Tairan He

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Summary

Research Interests: My research primarily lies in **machine learning** and **control theory**. My goal is to **build intelligent agents that are effective (beyond human-level performance) and with guarantees (stability, safety, robustness)**, bridging learning and control in a unified framework.

Highlight: 5 years of programming experience; 3 years of research experience with solid mathematical and theoretical background; 1 year of experience with real robotic platforms (Kinova gen3 and Rosbot 2.0 pro).

Relevant Courses: Machine Learning (A), Artificial Intelligence (A), Linear and Convex Optimization (A), Design and Analysis of Algorithms (A-), Information Theory (A-), Computer Systems Engineering (A), Probability and Stochastic Process (A-), Parallel and Distributed Programming (A), Data Mining (A), Engineering for Electronic Information (A), Mobile Internet (A).

Education

Shanghai Jiao Tong University   *Shanghai, China*
BACHELOR'S OF ENGINEERING (B.ENG.) IN COMPUTER SCIENCE   *Sep. 2018 - Jun. 2023 (expected)*
- Member of **IEEE Honors Class**, an elite CS program.
- Major GPA (CS/EE cources): **3.82/4**, **90.29/100**; Overall GPA: 3.65/4, 87.55/100

Carnegie Mellon University   *Pittsburgh, USA*
VISITING STUDENT IN INTELLIGENT CONTROL LAB AT ROBOTICS INSTITUTE   *Jan. 2022 - Jan. 2023 (expected)*
- Host: Prof. Changliu Liu

Publications (*equal contribution)

CONFERENCE PROCEEDINGS

[C8] State-wise Safe Reinforcement Learning: A Survey.
Weiye Zhao, **Tairan He**, Rui Chen, Tianhao Wei, Changliu Liu.
IJCAI (Survey Track), 2023. [Paper]

[C7] Probabilistic Safeguard for Reinforcement Learning Using Safety Index Guided Gaussian Process Models.
Weiye Zhao*, **Tairan He***, Changliu Liu.
L4DC, 2023. [Paper]

[C6] Visual Imitation Learning with Patch Rewards.
Minghuan Liu, **Tairan He**, Weinan Zhang, Shuicheng Yan, Zhongwen Xu.
ICLR, 2023. [Paper]

[C5] Safety Index Synthesis via Sum-of-Squares Programming.
Weiye Zhao*, **Tairan He***, Tianhao Wei, Simin Liu, Changliu Liu.
ACC, 2023. [Paper]

[C4] AutoCost: Evolving Intrinsic Cost for Zero-violation Reinforcement Learning.
Tairan He, Weiye Zhao, Changliu Liu.
AAAI, 2023. [Paper]

[C3] Reinforcement Learning with Automated Auxiliary Loss Search.
Tairan He, Yuge Zhang, Kan Ren, Minghuan Liu, Che Wang, Weinan Zhang, Yuqing Yang, Dongsheng Li.
NeurIPS, 2022. [Paper]

[C2] Model-free Safe Control for Zero-Violation Reinforcement Learning.
Weiye Zhao, **Tairan He**, Changliu Liu.
CoRL, 2021. [Paper]

[C1] Energy-Based Imitation Learning.
Minghuan Liu, **Tairan He**, Minkai Xu, Weinan Zhang.
AAMAS **(Oral)**, 2021. [Paper]

Professional Services

2023   **Program Chair Member/Reviewer**, Learning for Dynamics & Control Conference (L4DC)
2022   **Program Chair Member/Reviewer**, AAAI Conference on Artificial Intelligence (AAAI)
2022   **Program Chair Member/Reviewer**, Conference on Robot Learning (CoRL)

Skills

Programming	C/C++, Python, LaTeX, JAVA, Node.js, Wolfram Language, SQL, Linux, MATLAB, PHP
Frameworks	PyTorch, Tensorflow, NumPy, Flask, MySQL, Git, Anaconda, OpenCV.
Platforms	Kinova, Rosbot.

Research Experience

Carnegie Mellon University *Pittsburgh, USA*
RESEARCH ASSISTANT AT INTELLIGENT CONTROL LAB, ADVISED BY PROF. CHANGLIU LIU *Jan. 2022 - Present*
- **Research Topics**: safe reinforcement learning, safe control, control theory.
- Proposed a model-free safe control strategy to synthesize safeguards for DRL agents, which will ensure zero safety violation during training. Proposed an implicit safe set algorithm, which synthesizes the safety index (also called the barrier certificate) and the subsequent safe control law only by querying a black-box dynamic function (e.g., a digital twin simulator) [C2].
- Analyzed the failure of safe RL for not achieving zero cost, which suggests that a proper cost function plays an important role in constrained RL. Proposed AutoCost, an effective framework that automatically searches for cost functions that help constrained RL to achieve zero-violation safety [C4].
- Proposed a model learning and safe control framework to safeguard any RL agent, where its dynamics are learned as Gaussian processes [C7].
- Proposed a framework for synthesizing the safety index for general control systems using sum-of-squares programming. Showed that ensuring the non-emptiness of safe control on the safe set boundary is equivalent to a local manifold positiveness problem. We then prove that this problem is equivalent to sum-of-squares programming via the Positivstellensatz of algebraic geometry [C5].

Microsoft Research *Shanghai, China*
RESEARCH INTERN, ADVISED BY KAN REN AND YUGE ZHANG *Mar. 2021 - Dec. 2021*
- **Research Topics**: auto ML, reinforcement learning.
- Proposed a principled and universal method for learning better representations with auxiliary loss functions, named Automated Auxiliary Loss Search (A2LS), which automatically searches for top-performing auxiliary loss functions for RL. The discovered auxiliary loss (A2-winner) significantly improves the performance on both high-dimensional (image) and low-dimensional (vector) unseen tasks with much higher efficiency, showing promising generalization ability to different settings and even different benchmark domains [C3].

Shanghai Jiao Tong University *Shanghai, China*
RESEARCH ASSISTANT AT APEX LAB, ADVISED BY PROF. WEINAN ZHANG *Jul. 2019 - Present*
- **Research Topics**: reinforcement learning, imitation learning.
- Proposed a two-step solution for imitation learning: first estimate the energy of expert's occupancy measure, and then take the energy to construct a surrogate reward function as a guidance for the agent to learn the desired policy [C1].
- Proposed an efficient visual imitation learning method, PatchAIL, to learn explainable patch-based rewards that measure the expertise of different local parts of given images [C6].

Project Portfolio (Selected)

SJTU Anonymous Forum *Shanghai, China*
FOUNDER & DEVELOPER. [ANDROID CODE] / [IOS CODE] / [FAREWELL VIDEO] *Feb. 2020 - Apr. 2021*
- Develoed a care-free forum platform for SJTU students to share and talk using anonymous identities.
- More than **10000+** users used this app in the SJTU campus.

Stock Analysis System *Shanghai, China*
FOUNDER & DEVELOPER. [CODE] *Sep. 2019 - Jan. 2020*
- Developed a stock website to visualize the stock market and share stock news, providing analysis and predictions using unsupervised learning.

Mapmatic Academic System *Shanghai, China*
FOUNDER & DEVELOPER. [CODE] *Feb. 2019 - Jun. 2020*
- Developed a visualization for the academic system, which discovered connections and evolving features among researchers and papers using big data of academic literature.

Honors and Awards (Selected)

2021	**Microsoft Star of Tomorrow**, top-performing interns at Microsoft.
2020	**Shanghai Jiao Tong University Excellent Scholarship**, top 10% students in SJTU.
2019	**Zhiyuan Honorary Scholarship**, top 5% students in SJTU.