Tairan **He**

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Education

Shanghai Jiao Tong University — *Shanghai, China*

Bachelor of Engineering (B.Eng.) in Computer Science — *Sep. 2018 - Jun. 2023 (expected)*

- Member of **IEEE Honors Class**, which is an elite CS program for talented students.
- Overall GPA: 3.65/4, 87.55/100, Major GPA: **3.82/4**, **90.29/100**
- Relevant courses: CS385 Machine Learning (A), EI339 Artificial Intelligence (A), CS257 Linear and Convex Optimization (A), CS222 Design and Analysis of Algorithms (A-), CS258 Information Theory (A-), EI338 Computer Systems Engineering (A), MA227 Probability and Stochastic Process (A-), CS433 Parallel and Distributed Programming (A), EE359 Data Mining Techniques (A), EE208 Engineering for Electronic Information (A), EE447 Mobile Internet (A).

Carnegie Mellon University — *Pittsburgh, PA, USA*

Visiting student in Intelligent Control Lab at Robotics Institute — *Jan. 2022 - Jan. 2023 (expected)*

- Advisor: Prof.Changliu Liu

Research Interests

My research primarily lies in **learning** and **control**. My goal is to **build intelligent agents that are effective (beyond human-level performance) and with guarantees (safety)**. Currently, I concentrate on algorithms designs for reinforcement learning towards real-world applications including safe reinforcement learning / imitation learning / representation learning for RL.

Publications (*equal contribution)

Visual Imitation Learning with Patch Rewards (Blog) — *Under review*

Minghuan Liu*, **Tairan He***, Weinan Zhang, Shuicheng Yan, Zhongwen Xu

- 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.

Safety Index Synthesis via Sum-of-Squares Programming (PDF) — *Under review*

Weiye Zhao*, **Tairan He***, Tianhao Wei, Simin Liu, Changliu Liu

- 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.

AutoCost: Evolving Intrinsic Cost for Zero-violation Reinforcement Learning — *Under review*

Tairan He, Weiye Zhao, Changliu Liu

- 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.

Probabilistic Safeguard for Reinforcement Learning Using Safety Index Guided Gaussian Process Models (PDF) — *Under review*

Weiye Zhao*, **Tairan He***, Changliu Liu

- Proposed a model learning and safe control framework to safeguard any RL agent, where its dynamics are learned as Gaussian processes.

Reinforcement Learning with Automated Auxiliary Loss Search (PDF) — *NeurIPS 2022*

Tairan He, Yuge Zhang, Kan Ren, Minghuan Liu, Che Wang, Weinan Zhang, Yuqing Yang, Dongsheng Li

- 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.

Model-free Safe Control for Zero-Violation Reinforcement Learning (PDF) — *CoRL 2021*

Weiye Zhao, **Tairan He**, Changliu Liu

- 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).

Energy-Based Imitation Learning (PDF) — *AAMAS 2021 (oral)*

Minghuan Liu, **Tairan He**, Minkai Xu, Weinan Zhang

- 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.

Experience

Carnegie Mellon University — *Pittsburgh, PA, USA*

Research Intern at Intelligent Control Lab, advised by Prof.Changliu Liu — *Jan. 2022 - Present*

- Research topic: safe reinforcement learning, safe control, control theory.
- Worked on paper on synthesizing safeguards for DRL agents, which will ensure zero safety violation during training.
- Worked on paper on integrating model learning and safe control framework to safeguard any RL agent, where its dynamics are learned as Gaussian processes.
- Worked on paper on driving safe RL algorithms achieve zero safety violation after convergence with automated cost functions.
- Worked on paper on synthesizing the safety index for general control systems using sum-of-squares programming.

Microsoft Research — *Shanghai, China*

Research Intern, advised by Kan Ren and Yuge Zhang — *Mar. 2021 - Dec. 2021*

- Research topic: auto ML, reinforcement learning.
- Worked on paper on AutoRL to search for better auxiliary losses for representation learning of RL.

Shanghai Jiao Tong University — *Shanghai, China*

Research Intern at APEX Lab, advised by Prof.Weinan Zhang — *Jul. 2019 - Present*

- Research topic: reinforcement learning, imitation learning.
- Worked on paper on imitating the expert by estimating the energy of the 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.
- Worked on paper on efficient visual imitation learning by learning explainable patch-based rewards that measure the expertise of different local parts of given images.

Projects

SJTU Anonymous Forum — *Shanghai, China*

Founder & Developer. Android Code / iOS Code / Farewell Video — *Feb. 2020 - Apr. 2021*

- Develoed a carefree forum platform for SJTUers sharing and talking with anonymous identity.
- 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 portal website that visualizes stock market information and summarizes story news, giving analysis and predictions by unsupervised learning.

Mapmatic Academic System — *Shanghai, China*

Founder & Developer. Code — *Feb. 2019 - Jun. 2020*

- Developed a visualized academic system which fully discovered the connection and its evolving feature among researchers and papers in big scholarly data.

Academic Services

2022 **PC member/Reviewer**, AAAI Conference on Artificial Intelligence (AAAI) 2023

2022 **PC member/Reviewer**, Conference on Robot Learning (CoRL) 2022

Skills

Programming C/C++, Python, LaTeX, JAVA, Node.js, Wolfram Language, SQL, Linux, MATLAB, PHP

Tools PyTorch, Tensorflow, NumPy, Flask, MySQL, Git, Anaconda, OpenCV.