

# Tairan He

☎ (+1) 412-999-3458 | ✉ tairanhe1999@gmail.com | 🌐 tairanhe.com | 📷 TairanHe

## 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 (safety)**, bridging learning and control in a unified framework. Currently, I concentrate on algorithms designs for reinforcement learning towards real-world applications including safe reinforcement learning / imitation learning / representation learning for RL.

**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).

**Coursework:** 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

BACHELOR OF ENGINEERING (B.ENG.) IN COMPUTER SCIENCE

Shanghai, China

Sep. 2018 - Jun. 2023 (expected)

- Member of **IEEE Honors Class**, an elite CS program.
- Major GPA (CS/EE courses): **3.82/4, 90.29/100**; Overall GPA: 3.65/4, 87.55/100

### Carnegie Mellon University

VISITING STUDENT IN **INTELLIGENT CONTROL LAB** AT ROBOTICS INSTITUTE

Pittsburgh, USA

Jan. 2022 - Jan. 2023 (expected)

- Host: [Prof.Changliu Liu](#)

## Publications (\*equal contribution)

### PREPRINTS

#### [1] Visual Imitation Learning with Patch Rewards.

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

Under Review [\[Web\]](#)

#### [2] Safety Index Synthesis via Sum-of-Squares Programming.

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

Under Review [\[Paper\]](#)

#### [3] Probabilistic Safeguard for Reinforcement Learning Using Safety Index Guided Gaussian Process Models.

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

Under Review [\[Paper\]](#)

### CONFERENCE PROCEEDINGS

#### [4] AutoCost: Evolving Intrinsic Cost for Zero-violation Reinforcement Learning.

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

AAAI, 2023. [\[Paper \(Coming Soon\)\]](#)

#### [5] 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. [\[Paper\]](#)

#### [6] Model-free Safe Control for Zero-Violation Reinforcement Learning.

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

CoRL, 2021. [\[Paper\]](#)

#### [7] Energy-Based Imitation Learning.

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

AAMAS (**Oral**), 2021. [\[Paper\]](#)

## Professional Services

2022 **Program Chair Member/Reviewer**, AAAI Conference on Artificial Intelligence (AAAI) 2023

2022 **Program Chair Member/Reviewer**, Conference on Robot Learning (CoRL) 2022

## Skills

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

## Research Experience

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### 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) [6].
- 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 [4].
- Proposed a model learning and safe control framework to safeguard any RL agent, where its dynamics are learned as Gaussian processes [3].
- 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 [2].

### Microsoft Research

Shanghai, China

RESEARCH ASSISTANT, 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 [5].

### 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 [7].
- 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 [1].

## Project Portfolio (Selected)

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### SJTU Anonymous Forum

Shanghai, China

FOUNDER & DEVELOPER. [\[ANDROID CODE\]](#) / [\[IOS CODE\]](#) / [\[FAREWELL VIDEO\]](#)

Feb. 2020 - Apr. 2021

- Developed a carefree forum platform for SJTUs 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 website to visualize stock market 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 discovered the connection and its evolving feature among researchers and papers in scholar big data.

## Honors and Awards (Selected)

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- 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.