii) communicate with each other via a wireless communication network. Thus, the next generation of control systems will integrate classical control theory with machine learning and wireless networks. While both learning and wireless communication offer unprecedented flexibility, they at the same time introduce novel challenges. Wireless networks have a limited bandwidth, and abundant use of the network through communicating unnecessary information will lead to delay and even loss of sent messages. Learning requires the system to explore and try out actions. However, for application examples like mobile robots or autonomous cars that act around humans, strict safety guarantees are indispensable. Providing such guarantees has always been a major strength of control theory. Nevertheless, existing techniques must be enhanced to include the communication and learning system.

In this project, we seek to develop algorithms that allow learning and control of multi-agent systems over communication networks while providing safety guarantees. The concrete tasks within the project can be adjusted based on the background and interest of the applicant. The focus can be on the mathematical analysis of the developed algorithms, an evaluation in complex simulation environments, or an evaluation on a real robotic systems, e.g., a Franka robot arm or the Unitree Go2 quadruped.

2102 - Assistive Systems for Autonomous Vehicle

Field of study:	Control and Automation, Autonomous Vehicle	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Electrical Engineering and Automation	
Professor:	Ville Kyrki	ville.kyrki@aalto.fi
Academic contact person:	Shivam Chaubey	shivam.chaubey@aalto.fi

This internship focuses on leveraging assistive systems in robotics to address the critical challenge of ensuring safety and feasibility in robotic operations. As the adoption of robotic systems increases, guaranteeing safety under all conditions becomes paramount. The project emphasizes the development of methods to ensure safety, particularly in scenarios where incorrect user inputs could lead to unsafe outcomes, such as collision avoidance in autonomous vehicles.

The core of the project involves implementing and testing the assistive controller already developed based on Control Invariant Sets (CIS), which define a safe operating region for nonlinear systems, considering physical constraints and unsafe areas like obstacles. These sets will be computed and integrated with a Model Predictive Controller (MPC) to ensure feasibility and guarantee the system remains within the safe region. The implementation will be tested to ensure real-time execution, enabling its deployment on hardware.

Practical experiments will be conducted on small-scale autonomous vehicles to replicate real-world scenarios, including testing the assistive system's ability to avoid obstacles and stay within road boundaries. The project also opens avenues for further exploration in dynamic environments, such as lane changes, pedestrian collision avoidance, and fully autonomous.This work presents an opportunity to learn and implement advanced assistive controllers that ensure safety while addressing real-time computational challenges.

We will closely assist you throughout this project to ensure your success. Our support will include solving doubts, debugging code, and providing guidance with hardware implementation. Additionally, this project offers an excellent opportunity to collaborate on writing and publishing a research paper.

Key Responsibilities:

1. Implement the assistive controller algorithm in real-time.
2. Evaluate performance on simulation platforms for scenarios like obstacle avoidance or boundary control.
3. Identify non-linear model of the vehicle.
4. Integrate OptiTrack - Motion Capture Systems for localizing the vehicle.
5. Conduct experiments on small-scale autonomous vehicles.

Learning Outcomes:

1. Gain hands-on experience in implementing safety-critical controllers for robotic systems.
2. Understand advanced control methods like CIS and MPC for ensuring safety.
3. Tackle computational challenges associated with real-time implementation of algorithms.
4. Identifying the vehicle model from data/measurements.
5. Develop insights into practical safety applications in autonomous systems.

Background Required:

1. Course work: Control Systems, Optimization Methods.
2. Software: Python. Nice to have C++, ROS

2103 - Optimal preference selection in multi-objective reinforcement learning

Field of study:	Reinforcement learning, Multi-objective optimization, Deep learning	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Electrical Engineering and Automation	
Professor:	Joni Pajarinen	joni.pajarinen@aalto.fi
Academic contact person:	Santeri Heiskanen	santeri.heiskanen@aalto.fi

Recently, reinforcement learning (RL) has achieved remarkable success in many complex tasks, ranging from games to drug design. However, most existing methods consider only one objective, while real-world problems often require a trade-off between multiple objectives. Multi-objective reinforcement learning (MORL) is a branch of RL that considers multiple conflicting objectives simultaneously by finding a set of solutions with different trade-offs between the objectives.

MORL methods commonly convert the multi-objective problem into a series of single-objective tasks by fixing the trade-off between the objectives and then solving the single-objective task. This process is then repeated with different trade-offs [1]. While this approach is lucrative due to its simplicity, it can also be sample inefficient since a slight change in the trade-off between the objectives is likely to lead to similar policies. Thus, many existing methods try to improve the sample efficiency by smartly selecting the preferences used to train the agent [2], [3]. In this project, we model preference selection as an iterative optimization problem and seek to develop an algorithm that selects preferences that optimize the quality of the solution set without sacrificing the sample efficiency. The selected student will work on formulating and implementing the proposed idea. Furthermore, they will be responsible for benchmarking the solution across various MORL algorithms.

Required skills:

- Python programming & experience with deep learning frameworks (Pytorch / Jax).
- Understanding of reinforcement learning / deep learning methods.
- Experience with GPU clusters (Slurm) is considered a plus.
- Experience with Multi-objective optimization is considered a plus.

References

[1] C. F. Hayes et al., "A Practical Guide to Multi-Objective Reinforcement Learning and Planning," *Auton. Agents Multi-Agent Syst.*, vol. 36, no. 1, 2022.

[2] J. Xu, Y. Tian, P. Ma, D. Rus, S. Sueda, and W. Matusik, "Prediction-Guided Multi-Objective Reinforcement Learning for Continuous Robot Control," in *Proceedings of the 37th International conference on Machine learning*, 2020

[3] L. N. Alegre, A. L. C. Bazzan, D. M. Roijers, A. Nowe, and 8. C. da Silva, "Sample-Efficient Multi-Objective Learning via Generalized Policy Improvement Prioritization," in *Proceedings of the 2023 International Conference on Autonomous Agents and Multiagent Systems*, 2023

2104 - Multi-Agent Coordination for Bimanual Manipulation

Field of study:	Artificial intelligence, control and automation	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Electrical Engineering and Automation	
Professor:	Joni Pajarinen	joni.pajarinen@aalto.fi
Academic contact person:	Zhiyuan Li	zhiyuan.li@aalto.fi

Recent advancements in robotics have significantly enhanced robots' abilities to perform a variety of tasks in real-world environments [1, 2]. While many studies have focused on unimanual robots, bimanual manipulation capabilities remain relatively underdeveloped. Using a second arm enables humans to perform more complex tasks, such as handling objects that are too large for a single gripper or using one arm to stabilize an object while manipulating it with the other. However, tasks requiring bimanual manipulation, like unscrewing a bottle cap or cutting hair, present significant challenges. These tasks demand high precision and complex coordination between the two arms within a higher-dimensional action space [3, 4]. This project aims to achieve collaborative decentralized bimanual manipulation using a hierarchical MARL (Multi-Agent Reinforcement Learning) framework.

We are looking for a Master's student with a strong background in computer science, computer, or software engineering with familiarity with control and automation to work on this project. Knowledge and practical knowledge
of machine learning and artificial intelligence are needed.

References:

[1] Moo Jin Kim, undefined., et al, "OpenVLA: An Open-Source Vision-Language-Action Model," in *8th Annual Conference on Robot Learning*, 2024.

[2] Zitkovich, B., et al, "RT-2: Vision-Language-Action Models Transfer Web Knowledge to Robotic Control," in *Proceedings of the 7th Conference on Robot Learning*, 2023, pp. 2165–2183.

[3] Andrew Choong-Won Lee, undefined., et al, "InterACT: Inter-dependency Aware Action Chunking with Hierarchical Attention Transformers for Bimanual Manipulation," in *8th Annual Conference on Robot Learning*, 2024.

[4] Liu, Songming, et al. "Rdt-1b: a diffusion foundation model for bimanual manipulation." arXiv preprint arXiv:2410.07864 (2024).

Required skills:

- Course on (Deep) reinforcement learning / similar level of knowledge.
- Experience with at least one deep learning framework (Pytorch / TensorFlow).
- (Preferred) Experience with bimanual manipulation.
- (Preferred) Experience with running experiments on cluster (SLURM).
- (Preferred) Experience with writing mathematical formulations of problems.

2301 - Optimization of Reinforcement Learning Agents for Design

Field of study:	Optimization; Machine Learning; Software Engineering	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Francisco E. Fernandes Jr.	francisco.fernandesjunior@aalto.fi

We invite master's students to join our summer internship, focused on optimizing Reinforcement Learning (RL) agents for interface design through Computational Rationality [1]. You'll work on developing a robust, user-friendly system architecture that streamlines frontend, backend, and database communication for efficient optimization processes [2].

Your responsibilities will include refining the backend to manage complex RL-agent interactions, optimizing API performance, and enhancing our browser-based frontend to provide clear and intuitive feedback on trials and parameters. Additionally, you'll play a key role in experimenting with a new optimizer based on Transformers and Large Language Models, integrating cutting-edge AI capabilities into our optimization framework.

Required Skills:

- Proficiency in Python, backend frameworks (e.g., Flask, FastAPI), and frontend development (e.g., JavaScript, React).
- Experience with database management and optimization (e.g., SQL, ORM tools).
- Background in Machine Learning, with knowledge of RL and optimization methods.
- Familiarity with Transformers and Large Language Models (LLMs) is a plus.

This is an exciting opportunity to advance your skills in AI and software engineering while contributing to innovative design optimization solutions.

References:

[1] S. Chandramouli et al., "A Workflow for Building Computationally Rational Models of Human Behavior," *Comput Brain Behav*, vol. 7, no. 3, pp. 399–419, Sep. 2024, doi: 10.1007/s42113-024-00208-6.
[2] F. E. Fernandes Junior and A. Oulasvirta, "AgentForge: A Flexible Low-Code Platform for Reinforcement Learning Agent Design," Oct. 25, 2024, arXiv: arXiv:2410.19528. Accessed: Oct. 28, 2024. [Online]. Available: http://arxiv.org/abs/2410.19528

2302 - Modeling interactions on visualizations

Field of study:	User modeling; Visualization; Machine learning	
For students currently studying:	Master's or higher	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Danqing Shi	danqing.shi@aalto.fi

Interacting with visualizations is a problem-solving process that helps people make sense of data. Modeling these interactions is valuable for simulation, evaluation, design optimization, and supporting the development of advanced features. However, there are currently few models that can accurately reproduce human-like behaviors in visualizations. This project focuses on computational user modeling for visualizations. The goal is to create a computational model that can simulate interactions with visualizations and derive insights into human strategies during the process.

The summer intern will be involved in data processing and analysis, model development, building interactive demo, and conducting studies. The project is aiming for a top-tier paper.

Requirements:
1) Programming in Python/Javascript
2) Knowledge in machine learning, with a preference for reinforcement learning
3) Experience in conducting user studies and experiments (Optional)
4) Knowledge in information visualization or visual analysis (Optional)
5) Publication and research experience in human-computer interaction or visualization is a plus (Optional).

References:
[1] Wang, Y. and Bulling, A., 2023. Scanpath prediction on information visualisations. *IEEE Transactions on Visualization and Computer Graphics*.
[2] Chandramouli, Suyog, et al. "A workflow for building computationally rational models of human behavior." *Computational Brain & Behavior* 7.3 (2024): 399-419.

2303 - Simulating medical doctors' decision-making in anesthesiology

Field of study:	Computational rationality, reinforcement learning, medicine	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Jan Kompatscher	jan.kompatscher@aalto.fi

Anesthesiology is an important medical field since patients must not be awake or feel pain during surgery. The administration of incorrect drugs can have dire consequences. Medicine is constantly evolving, but doctors, as humans, have cognitive and physical limitations that restrict their ability to adapt indefinitely to complex, dynamic scenarios. Machine learning (ML) and interaction design can assist in addressing these challenges, making medical practice more efficient and accurate. Designing effective tools, such as user interfaces and decision-support systems, requires accurate models of both patients and doctors to ensure usability and alignment with real-world needs.

In this work, we are collaborating with experts from UCSF who are building simulator models based on large medical datasets gathered in the university hospital. Our objective is to create an accurate predictive model of anesthesiologists' decision-making.
We will collaborate closely with practitioners to improve anesthesia computationally.

The summer intern will have to help build the simulator, train RL models, test, and literature research.

Required skills:

1. Programming skills (Python)
2. Knowledge in machine learning, with a preference for reinforcement learning
3. At least an interest in medicine

References:

[1] Oulasvirta, A., Jokinen, J. P., & Howes, A. (2022, April). Computational rationality as a theory of interaction. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (pp. 1-14).
[2] Yun, Won Joon et al. "Hierarchical Deep Reinforcement Learning-Based Propofol Infusion Assistant Framework in Anesthesia." *IEEE Transactions on Neural Networks and Learning Systems* 35 (2022): 2510-2521.

2304 - Generating Interactive 3D Objects for Cross-Reality Applications

Field of study:	Generative model, machine learning	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Xuejing Luo	xuejing.luo@aalto.fi

Generative models have become increasingly popular, driving advancements in fields such as 3D modeling. However, the question of how to effectively interact with generative 3D content remains largely unexplored. Developing intuitive, human-centered interaction mechanisms for generative content can unlock their full potential, enabling novel applications in many fields such as games, vr/ar, and simulation.

This project focuses on developing computational frameworks and interactive systems to enable anyone to interact seamlessly with generative objects in a 3D world. The work aims to bridge the gap between generative models and user/agent interactions, paving the way for innovative applications and new research directions.

As a summer intern, you will work on model development to enable seamless interactions with generative 3D objects. You will also build interactive demos to demonstrate the capabilities of the developed systems and conduct analysis to evaluate the performance and usability of these interaction models.

Requirements:

1. Knowledge in machine learning, 3d vision, and/or generative models
2. Proficiency in Python and Pytorch programming.
3. Familiarity with Blender or Unity (preferred, but not required).
4. Research experience and publications in relevant fields are a strong plus.

2305 - Simulating human behaviour in traffic

Field of study:	Reinforcement learning, Computational rationality	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Wang Ruofeng	ruofeng.wang@aalto.fi

Recently, autonomous driving technology has become increasingly popular. However, most autonomous driving models primarily focus on drivers, surrounding vehicles, and the overall road environment factors that are relatively predictable. They struggle to deal with pedestrians, who represent a highly unpredictable element along with their real-world behaviors.

This project aims to leverage computational rationality, reinforcement learning, and computer vision to develop a more realistic and accurate pedestrian behavior model in traffic, providing valuable insights for future autonomous driving and traffic design.

Requirements: (Even if you are interested in this project and don't fulfill all requirements, we also encourage you to apply for it.)

1. Knowledge in reinforcement learning, machine learning, computer vision and human computer interaction.
2. Proficiency in Python and Pytorch programming.
3. Familiarity with carla or scenic.

Some references could let you know more about this project.
[1]Oulasvirta, Antti, Jussi PP Jokinen, and Andrew Howes. "Computational rationality as a theory of interaction." *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. 2022.
[2]Wang, Yueyang, et al. "Pedestrian crossing decisions can be explained by bounded optimal decision-making under noisy visual perception." arXiv preprint arXiv:2402.04370 (2024).

2306 - Multi-Agent Reinforcement Learning for Adaptive Cooperative Interfaces

Field of study:	Multi-Agent Reinforcement Learning; Human-computer interaction	
For students currently studying:	Master's	
Number of positions offered:	1+	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Thomas Langerak	thomas.langerak@aalto.fi

In Human-Computer Interaction (HCI), a central goal is to model human behavior with interfaces. The goal of these models is to optimize usability and efficiency. A common approach has been to represent the user as a reinforcement learning (RL) agent, enabling researchers to study and predict interaction patterns. Only recently, the field has begun to explore HCI as a multi-agent reinforcement learning problem, where both the human and the computer learn to interact and cooperate [1]. While this promising perspective has primarily been applied to single-user interfaces, its potential extends naturally to modeling human interactions within cooperative interfaces, offering a framework to study shared goals and collaborative dynamics.

The goal of this project is to model the behavior of users in a collaborative task using multi-agent reinforcement learning [2]. These behavioral models can then be used to 1) investigate the effect of interface design on collaboration (e.g., show users the same or different interfaces), and 2) optimize the interface for collaborative tasks.

This project will expose you to state-of-the-art user modelling, inspired by human cognition; reinforcement learning, and the cutting edge of human-computer interaction. You will develop technical and research skills, and contribute to impactful projects with

Requirements: (Even if you don't fulfill all the requirements, we strongly encourage interested people to apply.)

1. Proficiency in Python and Pytorch programming.
2. Knowledge in reinforcement learning and human-computer interaction.
3. Research experience is a strong plus.

References:

[1] Langerak, T., Christen, S., Albaba, M., Gebhardt, C., Holz, C., & Hilliges, O. (2024). MARLUI: Multi-Agent Reinforcement Learning for Adaptive Point-and-Click UIs. *Proceedings of the ACM on Human-Computer Interaction*, *8*(EICS), 1-27.

[2] S. Chandramouli, D. Shi, A. Putkonen, S. De Peuter, S. Zhang, J. Jokinen, A. Howes, and A. Oulasvirta, "A Workflow for building Computationally Rational Models of Human Behavior," *Computational Brain and Behavior*, 2024.

2307 - Modeling Human Collaboration Behaviors with AI

Field of study:	Human-computer interaction, reinforcement learning	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Shuai Ma	shuai.ma@aalto.fi

With the rapid advancement of AI, effective human-AI collaboration is increasingly vital. Humans naturally balance perception, cognition, and action, guided by computational rationality principles [2]. Moreover, social interactions with AI introduce new complexities to human behavior. However, much of the research remains focused on enhancing AI's individual performance, often neglecting the intricate dynamics of human-AI interaction. Designing seamless AI collaborators requires understanding and modeling how humans behave when collaborating with AI [1].

This project investigates human-AI collaboration through experiments and modeling, aiming to study interesting research questions such as trust, value alignment, and adaptability [3]. By bridging theoretical modeling and system implementation, it seeks to establish a solid foundation for advancing Human-AI Collaboration.

Requirements:

1. Strong Python programming skills and familiarity with ML (including Bayesian) and RL algorithms;
2. Ability to conduct literature reviews and identify innovative ideas;
3. Good communication and teamwork abilities;
4. Interest in Human-AI Collaboration and related topics like trust and value alignment.

What You Will Gain:

1. Hands-on Experience: Engage in cutting-edge research on Human-AI Collaboration;
2. Growth Opportunities: We are aiming for a top-tier paper.

References:

[1] Howes, A., Jokinen, J. P., & Oulasvirta, A. (2023). Towards machines that understand people. *AI Magazine*, 44(3), 312-327.
[2] Oulasvirta, A., Jokinen, J. P., & Howes, A. (2022, April). Computational rationality as a theory of interaction. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (pp. 1-14).
[3] Bhat, S., Lyons, J. B., Shi, C., & Yang, X. J. (2024, March). Evaluating the impact of personalized value alignment in human-robot interaction: Insights into trust and team performance outcomes. In *Proceedings of the 2024 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 32-41).

2308 - Modeling Human Creativity with Generative Agents

Field of study:	Human-computer interaction, creativity, design	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Antti Oulasvirta	antti.oulasvirta@aalto.fi
Academic contact person:	Joongi Shin	joongi.shin@aalto.fi

Human creativity is central to driving innovation in our society. Understanding how creativity works can lead to breakthroughs in designing more effective ways of performing and assisting creativity activities. To this end, diverse theories and cognitive models of creativity have been proposed [1]. However, testing these theories in practice has been challenging. *Difficulties in simulating human-like reasoning in creativity* have limited the assessment of these theories, often solely relying on qualitative analysis that may not capture the mechanism of creativity. *Could generative agents help test this systematically?*

The goal of this research project is to develop *generative agents that can simulate human-like cognitive processes in creativity activities*. A generative agent is an LLM-based agent that can incorporate human-like cognitive modules [2], making it ideal for simulating the theories of creativity. Focusing on idea generation and selection as the main creative activity, this project aims to demystify the mechanisms of how people form, combine, and reflect on novel ideas.

Requirements:

1. Proficiency in Python and Javascript programming.
2. Basic knowledge of prompt engineering.
3. Good collaborative work ethics.
4. Experience in conducting HCI research and user studies (optional).

What You Will Gain:

1. Experience in HCI research on creativity and modeling human behaviors.
2. Authorship in a potential publication.

References:

[1] Mekern, Vera, Bernhard Hommel, and Zsuzsika Sjoerds. "Computational models of creativity: a review of single-process and multi-process recent approaches to demystify creative cognition." *Current Opinion in Behavioral Sciences* 27 (2019): 47-54.
[2] Webb, Taylor, et al. "A prefrontal cortex-inspired architecture for planning in Large Language Models." arXiv e-prints (2023): arXiv-2310.

2309 - Carbon-aware cloud computing

Field of study:	Computer Science, sustainable computing	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Electrical Engineering	
Department:	Department of Information and Communications Engineering	
Professor:	Gopika Premsankar	gopika.premsankar@aalto.fi
Academic contact person:	Gopika Premsankar César Iván Olvera Espinosa	gopika.premsankar@aalto.fi cesar.olveraespinosa@aalto.fi

In our research, we aim to minimize the environmental impact of cloud computing systems. Towards this end we are focusing on the carbon emissions associated with AI workloads in the cloud [Dodd2022]. In this internship, you will work on building a consequential life cycle assessment model for estimating the carbon emissions of cloud computing workloads. The goal is to quantify the long-term impact on carbon emissions, including both operational [Suk2024] and embodied emissions [Lyu2023]. Tasks include running simulations, modeling the causal chains between different components, and / or generating scenarios to test.

Pre-requisites:

- Solid programming skills
- Experience with using the Linux command line terminal or scripting
- Basic coursework in distributed systems or cloud computing, and machine learning
- Understanding of attributional and consequential life cycle assessment (check references below)
- Understanding of embodied and operational carbon emissions (check references below)

References:

[Dod2022] Jesse Dodge et al. 2022. Measuring the Carbon Intensity of AI in Cloud Instances. In Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency (FAccT '22). Association for Computing Machinery, New York, NY, USA, 1877–1894. https://doi.org/10.1145/3531146.3533234

[Lyu2023] Jialun Lyu at al. 2023. Myths and Misconceptions Around Reducing Carbon Embedded in Cloud Platforms. In Proceedings of the 2nd Workshop on Sustainable Computer Systems (HotCarbon '23). https://doi.org/10.1145/3604930.3605717

[Suk2024] Thanathorn Sukprasert et al. 2024. On the Limitations of Carbon-Aware Temporal and Spatial Workload Shifting in the Cloud. In Proceedings of the Nineteenth European Conference on Computer Systems (EuroSys '24). Association for Computing Machinery, New York, NY, USA, 924–941. https://doi.org/10.1145/3627703.3650079

School of Engineering

Department of Civil Engineering

3201 - Digitization of construction - Digital twins (1)

Field of study:	Construction management/Computer science	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Engineering	
Department:	Department of Civil Engineering	
Professor:	Olli Seppänen	olli.seppanen@aalto.fi
Academic contact person:	Olli Seppänen	olli.seppanen@aalto.fi

Description: Digital twins are an emerging concept which has drawn attention in manufacturing as well as construction industry. The digital twins of construction process are a digital replica of the construction process which can be used to model, simulate, compare, and evaluate the performance of processes. Accurate digital twins will be helpful in streamlining the process of construction to reduce delays and cost overruns associated with construction projects. This will not only be helpful in the economy of a nation but also reduce carbon footprints as wastage related to construction will be reduced.

The intern will participate in the work package of the project that is related to modeling and simulation. The aim of the project is to provide real-time implementation of site situations to analyze and predict the behaviors and activities for the construction workers.

We expect the following skills from the intern:

- Knowledge and experience in Agent-Based modeling and simulation.
- Knowledge of Anylogic: Simulation Modeling Software.
- Experience in Java /Python programming.
- Creative and intelligent mind to develop unique algorithms.
- Good writing and verbal communication skills.
- Interactive and collaborative problem solver.

The intern is expected to work at the Department of Civil Engineering in the research group of Performance in building design and construction.

3202 - Digitization of construction - Digital twins (2)

Field of study:	Computer vision/construction management	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Engineering	
Department:	Department of Civil Engineering	
Professor:	Olli Seppänen	olli.seppanen@aalto.fi
Academic contact person:	Olli Seppänen	olli.seppanen@aalto.fi

Description: Digital twins, an emerging concept in manufacturing and construction, offer digital replicas of real structures that support planning, design, construction, and facility management. Accurate digital twins can streamline construction, reducing delays and cost overruns. Achieving this accuracy requires automating data capture and interpretation, though current methods in construction need further research for full application in transforming site data into digital information. This project aims to explore these methods on real construction data to produce valuable insights for construction planning and management.

The intern will collaborate in designing and developing the framework for 360- degree video processing for construction related data interpretation.

The intern is therefore expected to have the following skills:

- Good coding skills. Preferred language: Python
- Experience in using deep learning libraries like tensorflow, keras, pytorch.
- Good Computer vision knowledge.
- Interest in object detection/semantic segmentation.
- Good communication skills.
- Willing to work in a team.

The intern is expected to work at the Department of Civil Engineering in the research group of Performance in building design and construction.

School of Science

Department of Applied Physics

4101 - Replacing plastics by functionalizing biodegradable foams

Field of study:	Physics	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Mikko Alava	mikko.alava@aalto.fi
Academic contact person:	Juha Koivisto	juha.koivisto@aalto.fi

Forest based biofoams are an alternative for fossil oil based plastics. We have recently developed a proof-of-concept biofoam with high strength per weight. In this task more functionalities are added to the foam. Examples of these new functionalities include fire and water resistance, conductivity, reaction to heat and temperature. The task can also include applications as demonstrator purposes. The tasks can be adjusted to the interest and background of the student. Experimental, technical or design background is a plus. The topic is related to the Archibiofoam EU-project (www.archibiofoam.eu).

4102 - Noise spectroscopy of edge states in graphene confined geometry

Field of study:	Physics	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Pertti Hakonen	pertti.hakonen@aalto.fi
Academic contact person:	Manohar Kumar	manohar.kumar@aalto.fi

Graphene's atomically thin structure, combined with its unique dielectric properties, makes it an ideal platform for realizing non-Abelian anyons essential for the development of topological qubits. In this context, non-Abelian anyons, such as fractional quantum Hall states at filling factor n = 5/2, with higher energy gaps, can be achieved. A key component for enabling topological qubits is the quantum point contact (QPC). However, graphene's semi-metallic nature, characterized by the absence of a bandgap, leads to a non-conventional QPC design.

Transport measurements conducted on a Hall bar with a QPC geometry have demonstrated clear signatures of quantized conductance plateaus. These quantized steps, however, are significantly influenced by various equilibration processes of the edge states within the QPC. In our recent work, we reported quantization at $n = 5/2$, attributed to equilibration between two Abelian states. The precise origin of this exotic state remains elusive and demands investigation beyond conductance measurements. To this end, we plan to perform shot noise measurements, a sensitive probe to elucidate the scattering mechanisms in the QPC region.

Understanding the scattering processes in graphene QPCs is an evolving field. At Aalto, we are collaborating with Prof. Tworzydło from the University of Warsaw to develop a more refined theoretical model. This model goes beyond the conventional scattering matrix framework used for QPCs in GaAs/AlGaAs heterostructures and incorporates tight-binding calculations tailored for graphene.

Experimentally and theoretically, we aim to explore quantum transport in confined graphene geometries. Insights from the study of a single QPC will guide the design of two-QPC systems, such as Fabry-Pérot interferometers, within the quantum Hall regime. These interferometers will serve as fundamental building blocks for topological qubits.

This research is part of a long-term effort within the Nano group, with theoretical support from Prof. Tworzydło. We are seeking a highly motivated student with a strong background in tight-binding calculations to join this project. The successful candidate will collaborate with a PhD student on experimental aspects. Interested individuals are encouraged to contact the supervising academic or professor for further details.

The following three are good references:

1. Phys. Rev. B **82**.205412 (2010)
2. Phys. Rev. B **105**, L241409 (2022)
3. ArXiv.2410.03896

4103 - Superconducting field effect transistor in Si-based Josephson junctions

Field of study:	Engineering Physics	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Applief Physics	
Professor:	Pertti Hakonen	pertti.hakonen@aalto.fi
Academic contact person:	Jere Mäkinen	jere.makinen@aalto.fi

Abstract
Superconducting circuits have the potential to realize electronics with ultrafast switching capabilities and ultra-low power consumption compared to semiconductor technology. To address the power-intensive cooling requirements of high-density semiconductor-based microchips, various architectures have been introduced to integrate semiconductor technologies with superconducting devices. In order to realize scalable superconducting transistors, the ability to control them electrically via gate electrodes is essential. Silicon (Si), as a widely used material in semiconductor technology, offers an excellent platform for scalability in transistor applications. Implementing superconducting devices in Si could enable seamless integration with existing semiconductor technologies, minimizing additional costs and the complexity of technology transfer. Superconducting silicides, which can be epitaxially grown by annealing Si wafers coated with specific metals, avoid problems associated with large Schottky barriers at the metal-silicon interface and thus present a promising candidate for scalable Si-based superconducting devices. For instance, gate-tunable Josephson junctions could be realized by forming two silicide regions separated by a slightly doped Si region. By applying an electric field via a gate, the charge carriers in the Si region can be modulated, allowing the supercurrent to be tuned effectively.

Project description
The candidate will fabricate Silicide/Si/Silicide junctions by sputtering a suitable metal onto an intrinsic silicon layer patterned using electron beam lithography (EBL). The silicide regions will then be formed by annealing the substrate under appropriate conditions. Additionally, the candidate will employ various doping techniques to adjust the intrinsic Si region, optimizing the charge carrier concentration to enable effective gate-tuning of the carriers. The fabricated devices will be characterized at ultra-low temperatures, using a dilution refrigerator operating at a base temperature of 10 millikelvin (mK).

Prerequisites
Previous experience with cryogenics, semiconductors, superconductors and/or lithography are seen as an advantage.

4104 - Extracting many-body correlation from strongly correlated systems with machine learning

Field of study:	Physics	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Jose Lado	jose.lado@aalto.fi
Academic contact person:	Faluke Aikebaier Elizabeth Pereira	faluke.aikebaier@aalto.fi elizabeth.pereira@aalto.fi

Summary:
Correlations in many-body quantum systems are fundamental to the diverse emergent phenomena that define quantum materials, such as high-temperature superconductivity and exotic topological states. Understanding and characterizing these correlations is essential for unraveling the fundamental principles governing such systems and for advancing quantum technologies. The ability to quantify these correlations is crucial, yet experimentally measuring them in interacting systems is notoriously difficult. Traditional methods often require evaluating correlators over macroscopic samples, a task that becomes increasingly infeasible as system size and complexity grow. This limitation underscores the need for alternative approaches that can provide accurate characterizations. In this work, we aim to introduce a machine learning-based approach to develop an efficient and scalable method to extract correlations without exhaustive measurements. Our goal is to offer a practical and scalable solution for studying many-body correlations and opens new avenues for integrating machine learning into quantum materials research.

Required skills:
A foundational understanding of quantum mechanics at the undergraduate level is required, with familiarity with the Hubbard model preferred. Some programming experience in at least one high-level language, ideally Python, is also necessary. A basic knowledge of machine learning concepts is beneficial, with experience in machine learning techniques being a plus.

4105 - Quantum States in Moiré Complex Oxides

Field of study:	Physics	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Jose Lado	jose.lado@aalto.fi
Academic contact person:	Adolfo Fumega	adolfo.oterofumega@aalto.fi

Summary:
This is a project in theoretical and computational condensed matter physics, in particular in the field of moire quantum phases and complex oxides. The project can be suitable for a bachelor's thesis, a special assignment, or a master's thesis, and its difficulty can be adjusted to your level. The project will be carried out in the Correlated Quantum Materials group led by Prof. Jose Lado, and it will be co-supervised by Dr. Adolfo O. Fumega.

Background:
Complex oxides are a broad family of materials which huge potential for technological applications due to their air stability. Remarkably, the most intriguing quantum phases of matter have been found in this class of compounds. These include different sorts of magnets, charge density waves, ferrolectrics, heavy-fermions, multiferroics and the celebrated high-temperature superconductors. The recent development of experimental techniques allows now to synthesized complex oxides displaying a moire pattern. This sort of moire structural arrangement can lead to emergent quantum phases, as it has been shown for the family of van der Waals materials such as superconducting twisted bilayer graphene. However, studies in moiré complex oxides are still scarce, hindering the potential to enhance quantum phases of matter by wisely synthesizing these materials forming a specific moiré pattern.

Task:
In this project, you will model a moire complex oxide using computational techniques. You will study the system in different regimes that will be controlled with the different parameters entering the model. From this analysis, your aim will be to get a phase diagram and the physical quantities that characterize each of those phases. Your results will allow to provide the signatures of the different phases that a moiré complex oxide can realize, setting the theoretical designs for future experimental realizations in these materials.
For more details, do not hesitate to contact Dr. Adolfo O. Fumega (adolfo.oterofumega@aalto.fi)

4106 - Radiation damage modelled with two-temperature molecular dynamics

Field of study:	Physics	
For students currently studying:	Master's	
Number of positions offered:	2	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Andrea Sand	andrea.sand@aalto.fi
Academic contact person:	Andrea Sand	andrea.sand@aalto.fi

Description:
Particle irradiation modifies the physical and mechanical properties of materials, and plays an increasing role in modern technological developments. For example, climate change is driving the need for green energy, with nuclear fusion and next generation fission standing as two of the strongest candidates for efficient and reliable energy production of the future, yet the challenges posed to reactor materials in the high radiation environments are significant. Modelling provides an essential tool for predicting the response of reactor components in future nuclear devices. The damage in materials created by energetic impacting particles is highly sensitive to the mechanisms of dissipation of the impinging particle's kinetic energy. This summer project involves performing simulations employing a recently developed atomistic model, which accounts for energy dissipation in unprecedented detail, to predict the primary radiation damage in structural materials under different incident neutron and ion energies. Focus will be on analysis of the surviving damage, including defect numbers and morphology, and comparison to experiments. The student will gain knowledge of the processes of radiation damage formation in metals, learn the basics of performing molecular dynamics simulations of highly non-equilibrium events, and develop a familiarity with high performance computing environments.

Necessary skills:
Experience in programming, e.g. with Python, is highly desirable. The candidate should also have basic knowledge of solid-state physics and computational physics. Previous experience of molecular dynamics or high-performance computing is considered a plus.

4107 - Macroscopic Quantum Optics

Field of study:	Physics	
For students currently studying:	Bachelor's and Master's	
Number of positions offered:	2+	
School:	School of Science	
Department:	Department of Applied Physics	
Professor:	Anton V. Zasedatelev	anton.zasedatelev@aalto.fi
Academic contact person:	Anton V. Zasedatelev	anton.zasedatelev@aalto.fi

Description:
The newly established experimental Macroscopic Quantum Optics group offers exciting projects for Bachelor's and Master's students. Our research focuses on quantum phenomena in large-scale and complex systems, such as macroscopic quantum states of Bose-Einstein condensates (BEC). Using the advanced toolkit of quantum optics, you will learn to create light-matter BEC in the lab, even at room temperature, and contribute to achieving the first Bose-Einstein condensation of phonons and collective vibrations of matter, an experimental frontier yet to be realized.

In collaboration with our business partners at IBM and Microsoft, you will also have the opportunity to develop ultra-fast and energy-efficient optical computing technologies based on light-matter BEC, pushing beyond the state-of-the-art.

Necessary skills:
We are seeking passionate and driven BSc and MSc students with a preferable background / interest in atomic, molecular and optical (AMO) physics or quantum physics. Prior experimental experience is beneficial but not required.

Motivated students will have the chance to continue their research as PhD candidates in our group.

4201 - Toward Robust and Reliable Algorithmic Recourse

Field of study:	Artificial Intelligence, Machine Learning, Responsible AI/ML, Data-Centric AI/ML, AI and Law, AI and Society, Human Factors in AI	
For students currently studying:	Bachelor's or Master's or PhD	
Number of positions offered:	1-2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Corinna Coupette Amir-Hossein Karimi (U Waterloo)	corinna.coupette@aalto.fi a6karimi@uwaterloo.ca
Academic contact person:	Corinna Coupette	corinna.coupette@aalto.fi

As part of a collaboration between the Telos Lab at Aalto University, Finland (Corinna Coupette) and the CHARM Lab at the University of Waterloo, Canada (Amir-Hossein Karimi), we invite applications for several projects conducting **frontier research in the area of algorithmic recourse** [1]. Algorithmic recourse provides individuals with actionable steps to reverse or contest unfavorable decisions made by AI systems. By enabling affected individuals to understand and respond to automated decisions, algorithmic recourse plays a crucial role in the development of responsible artificial intelligence.

Depending on interns' preferences and skills, topics for summer projects include:

1. **Strategic behavior and robust recourse:** Design recourse mechanisms that are resilient to manipulation while still offering meaningful and actionable options to users. *(Desirable: Familiarity with game theory.)*
2. **Secure and private recourse:** Develop robust algorithms that balance the need for effective recourse with the imperative to protect against security breaches and privacy violations. *(Desirable: Familiarity with threat modeling and privacy-preserving ML techniques.)*
3. **Algorithmic recourse and law:** Analyze how algorithmic recourse relates to legal requirements (e.g., the right to an explanation) and legal procedures (e.g., judicial proceedings). *(Required: Legal background.)*
4. **Recourse in networks:** Analyze the challenges of algorithmic recourse for node-level and edge-level graph-learning tasks and develop robust algorithms for algorithmic recourse in networks. *(Required: Experience working with graphs and networks.)*
5. **Benchmarking recourse methods:** Contribute to an open-source benchmark suite for algorithmic-recourse methods (cf. our ongoing work on GitHub; [2]). *(Desirable: Experience in software-engineering.)*

Programming Languages: Python, Julia, R

Libraries/Frameworks: TensorFlow, PyTorch, Scikit-learn, game-theory libraries (e.g., Nashpy), CounterfactualExplanations.jl, CausalML, CAI Algorithmic Recourse, OpenMined (privacy-preserving ML)

Potential Tasks: Literature review; algorithm development and experimental validation; theoretical analysis; benchmark design, validation, and testing; algorithm implementation; collaboration and community engagement

References:

[1] Karimi, A.-H., Barthe, G., Schölkopf, B., & Valera, I. (2022). A Survey on Algorithmic Recourse: From Counterfactual Explanations to Interventions. *ACM Computing Surveys (CSUR)*. Link

[2] Pawelczyk, M. et al. (2021). "CARLA: A Python Library to Benchmark Algorithmic Recourse and Counterfactual Explanation Algorithms." *NeurIPS Datasets and Benchmarks*. Link

4202 - Legal Network Science

Field of study:	Network Science, Data Science, Computational Social Science, Computational Legal Studies, Artificial Intelligence and Law	
For students currently studying:	Bachelor's or Master's or PhD	
Number of positions offered:	1-2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Corinna Coupette Dirk Hartung	corinna.coupette@aalto.fi dirkhartung@smu.edu.sg
Academic contact person:	Corinna Coupette	corinna.coupette@aalto.fi

As part of a collaboration between the Telos Lab at Aalto University, Finland (Corinna Coupette) and the Center for Digital Law at Singapore Management University (Dirk Hartung), we invite applications for several projects conducting **frontier research in the area of legal network science**. Starting from the premise that legal systems are complex systems, legal network science develops and applies network methods to study the structure, function, and dynamics of legal systems [1]. To this end, we work with large amounts of legal data (from treaties, legislation, regulation, and court decisions to patents, company disclosures, administrative permits, and metadata on legal systems), which we often collect and clean ourselves using web-scraping techniques and NLP tools (see, e.g., [2]).

Depending on interns' preferences and skills, topics for summer projects include:

1. **Models and methods for multilayer legal networks.** *(Desirable: Familiarity with multilayer networks.)*
2. **Models and methods for temporal legal hypergraphs** (see [3])**.**
   (Desirable: Familiarity with hypergraphs and DAG representations of temporal networks.)
3. **Accounting for institutions or procedures in legal networks.**
   (Required: Familiarity with constitutional law or procedural law in at least one jurisdiction.)
4. **Integrating legislative, regulatory, and judicial networks.** *(Desirable: Data-engineering experience.)*
5. **Building an open research infrastructure for computational legal studies.**
   (Desirable: Data-engineering or software-engineering experience.)

All projects require comfort with computational data analysis and (1) basic knowledge of networks (e.g., from a course in network analysis or complex networks) or (2) basic knowledge of at least one legal system (e.g., from a degree program or a minor); experience in developing models, measures, or methods for data analysis is a plus.

Programming Languages: Python, Julia, R

Libraries/Frameworks: Handling dataframes, networks, databases, visualization, NLP tasks, ML tasks, scraping tasks

Potential Tasks: Literature review; data collection, data preprocessing, and data engineering; network modeling; theoretical analysis; method development and experimental validation; data analysis and data visualization; software development, validation, and testing; collaboration and community engagement

References:

[1] Ruhl, JB, Katz, DM, and Bommarito, MJ (2017). Harnessing legal complexity. *Science.* Link
[2] Coupette, C., Beckedorf, J., Hartung, D., Bommarito, MJ, and Katz, DM (2021). Measuring law over time. *Frontiers in Physics*. Link

4203 - Computational Perspectives on Democracy

Field of study:	Data Science, Computational Social Science, Computational Politics, Computational Legal Studies, HCI, Game Design	
For students currently studying:	Bachelor or Master or PhD	
Number of positions offered:	1-2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Corinna Coupette	corinna.coupette@aalto.fi;
Academic contact person:	Corinna Coupette Ali Faqeeh (Postdoc) Titus Pünder (PhD)	corinna.coupette@aalto.fi; ali.faqeeh@aalto.fi; titus.puender@aalto.fi

We invite applications for several projects **developing computational perspectives on democracy**. While modern societies and technologies have changed dramatically over the past decades, the structure and procedures of our democratic systems have remained largely unaltered. In this project, we analyze existing decision-making protocols in deliberative assemblies (such as parliaments), investigate their shortcomings, and explore potential strategies to improve democratic processes.

Depending on interns' preferences and skills, topics for summer projects include:

1. **Data science for democracy.** Analyze political and legal data, e.g., to characterize power dynamics or quantify fairness and transparency in existing policymaking systems [1], and develop methods to study domain-specific text data. *(Desirable: Experience handling complex data, esp. from law or political science)*
2. **Agent-based modeling of policymaking systems.** Simulate current policymaking systems and state-of-the-art alternatives to evaluate and compare their performance.
   (Desirable: Experience with computational modeling and simulation design)
3. **Theoretical approaches to democratic processes.** Analyze the mathematical and computational properties of existing procedures for collective decision-making [2], especially with regard to their power dynamics, fairness, and transparency, and investigate the properties of promising alternatives. *(Desirable: Experience with mathematical modeling and interest in societal applications of theoretical computer science)*
4. **Application development for experiments on collective decision-making.** Contribute to the development of an application to facilitate (gamified) experiments on collective decision-making under different policymaking systems. *(Desirable: Experience with application development, HCI, or game design)*

Programming Languages: Python (for 1., 2., and 4.), frontend-development software stack (for 4.)

Libraries/Frameworks: Handling dataframes, databases, modeling, simulation, data analysis, data visualization, NLP, data mining, ML, scraping, application development (topic-dependent)

Potential Tasks: Literature review (all); data collection, data preprocessing, and data engineering (1.); computational modeling and simulation (2.); problem formalization and theoretical analysis (3.); requirements engineering and application design (4.); method development and validation (all); data analysis and visualization (1., 2.); software development, validation, and testing (1., 2., 4.); collaboration and community engagement (all)

References:

[1] Emerson, P. ed. (2007). Designing an all-inclusive democracy: Consensual voting procedures for use in parliaments, councils and committees. Link
[2] Brandt, F. et al. (eds.) (2016). Handbook of Computational Social Choice. Link

4204 - Machine Learning: Foundations and New Frontiers

Field of study:	Machine Learning, including, but not restricted to Generative Models, Topological Methods, Geometric Learning, Representation Learning, Neural ODEs, Physics-informed Learning, Deep Learning, Large Language Models, Computational Biology, (Applied) Math, an	
For students currently studying:	Bachelor's or Master's or PhD	
Number of positions offered:	5 (approx)	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Vikas Garg	vikas.garg@aalto.fi
Academic contact person:	Vikas Garg	vikas.garg@aalto.fi vgarg@csail.mit.edu

Applications are invited for various internship positions in our group (see e.g., [1-15] below for our contributions to representation learning, graph neural networks, generative models, drug discovery, and climate prediction). An ideal student would be eager to push the frontiers of science; have strong mathematical, theoretical, statistical, or algorithmic background; and be comfortable with programming in Deep Learning. **We particularly invite students with strong Pure or Applied Math, Physics, and Biochemistry backgrounds to apply.** We also value diversity and encourage candidates from underrepresented backgrounds to apply. Indeed, our group is very diverse – previously, we have hosted interns from around the globe: e.g., universities in US such as MIT, Berkeley, Harvard, Brown; Europe such as Oxford; and Asia such as IIT Bombay.

Interns in our group from previous years have produced stellar research, resulting in multiple publications [1, 2, 3] at premier conferences including an Oral presentation at NeurIPS. Here's an article (https://shorturl.at/9ctHH) if you would like to know more about how it is working with our group.

Projects are flexible/customized to be aligned with each intern - topics of interest may include (but are not limited to):
(1) Generative Models, Neural ODEs/PDEs/SDEs
(2) Transformers, State Space Models, Large Language Models
(3) (Temporal) Graph Neural Networks, Topological Deep Learning, Topological Data Analysis (e.g., Persistent Homology)
(4) Differential Geometry/Information Geometry/Algebraic/Spectral Methods for Deep Learning
(5) Learning under limited data, distributional shift, and/or uncertainty; Conformal Prediction
(6) (Approximate) Equivariant and Invariant models
(7) Fair, interpretable, or explainable methods
(8) Reinforcement learning, multiagent systems, and AI-assisted human-guided models
(9) Applications in drug discovery, material design, climate prediction, quantum chemistry, etc.
(10) Quantum Machine Learning

Representative publications (interns marked in bold):
[1] **Brilliantov** et al. Compositional PAC-Bayes: Generalization of GNNs with persistence and beyond, NeurIPS, 2024.
[2] **Pham** and Garg. What do Graph Neural Networks learn? Insights from Tropical Geometry, NeurIPS, 2024.
[3] **Immonen**(*), Souza (*), and Garg. Going beyond persistent homology using persistent homology. NeurIPS, 2023 (Oral).
[4] Kogkalidis, Bernardy, and Garg. Algebraic Positional Encodings, NeurIPS, 2024 (Spotlight).
[5] Mercatali(*), Verma(*), et al. Diffusion Twigs with Loop Guidance for Conditional Graph Generation, NeurIPS, 2024.
[6] Karczewski, Souza, and Garg. On the Generalization of Equivariant Graph Neural Networks, ICML, 2024.
[7] Verma et al. ClimODE: Climate and Weather Forecasting with Physics-informed Neural ODEs, ICLR, 2024 (Oral).
[8] Verma, Heinonen, and Garg. AbODE: Ab initio antibody design using conjoined ODEs, ICML, 2023.
[9] Garipov et al. Compositional Sculpting of Iterative Generative Processes, NeurIPS, 2023.
[10] Alvarez-Melis(*), Garg(*), and Kalai(*). Are GANs overkill for NLP?, NeurIPS, 2022 (Spotlight)
[11] Souza, Mesquita, Kaski, and Garg. Provably expressive temporal graph networks, NeurIPS, 2022.
[12] Mercatali, Freitas, and Garg. Symmetry-induced disentanglement on graphs, NeurIPS, 2022.
[13] Garg, Jegelka, and Jaakkola. Generalization and Representational Limits of Graph Neural Networks, ICML, 2020.
[14] Ingraham, Garg, Barzilay, and Jaakkola. Generative Models for Protein Design, NeurIPS, 2019.
[15] Garg and Jaakkola. Solving graph compression via Optimal Transport. NeurIPS, 2019.

4205 - Building Game Prototype(s) to Explore Game Feel Design for Emotional Experiences

Field of study:	Computer games	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Perttu Hämäläinen	perttu.hamalainen@aalto.fi
Academic contact person:	Prabhav Bhatnagar	prabhav.bhatnagar@aalto.fi

Game Feel is the moment-to-moment experience of playing video games. One way to think about it is as a "Virtual Sensation", a composite of visual, aural and tactile feedback [1, 2, 3]. The design of game feel involves careful tuning of game parameters such as input, response, context, metaphor, rules and polish towards a desired experience[1]. This desired experience may include negative emotions which have been shown to lead to positive experiences in video games [4, 5, 6]. Though game feel has been widely understood and explored in the context of empowering experiences in action, adventure and platforming games, its design for wider emotional experiences remains unexplored. We developed a theoretical foundation to address this gap and want to support (or challenge) this theory through design and development [7]. You will be involved in brainstorming and designing game prototypes to test out the theory while maintaining a diary, adhering to research through design methods [8].

Necessary skills:

- Fundamental knowledge of Game Design principles.
- Proficiency with a game engine (Godot, Unity or Unreal preferred)
- Solid programming capability of Scripting Language used by your game engine of choice.
- Previous experience in game projects/game jams.

Preferred skills:

- Interest in a variety of video games!

References:

[1] Swink, Steve. _Game Feel: A Game Designer's Guide to Virtual Sensation_. Amsterdam ; Boston: Morgan Kaufmann Publishers/Elsevier, 2009.
[2] Pichlmair, Martin, and Mads Johansen. "Designing Game Feel. A Survey."https://doi.org/10.1109/TG.2021.3072241.
[3] _Secrets of Game Feel and Juice_, 2015. https://www.youtube.com/watch?v=216_5nu4aVQ.
[4] Bopp, Julia Ayumi, Elisa D. Mekler, and Klaus Opwis. "Negative Emotion, Positive Experience? Emotionally Moving Moments in Digital Games." https://doi.org/10.1145/2858036.2858227.
[5] Bopp, Julia A., Jan B. Vornhagen, and Elisa D. Mekler. "'My Soul Got a Little Bit Cleaner': Art Experience in Videogames." https://doi.org/10.1145/3474664.
[6] Denisova, Alena, Julia Ayumi Bopp, Thuy Duong Nguyen, and Elisa D Mekler. "'Whatever the Emotional Experience, It's Up to Them': Insights from Designers of Emotionally Impactful Games." https://doi.org/10.1145/3411764.3445286.
[7] Bhatnagar, Prabhav, Markus Laattala, Supriya Dutta, and Perttu Hämäläinen. "Understanding the Design of Emotionally Impactful Game Feel." https://doi.org/10.1145/3665463.3678781.
[8] Khaled, Rilla, Jonathan Lessard, and Pippin Barr. "Documenting Trajectories in Design Space: A Methodology for Applied Game Design Research." https://doi.org/10.1145/3235765.3235767. (edited)

4206 - Learning Movement Plans with Generative Models

Field of study:	Computer Science, Machine Learning, Data Science, Robotics, Graphics	
For students currently studying:	Master's	
Number of positions offered:	1+	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Perttu Hämäläinen	perttu.hamalainen@aalto.fi
Academic contact person:	Nam Hee Gordon Kim	namhee.kim@aalto.fi

The world is full of moving creatures performing complex movements. The ability to plan movements in a long horizon in dynamic situations is a foundational property of movement intelligence, yet modeling this ability remains an open challenge in artificial intelligence. In this work, we study and apply modern generative modeling techniques to rich motion data to equip embodied virtual agents with movement planning capabilities. In so doing, we will investigate the effect of various generative model architectures, training paradigms, and representation of perceptive information for the emergence of agentic and intelligent movement planning behaviours. We will pursue both axiomatic and practical research questions such as:

- How does long-horizon movement planning emerge via learning from motion data?
- How do various granularities and modalities of perception influence embodied agents' movement plans?
- What kind of learning architectures can capture and enable the ability to reason about plans?
- What kind of applications can we build from this to provide better tools for creative industries?

This work will build on existing motion synthesis and control work as a foundation, extending towards dynamic environments, such as interactions with moving objects and avoiding collisions with other agents, requiring flexible planning and adaptation in response to various and evolving perception modalities.

The ideal candidate should demonstrate the following background:

- Hands-on programming experience in deep reinforcement learning
- Hands-on programming experience in generative models (e.g., transformers, denoising diffusion)
- Solid academic background in machine learning, character animation, and robotics

Key references:

- Janner M, Du Y, Tenenbaum JB, Levine S. Planning with diffusion for flexible behavior synthesis. arXiv preprint arXiv:2205.09991. 2022 May 20.
- Janner M, Li Q, Levine S. Offline reinforcement learning as one big sequence modeling problem. Advances in neural information processing systems. 2021 Dec 6;34:1273-86.
- Shi Y, Wang J, Jiang X, Lin B, Dai B, Peng XB. Interactive character control with auto-regressive motion diffusion models. ACM Transactions on Graphics (TOG). 2024 Jul 19;43(4):1-4.
- Zhang Z, Liu R, Hanocka R, Aberman K. Tedi: Temporally-entangled diffusion for long-term motion synthesis. In ACM SIGGRAPH 2024 Conference Papers 2024 Jul 13 (pp. 1-11).
- Jiang B, Chen X, Liu W, Yu J, Yu G, Chen T. Motiongpt: Human motion as a foreign language. Advances in Neural Information Processing Systems. 2023 Dec 15;36:20067-79.
- Yao H, Song Z, Zhou Y, Ao T, Chen B, Liu L. Moconvq: Unified physics-based motion control via scalable discrete representations. ACM Transactions on Graphics (TOG). 2024 Jul 19;43(4):1-21.
- Shafir Y, Tevet G, Kapon R, Bermano AH. Human motion diffusion as a generative prior. arXiv preprint arXiv:2303.01418. 2023 Mar 2.

4207 - Modelling weak signals in high-dimensional neuroscientific data

Field of study:	Computer Science	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Samuel Kaski	
Academic contact person:	Anttoni Ojanperä	anttoni.ojanpera@aalto.fi

In this internship, the goal is to work on probabilistic machine learning methods to model subject-specific signals in M/EEG data, which can further be used, e.g., to assess cognitive decline. When modelling complex real-life systems, such as the human brain, a critical problem can be the weakness of interesting and valuable signals compared to other signals in the data. In addition, the data is usually extremely high-dimensional but the sample size is low. Therefore, it is crucial to develop sample-efficient methods to model these weak signals in the presence of structured noise. The problem can be approached, e.g., with Bayesian reduced-rank regression by modelling the interesting signal and the structured noise through a latent space [1]. This approach has previously been applied to MEG data to detect neural fingerprints, which represent subject-specific and stable patterns of brain activity [2, 3].

Prerequisites:
Bayesian inference, Probabilistic machine learning, multivariate regression, R, Python

References:

[1] Gillberg, J., Marttinen, P., Pirinen, M., Kangas, A. J., Soininen, P., Ali, M., Havulinna, A. S., Järvelin, M. R., Ala-Korpela, M. & Kaski, S. (2016). Multiple output regression with latent noise. Journal of Machine Learning Research, 17(122), 1-35.

[2] Haakana, J., Merz, S., Kaski, S., Renvall, H., & Salmelin, R. (2024). Bayesian reduced rank regression models generalizable neural fingerprints that differentiate between individuals in magnetoencephalography data. European Journal of Neuroscience, 59(9), 2320-2335.

[3] Leppäaho, E., Renvall, H., Salmela, E., Kere, J., Salmelin, R., & Kaski, S. (2019). Discovering heritable modes of MEG spectral power. Human brain mapping, 40(5), 1391-1402.

4208 - The leaky Pipeline in Academia

Field of study:	Computational Social Science	
For students currently studying:	Master's preferred	
Number of positions offered:	2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Barbara Keller	Barbara.keller@aalto.fi
Academic contact person:	Barbara Keller	Barbara.keller@aalto.fi

"The leaky pipeline" is a phenomenon where women disproportionately leave the workforce, particularly in STEM (Science, Technology, Engineering, and Mathematics) fields. We are interested in investigating this phenomenon in academic collaboration networks. The project involves both, mathematical reasoning investigating mathematical graph models such as the preferential attachment model, as well as real world data analysis with python.
This position is suitable for someone who has interest in the topic, mathematical analysis and coding skills (preferably in Python), familiarity with graph theory and some knowledge of social media data analysis methods. Experience with analyzing data will be a plus.

4209 - Distances in geometric (intersection) graphs

Field of study:	Theoretical computer science, geometric algorithms	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Sándor Kisfaludi-Bak	sandor.kisfaludi-bak@aalto.fi
Academic contact person:	Sándor Kisfaludi-Bak	sandor.kisfaludi-bak@aalto.fi

Geometric graphs are graphs where vertices are associated with points in some metric space (typically Euclidean space) and edges are weighted according to the distance of those points in the ambient space. In intersection graphs the vertices are associated with geometric objects (e.g., disks, squares) and edges are unweighted and they correspond to pairwise intersecting objects. In this project we will investigate the metric properties of such graphs: depending on the specific setting, we will be interested in distance computation in the graph, the possibility of finding so-called spanners (subgraphs that represent distances), or low-distortion embeddings of such graphs into other important graph metrics.

This is a theory project with no coding involved. You will be expected to write a short technical report at the end of the internship. Please only apply if you have a strong background in algorithm theory as well as in discrete mathematics or geometry. You need to be highly skilled in writing formal mathematical proofs. It will be an advantage if you have already had some exposure to computational geometry.

4210 - Approaching exascale using physics simulations with the help of machine learning

Field of study:	Computer science	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Maarit Korpi-Lagg	maarit.korpi-lagg@aalto.fi
Academic contact person:	Maarit Korpi-Lagg	maarit.korpi-lagg@aalto.fi

Our research group [1] aims at unveiling the mysteries of the magnetized universe using numerical simulations designed to efficiently run in world's largest supercomputers. Grid-based numerical solutions to model physical and engineering problems are computationally expensive, requiring large parallel calculations and integrating for many hours or even months. Particularly in astrophysics the problems under investigation can require very high resolution to resolve the turbulent dynamics which are ubiquitous in space, while also requiring massive domains to contain the large structures of interest, such as stars or galaxies, and the whole universe! **We are looking for highly motivated individuals who want to combine state-of-the-art computer science skills with exciting application domain science.**

Machine learning (ML) can help to mitigate these challenges: it can be applied to high-fidelity turbulence data to learn models. These can then be applied at coarser resolution to reproduce the small-scale effects below the resolution of the grid, hence called sub-grid-scale (SGS) models. When a successful ML model is found, it would reduce the load on the computation for modelling these large objects, while retaining the essential realistic feedback of the subgrid processes.

We have developed, together with NVAITC professionals [2], a proof-of-concept simulation-in-the-loop high performance computing pipeline to train and validate simple ML approaches to form the SGS model. While the HPC pipeline is now ready to run with top tier supercomputers such as LUMI-G [3] and the forthcoming Roihu [4], the ML techniques still require more work. **The goal of the internship is specifically to improve the ML approach. This work is of uttermost importance to enable physics simulations of this kind at exascale.**

References:

[1] Group homepage: https://www.aalto.fi/en/department-of-computer-science/astroinformatics

[2] NVAITC homepage: https://fcai.fi/nvaitc

[3] LUMI documentation: https://docs.lumi-supercomputer.eu

[4] Roihu, the forthcoming Finnish supercomputer: https://csc.fi/en/media-release/significant-investment-in-science-finland-renews-its-national-supercomputer/

4211 - The DNAforge design tool for nucleic acid nanostructures

Field of study:	Computer Science / Computational Biology	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1-2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Pekka Orponen	pekka.orponen@aalto.fi
Academic contact person:	Pekka Orponen	pekka.orponen@aalto.fi

DNAforge (https://dnaforge.org) is a fully automated, user-friendly online design tool for DNA and RNA wireframe nanostructures [1, 2, 3]. To create a nanostructure design, the user simply uploads a 2D or 3D mesh model of the targeted structure and chooses the desired design approach, together with some parameters such as the preferred nanometer scale of the structure. The tool then performs the complex task of creating a system of DNA or RNA strands which, when synthesised, will fold to the target structure in nanoscale.

The tool was launched in Spring 2024 [4] and is attracting increasing attention in the DNA nanotechnology community. The main task in this summer project is to augment the tool with support for some currently topical research directions, such as the design of RNA:DNA hybrid nanostructures [5] and co-transcriptionally folding RNA nanostructures.

The project requires familiarity with basic algorithm design techniques, facility with combinatorial thinking, and good programming skills. Knowledge of biomolecules is not necessary, but familiarity with Javascript (or willingness to learn) is a prerequisite. For further information about our work, please see the research group webpage at https://research.cs.aalto.fi/nc/.

[1] https://en.wikipedia.org/wiki/DNA_nanotechnology
[2] https://doi.org/10.1007/s11047-017-9647-9
[3] https://doi.org/10.1021/acsnano.2c06035
[4] https://doi.org/10.1093/nar/gkae367
[5] https://doi.org/10.1038/s41467-023-36156-1

4212 - Positions in Probabilistic Machine Learning

Field of study:	Computer science, Machine learning	
For students currently studying:	Master's	
Number of positions offered:	2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Arno Solin	arno.solin@aalto.fi
Academic contact person:	Mohammad Vali	mohammad.vali@aalto.fi

We are seeking motivated and talented interns to join our current research projects focused on probabilistic machine learning with positions in tractable modelling, uncertainty quantification in deep learning, and multi-modal (computer vision + language) modelling. This project is part of our broader initiative aiming to advance the frontiers of understanding and develop novel methods in the field of machine learning. More specifically, the research interests are in uncertainty quantification in large-scale machine learning models, as well as combining semantic understanding with scene reconstruction (Gaussian splatting / NeRF models).

Interns will have the opportunity to work on cutting-edge research problems, including uncertainty quantification in neural networks and the development of innovative inference methods. Our team values creativity, analytical skills, and a collaborative spirit. A successful candidate is expected to have knowledge of probabilistic modelling and approximate inference, and general machine learning methods as well as experience with programming in Python (e.g., TensorFlow, JAX, PyTorch, etc.).

This internship presents a unique opportunity to contribute to significant research in a dynamic and supportive environment. We encourage students who are enthusiastic about probabilistic modelling and have a keen interest in language models and computer vision to apply. Highlight your specific skills and interests in your application to align with our team's needs.

See the supervisor's home page for representative publications: https://arno.solin.fi

4213 - Theory of distributed and parallel computing

Field of study:	Theoretical computer science	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Jukka Suomela	jukka.suomela@aalto.fi
Academic contact person:	Jukka Suomela	jukka.suomela@aalto.fi

Our research group "Distributed Algorithms" is looking for a summer intern to help us with our research related to the theoretical foundations of distributed and parallel computing. We expect a good understanding of mathematics (especially in discrete math and graph theory) and algorithms and theoretical computer science. We also often try to outsource our work to computers, so if you have good programming skills and/or some knowledge of e.g. SAT solvers or proof assistants, it is a plus. We have also exciting opportunities for those who are interested in quantum computation in the distributed setting. For more information, see https://research.cs.aalto.fi/da/

4214 - Bayesian workflow

Field of study:	Bayesian computational modeling	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Aki Vehtari	aki.vehtari@aalto.fi
Academic contact person:	David Kohns	david.kohns@aalto.fi

You will take part in developing computational diagnostic tools for different parts of Bayesian workflow (see, e.g. https://arxiv.org/abs/2011.01808). Possible more specific topics include model checking diagnostics, cross-validation, better priors, inference diagnostics.

Prerequisites: Bayesian inference and MCMC.

4215 - Distributed training of LLMs with reinforcement learning from human feedback (RLHF)

Field of study:	Deep Learning, Reinforcement Learning, Distributed systems, Machine learning systems	
For students currently studying:	Master's	
Number of positions offered:	1-2	
School:	School of Science	
Department:	Department of Computer Science	
Professor:	Bo Zhao	bo.zhao@aalto.fi
Academic contact person:	Tuo Shi	tuo.shi@aalto.fi

Topic: RLHF has enabled language models to begin to align a model trained on a general corpus of text data to that of complex human values. RLHF's most recent success was its use in ChatGPT (GPT-4), LLama 3 and Gemini. RLHF training requires sophisticated distribution policies to execute multiple LLMs and their interactions on large GPU clusters.

Task: This summer research project aims to answer the question "how to co-design multiple layers of the software/system stack to improve the scalability and performance of RLHF systems". Specifically, it addresses the challenges to build:

1. flexible distributed training systems to accelerate and parallelize the RLHF training loop,
2. statement management for GPU device allocation, multi-dimensional parallelism, and mixture of experts (MoE) training,
3. holistic end-to-end training pipelines,
4. the selected candidate will have the chance to develop such systems (across thousands of GPUs) on the LUMI supercomputer, Europe's fastest supercomputer.

The project aims at publishing at top-tier conferences with solid open-source software.

Necessary skills:

- Solid knowledge of computer systems (e.g., distributed systems, data management systems, compilers).
- Familiar with machine learning frameworks including PyTorch, TensorFlow, Megatron-LM, DeepSpeed.
- Familiar with HPC environments.
- Knowledge of distributed ML training using Ray.
- Solid programming capability of C++, Python, Go and/or Rust, etc.
- Strong analytical thinking skills.
- Excellent scientific communication and writing skills.

Preferred skills:

- Publications on top system venues or industry internship experience of distributed ML systems.
- Knowledge of quantum machine learning is a plus – we are building ML systems for quantum computers.

Department of Industrial Engineering and Management

4301 - Incentivizing globally sustainable production in the local environment

Field of study:	Operations Management	
For students currently studying:	Master's (or late Bachelor's) preferable	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Industrial Engineering and Management	
Professor:	Jan Holmström	jan.holmstrom@aalto.fi
Academic contact person:	Esko Hakanen	esko.hakanen@aalto.fi

The intern will get an opportunity to participate in a multidisciplinary research project work hands-on. The work will support subsequent academic publication. The scope of the work will be adjusted to fit the chosen candidate's capabilities and interest, but the aim is that the internship enables the candidate to participate and contribute to the writing process of an academic research article. In short, the internship will provide a "crash course" on qualitative management research.

The project connects to and builds on the ongoing research projects on facilitating more sustainable practices in the plastics industry: ValueBioMat and PlastLIFE. ValueBioMat has focused on the value-added potential of bio-based materials and the means to substitute fossil-based raw materials with renewable alternatives (https://valuebiomat.fi). PlastLIFE promotes national cooperation with the goal of enabling a sustainable circular economy for plastics in Finland by 2035 (https://www.materiaalitkiertoon.fi/en-US/PlastLIFE).

The internship provides the candidate an opportunity to participate in these projects by considering the practices for "***Incentivizing globally sustainable production in the local environment***". In essence, the work focuses on the means for supporting the transition toward more sustainable practices in the plastics industry. The internship provides an opportunity to contribute to the "carbon-transfer model," an input-output system model for the plastics industry that has been developed at Aalto University, aimed on differentiating sustainable practices (to be supported) from unsustainable ones (to be discouraged). We wish that the candidate can help us in evaluating the ideas derived from these ongoing projects in the Finnish context and reconsider the applicability of the research results and implications in their local context (in the originating country). Hence, the internship provides a valuable opportunity on both sides and the research projects involved.

In practice, some of the tasks planned for the internship are:

- Finding, reading, and summarizing academic research articles on a timely topic
- Searching for and synthesizing information regarding the problem space at the candidate's home context
- Comparing and discussing the key observations with colleagues
- Synthesizing the results in the academic form, developing the argumentation
- Participation to the writing of an academic research paper (aimed to a sustainability-themed conference) that will be subsequently peer-reviewed

The most important requirement for an applicant is the internal drive and motivation to participate in academic research. The candidate should be confident in working in a team of diverse backgrounds and disciplines. Success relies on an ability to read, comment, and write text to develop argumentation in collaboration with the research team members. Knowledge on qualitative research practices (e.g., data analysis and coding) is considered a benefit. Yet, prior experiment on research is not a prerequisite – personal interest and capacity to absorb and assimilate knowledge on a fast pace is far more important.

It is possible to continue to the collaboration after the internship should the applicant wishes to do so.

4302 - Digital transformation of manufacturing and operations

Field of study:	Industrial Engineering and Management	
For students currently studying:	Bachelor's or Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Industrial Engineering and Management	
Professor:	Siavash H. Khajavi	Siavash.khajavi@aalto.fi
Academic contact person:	Siavash H. Khajavi	Siavash.khajavi@aalto.fi

The research will explore the digital transition in the context of industrial operations and manufacturing, focusing on novel technologies. This multidisciplinary approach will cover topics such as the impact evaluation of autonomous humanoid robots, industrial additive manufacturing, digital twins, blockchain-enabled technologies, and large language & vision models (LVLM). The aim is to understand their combined impact on the future of operations and supply chain management and industrial operations.

Skills:

- Strong analytical and problem-solving skills.
- Excellent written and verbal communication skills in English.

Responsibilities:

- Conducting supervised research in the field of industrial engineering and management.
- Collaborating with other researchers, industry partners, and stakeholders.
- Developing research and publication skills.

4303 - A system dynamic model for analyzing dynamics of technology markets

Field of study:	Industrial Engineering and Management	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Industrial Engineering and Management	
Professor:	Kimmo Karhu	kimmo.karhu@aalto.fi
Academic contact person:	Kimmo Karhu	kimmo.karhu@aalto.fi

We are seeking to hire one summer intern to work on system dynamic modelling of technology-driven markets. We have two potential topics for the intern:

1. Platform competition between X (Twitter), Bluesky, Threads, and Mastodon

We are witnessing turbulent times in social media dynamics. X has been in trouble for the past years, but the competing platforms have so far been unable to gain significant market share. In this project, you would build a system dynamic model for platform competition and evaluate it by calibrating the model with the data available for the above social media platforms. For the baseline single platform growth model, see:
Karhu, K., Heiskala, M., Ritala, P., Thomas, L.D.W., 2024. Positive, Negative, and Amplified Network Externalities in Platform Markets. AMP 38, 349–367. https://doi.org/10.5465/amp.2023.0119

2. Techno-economic analysis of an emerging regional hydrogen market

Hydrogen economy is envisioned to help societies in green transition and cutting the CO2 emissions. Finland and the Baltic Sea region are in great position to be fore runners in hydrogen economy. In this project, you would conduct a techno-economic analysis for a regional hydrogen valley being built in Baltic Sea region. You would collaborate with a Horizon 2020 funded project for which we have already built a baseline model for Finland. Your task would be to refine the model for the broader Baltic Sea region, collect the necessary data for the analysis with the help of project participants, and conduct an initial techno-economic analysis of the market. For more information about the BalticSeaH2 project, see: https://balticseah2valley.eu/

We expect applicant to be genuinely interested in mathematical modelling and having experience in either system dynamic modelling and/or working with systems of differential equations. We use Vensim and R as tools for the modelling and analysis. You would join a supportive small research group studying digitalization, platform economy, and their dynamics at the department of industrial engineering and management.

More information about the department:
https://www.aalto.fi/en/department-of-industrial-engineering-and-management

4501 - Cognitive Neuroimaging with naturalistic stimuli

Field of study:	Cognitive neuroscience	
For students currently studying:	Master's	
Number of positions offered:	1	
School:	School of Science	
Department:	Department of Neuroscience and Biomedical Engineering	
Professor:	Iiro Jääskeläinen	Iiro.jaaskelainen@aalto.fi
Academic contact person:	Iiro Jääskeläinen	Iiro.jaaskelainen@aalto.fi

In the Brain and Mind Laboratory at the Department of Neuroscience and Biomedical Engineering, we have a long track record of using naturalistic stimuli such as movies to study higher cognitive functions, especially social cognition and emotions. In the coming summer, we plan to extend this to video games where the experimental subjects are active agents making decisions in social contexts during functional magnetic resonance imaging of brain activity. This way, we will be able to disclose how the brain supports social cognitive and emotional processing in a simulated naturalistic environment. While the studies will be conducted in healthy participants the results contribute basic research insights that will also pave way for clinical research.

The summer intern would most preferably have previous studies and keen interest in both cognitive neuroscience, especially in the area of social cognition and emotions, and machine learning data analysis methods. Previous experienced with functional magnetic resonance imaging is a plus.