Kai-Chieh Hsu

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I work on combining game-theoretic reasoning and machine learning techniques for safe human-centered robotic systems.

Experience

Machine Learning Research Scientist

Mountain View, CA

Nuro Inc. (Manager: Matt Sarett)

July 2024 - PRESENT

Research Assistant

Princeton, NJ

Princeton University, Safe Robotics Laboratory (Advisor: Jaime Fernández Fisac)

Aug. 2020 - May 2024

My work applies algorithmic and theoretical techniques from machine learning, control theory, and game theory to ensure the safety of learning-enabled autonomous systems. These algorithms scale to high-order dynamic systems and can handle complex deployment conditions. Additionally, they systematically unify the autonomy stack to prevent unwarranted conservativeness.

Engineering Intern

San Diego, CA

Qualcomm Research (Manager: Stephen Chaves, Mentor: Pranav Desai)

May 2023 - Aug. 2023

I Proposed a **unified neural backbone** for agent predictor and behavior planner in autonomous vehicles software stack and used reinforcement learning and imitation learning for implementing behavior planners.

Research Scientist Intern

Remote

NVIDIA Research, Autonomous Vehicle (Manager: Prof. Marco Pavone, Mentor: Prof. Karen Leung, Yuxiao Chen)

May 2022 - Dec. 2022

I Formalized **responsibility** by safety margin decrease and policy shift with **counterfactual reasoning** and estimated the responsibility level online with **hidden Markov model**. I incorporated the estimated responsibility into **trajectory prediction** models to improve prediction accuracy and interpretability.

Education

Princeton University

Princeton, NJ

Ph.D. in Electrical and Computer Engineering

Sept. 2021 - May 2024

M.A. in Electrical and Computer Engineering

Sept. 2019 - May 2021

- Concentration: Machine learning and Robotics
- 4.0/4.0 GPA
- Advisor: Prof. Jaime Fernández Fisac
- Thesis: Scaling Full-Stack Safety for Learning-Enabled Robot Autonomy

National Taiwan University

Taipei, Taiwan

B.S. in Electrical Engineering

Sept. 2014 - Jan. 2019

- Concentration: Signal processing and Digital IC design
- 4.19/4.30 GPA and ranked in **top 10** of the class
- Research Advisors: Prof. An-Yeu (Andy) Wu and Prof. Jean-Fu Kiang

Selected Publications

Journal Papers

[J1] **K.-C. Hsu**, Haimin Hu, and J. F. Fisac, The Safety Filter: A Unified View of Safety-Critical Control in Autonomous Systems, in*Annual Review of Control, Robotics, and Autonomous Systems,*Feb 2024.

[J2] A. R. Kumar, **K.-C. Hsu**, P. J. Ramadge, and J. F. Fisac, Fast, Smooth, and Safe: Implicit Control Barrier Functions through Reach-Avoid Differential Dynamic Programming, in*IEEE Control Systems Letters,*vol. 7, pp. 2994-2999, June 2023.

[J3] **K.-C. Hsu***, A. Z. Ren*, D. P. Nguyen, A. Majumdar^{+}, and J. F. Fisac^{+}, Sim-to-Lab-to-Real: Safe Reinforcement Learning with Shielding and Generalization Guarantees, in*Artificial Intelligence,*Jan 2023. | Spotlight in ICLR Workshop and NeurIPS Workshop

[J4] C.-Y. Chou, **K.-C. Hsu**, B.-H. Cho, K.-C. Chen, and A.-Y. (Andy) Wu, Low-Complexity On-demand Reconstruction for Compressively Sensed Problematic Signals, in*IEEE Transactions Signal Processing,*vol. 68, pp. 4094-4107, July 2020.

Conference Papers

[C1] H. Hu, K. Nakamura, **K.-C. Hsu**, N. E. Leonard, and J. F. Fisac, Emergent Coordination through Game-Induced Nonlinear Opinion Dynamics, in*Proc. IEEE Conf. Decision and Control,*Singapore, Dec 2023.

[C2] **K.-C. Hsu**, K. Leung, Y. Chen, J. F. Fisac, and M. Pavone, Interpretable Trajectory Prediction for Autonomous Vehicles via Counterfactual Responsibility, in*IEEE/RSJ Int. Conf. Intelligent Robots & Systems,*Detroit, MI, USA, Oct 2023.

[C3] **K.-C. Hsu***, D. P. Nguyen*, and J. F. Fisac, ISAACS: Iterative Soft Adversarial Actor-Critic for Safety, in*Learning for Dynamics & Control,*Philadelphia, PA, USA, Jun 2023.

[C4] H. Chen, **K.-C. Hsu**, W. Turner, P.-H. Wei, K. Zhu, D. Pan, and H. Ren, Reinforcement Learning Guided Detailed Routing for FinFET Custom Circuits, in*Proc. Int. Symp. Physical Design,*Virtually, Mar 2023.

[C5] **K.-C. Hsu***, V. Rubies-Royo*, C. J. Tomlin, and J. F. Fisac, Safety and Liveness Guarantees through Reach-Avoid Reinforcement Learning, in*Proc. Robotics: Science and Systems,*Virtually, July 2021.

Awards and Honors

Hon Hai Technology Award — Hon Hai Education Foundation, Taiwan
Rewarding outstanding performance in robotics — June 2024

Bede Liu Fund for Excellence — Princeton University, NJ
Oct. 2023, Mar. 2024

Travel Grant — Princeton University, NJ
From the School of Engineering and Applied Science — Nov. 2022

Teaching Assistant Award — Princeton University, NJ
For the new *Intelligent Robotic Systems* course — Sept. 2022

3rd Prize in Integrated Circuit Design Contest — Ministry of Education, Taiwan
Out of about 300 teams — July 2018

2nd Prize in Taiwan Creative Electromagnetic Implementation Competition — High-speed RF and mm-Wave Tech. Center, Taiwan
Under the supervision of Prof. Tzong-Lin Wu | — Aug. 2017

8th place in Cadence Data Structure and Programming Contest — Taipei, Taiwan
Out of about 250 students — Mar. 2017

Graduate Representative — National Taiwan University, Taiwan
Top ten students in the Department of Electrical Engineering — June 2018

Professor Chun-Hsiung Chen Scholarship — Electromagnetic Industry-Academia Consortium, Taiwan
Rewarding outstanding performance in electromagnetic research — Jan. 2018

Dean's List — National Taiwan University, Taiwan
June 2014, June 2016

Invited Talks

USC, Safe and Intelligent Autonomy Lab — Los Angeles, CA
Title: Scaling Systematic Safety for Learning-Enabled Robot Autonomy — Mar. 2024

Creative Convergence Workshop — Princeton, NJ
Title: Safe Learning-Based Control — Oct. 2023

IROS Workshop on Formal Methods Techniques in Robotics Systems: Design and Control — Detroit, MI
Title: Role of Safety: from Safety-Critical Control to Safety-Informed Motion Forecasting — Oct. 2023

References

Jaime Fernández Fisac
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Anirudha Majumdar
Assistant Professor, Mechanical and Aerospace Engineering, Princeton University
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Karen Leung
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Research Scientist, Autonomous Vehicle Research, NVIDIA
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Peter Ramadge
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