

Hao-Lun Hsu

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Education

Duke University

Ph.D. Computer Science in Reinforcement Learning (RL)

Medical Robotics Certificate

Committee: Miroslav Pajic (advisor), Ronald Parr, Michael Zavlanos

Collaborator: Pan Xu, Vahid Tarokh, Tananun Songdechakraiwt, Omid Khosravani

Durham, NC, USA

Aug. 2022 – Present

Duke University

M.A. Economics

Durham, NC, USA

Jan. 2024 – Present

Georgia Institute of Technology

M.S. Biomedical Engineering

Advisor: Sehoon Ha, Babak Mahmoudi

Collaborator: Qihua Huang (Pacific Northwest National Laboratory)

Atlanta, GA, USA

Aug. 2019 – May 2021

National Taiwan University

B.S. Mechanical Engineering

Taipei, Taiwan

Sep. 2014 – Jun. 2018

Publications (*Equal contribution)

Preprints

- P1. J Dong*, **HL Hsu***, Q Gao, V Tarokh, and M Pajic, “Robust Reinforcement Learning through Efficient Adversarial Herding”, 2023, available on [arxiv](https://arxiv.org/abs/2308.10000)

Conference and Journal Papers

- C1. **HL Hsu***, W Wang*, M Pajic and P Xu, “Randomized Exploration in Cooperative Multi-Agent Reinforcement Learning”, in *Advances in Neural Information Processing Systems (NeurIPS)*, 2024
- J1. P Sarikhani, **HL Hsu**, M Zeydabadinezhad, Y Yao, M Kothare, and B Mahmoudi, “Reinforcement Learning for Closed-loop Regulation of Cardiovascular System with Vagus Nerve Stimulation: A Computational Study”, in *Journal of Neural Engineering*, 2024
- C2. **HL Hsu**, A Bozkurt*, J Dong*, Q Gao, V Tarokh, and M Pajic, “Steering Decision Transformers via Temporal Difference Learning”, in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2024
- C3. A Gazi, M Chan, **HL Hsu**, D Bremner, C Rozell, and O Inan, “StressFADS: Learning Latent Autonomic Factors of Stress in the Context of Trauma Recall and Neuromodulation”, in *IEEE International Conference on Wearable and Implantable Body Sensor Networks (BSN)*, 2024
- C4. **HL Hsu**, and M Pajic, “Robust Exploration with Adversary via Langevin Monte Carlo”, in *Learning for Dynamics and Control Conference (L4DC)*, 2024
- C5. **HL Hsu**, H Meng, S Luo, J Dong, V Tarokh, and M Pajic, “REFORMA: Robust REinFORceMent Learning via Adaptive Adversary for Drones Flying under Disturbances”, in *IEEE International Conference on Robotics and Automation (ICRA)*, 2024
- C6. T Jin, **HL Hsu**, W Chang, and P Xu, “Finite-Time Frequentist Regret Bounds of Multi-Agent Thompson Sampling on Sparse Hypergraphs”, in *38th AAAI Conference on Artificial Intelligence (AAAI)*, 2024 (**Oral with acceptance rate 2.3 %**)

- C7. **HL Hsu**, Q Gao, and M Pajic, “ ϵ -Neural Thompson Sampling of Deep Brain Stimulation for Parkinson Disease Treatment”, in *International Conference on Cyber-Physical Systems (ICCPs)*, 2024
- C8. P Sarikhani, **HL Hsu**, and B Mahmoudi, “Automated Tuning of Closed-loop Neuromodulation Control Systems using Bayesian Optimization”, in *44rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, 2022
- C9. **HL Hsu**, Q Huang, and S Ha, “Improving Safety in Deep Reinforcement Learning Using Unsupervised Action Planning”, in *IEEE International Conference on Robotics and Automation (ICRA)*, 2022
- C10. JH Chen, **HL Hsu**, WH Yang, YC Chen, and HM Hsiao, “New Spherical Stent Concept for Occlusion”, in *Annual Scientific Meeting of Taiwanese Society of Biomechanics*, 2017

Workshop Papers

- W1. **HL Hsu***, W Wang*, M Pajic and P Xu, “Randomized Exploration in Cooperative Multi-Agent Reinforcement Learning”, in *RLC CoCoMARL Workshop*, 2024
- W2. P Sarikhani, **HL Hsu**, JK Kim, S Kinzer, E Mascarenhas, H Esmailzadeh, and B Mahmoudi, “Neuroweaver: Towards a Platform for Designing Translatable Intelligent Closed-loop Neuromodulation Systems”, in *NeurIPS Research2Clinics Workshop*, 2021
- W3. **HL Hsu**, Q Huang, and S Ha, “Safe Exploration for Reinforcement Learning Using Unsupervised Action Planning”, in *RSS Workshop on Integrating Planning and Learning*, 2021

Abstract

- A1. P Sarikhani, H Xu, ST Wang, S Kinzer, **HL Hsu**, Y Zhu, J Krasney, J Manns, H Esmailzadeh, B Mahmoudi, “Neuroweaver: a translational platform for embedding artificial intelligent in closed-loop neuromodulation systems”, in *Neuroscience 2023, 52nd Annual Meeting*, 2023
- A2. P Sarikhani, **HL Hsu**, M Zeydabadinezhad, Y Yao, M Kothare, and B Mahmoudi, “Sparc: Adaptive Closed-loop Control of Vagal Nerve Stimulation for Regulating Cardiovascular Function Using Deep Reinforcement Learning: A Computational Study”, in *Neuroscience 2021, 50th Annual Meeting*, 2021
- A3. P Sarikhani, **HL Hsu**, O Kara, JK Kim, H Esmailzadeh, and B Mahmoudi, “Neuroweaver: A Platform for Designing Intelligent Closed-loop Neuromodulation Systems”, in *4th International Brain Stimulation Conference*, 2021
- A4. **HL Hsu**, “Functional Connectivity Correlates to Individual Difference in Human Brains during Working Memory Task and Resting State”, in *IEEE EMBS North American Virtual International Student Conference*, 2021

Honors & Awards

AAAI 2024 Oral , acceptance rate 2.3 %	Feb. 2024
NSF TAST-NRT Fellowship , 1 of 6 awardees	Aug. 2022 - Jul. 2023
Ph.D. Departmental Fellowship , Computer Science, Duke University	Aug. 2022 - Jul. 2024
Thank a Teacher Award , Center of Teaching and Learning, Georgia Tech	Apr. 2021
Travel Grants for Ph.D. Fellowship workshop , Hong Kong government	Jul. 2018
Material Innovation Award , Material Research Society Taiwan	Oct. 2016
Third Prize , Manufacturing Practice Competition, Mechanical Engineering, NTU	Jan. 2015

Work Experience

Philips Research

Autonomous Ultrasound AI Research Intern

Cambridge, MA, USA

Jun. 2024 – Present

Mentor: Dr. Mohsen Zahiri and Dr. Balasundar Raju

- Imaged-based RL with Langevin Monte Carlo and Foundation Models (segmentation) as reward function for ultrasound active guidance in Focused Assessment with Sonography in Trauma (FAST)
- Offline actor-critic framework with marginalized importance sampling and diffusion model for incomplete trajectories and perturbed observations

Curai Health

Machine Learning Research Intern

Palo Alto, CA, USA (Remote)

May 2022 – Sep. 2022

Mentors: Dr. Anitha Kannan and Dr. Ilya Valmianski

- Built Decision Transformer for sequence modeling in high dimensional medical history taking
- Interpreted connection between queries and diagnosis with scalability and generalization

Reazon Holdings, Inc.

Machine Learning Research Intern

Tokyo, Japan (Remote)

Oct. 2021 – Dec. 2021

Mentors: Shubham Gupta MD. and Dr. Daijro Mori

- Built computer vision architectures (ShuffleNet and GhostNet) for gaze estimation and eye moving tracking on mobile devices improving upon published accuracy
- Adapted a Capsule Network to gaze estimation problem including eyes, face, and gray frame models and incorporated reconstruction loss to the original objective function
- Abstracted original PyTorch implementation via PyTorch Lightning

Abbott Vascular Taiwan

Software Engineering Intern

Taipei, Taiwan

Jun. 2018 – Jul. 2019

- Built an administrative system to share information among marketing, sales, and finance departments, and improved 75% of operation time in the sales database of vascular products, facilitating fast targeting
- Forecasted vascular product marketing trend by digitizing routine documents and incorporated the original database with Power BI to provide interactive visualizations and business intelligence capabilities to create reports and dashboards

Research Experience

Duke University

Cyber-Physical Systems Lab

Durham, NC, USA

Aug. 2022 – Present

Advisor: Prof. Miroslav Pajic

- Transformer-based offline in-context RL (1) via temporal difference (2) with robustness for out-of-distribution (OOD) and (3) with human feedback
- Robust RL with (1) adversarial herding and (2) non-stationary adaptation
- Pulse frequency prediction of deep brain stimulation with (1) less exploration via ϵ -Neural Thompson Sampling and (2) robust exploration
- Offline RL for selecting frames with ORB features in AR-SLAM

Duke University

Theoretical RL group

Durham, NC, USA

Feb. 2023 – Present

Mentor: Prof. Pan Xu

- Cooperative framework with randomized exploration for multi-Agent RL via Thompson sampling and Langevin Monte Carlo
- Multi-agent Thompson sampling on sparse hypergraphs with frequentist regret bounds

Duke University*Duke Quantum Center*

Collaborator: Omid Khosravani

Durham, NC, USA

Nov. 2023 – Present

- Developing RL for detecting and correcting errors in Quantum Error Correcting Codes (QECCs)

Duke University*Topological Learning Lab*

Mentor: Prof. Tananun Songdechakraiwt

Durham, NC, USA

Dec. 2023 – Present

- Topology-enhanced RL for the human brain via gathering complementary information from topological centroids in multiple modalities

Emory University*Neuroinformatics & Intelligent System Lab*

Advisor: Prof. Babak Mahmoudi

Atlanta, GA, USA

Jan. 2021 – Jul. 2022

- Deep brain stimulation improvement in (1) computation cost reduction via quantization RL, (2) automated PI controller via Bayesian optimization, and (3) safe RL with penalty for neuron suppression in Parkinson's diseases
- Vagus nerve stimulation with (1) set-point control based RL and (2) Few-shot adaption from healthy to hypertension cardiac model via transfer learning

Georgia Institute of Technology*Robotics & Computer Animation Lab*

Advisor: Prof. Sehoon Ha

Atlanta, GA, USA

Jan. 2020 – Oct. 2021

- Integrated on-policy RL agent with unsupervised action planning for safe exploration
- RL transfer for power grid control via (1) Augmented Random Search to adapt to less controllable renewables and (2) domain randomization for different power load

Academic Service

Paper Review: L4DC'24, ICRA'23-24, IROS'23, NeurIPS'23, ICLR'24-25, AISTATS'24-25, ICML'24, ICML'23 Frontiers4LCD, NeurIPS'23 AI4Science, NeurIPS'23 GenBio, ICML'24 AI4Science, ICML'24 SPIGM

Research Proposal Review: PURA (President's Undergraduate Research Award) Fall 2022

Teaching Assistant: Algorithmic Game Theory (Expected Spring 2024), Data Science (Spring 2023), Network Science (Spring, Summer, and Fall 2021), Clinical Application of Medical Electronic Device (Fall 2017), Clinical Observation & Demands Exploration (Summer 2017)

Research Mentoring (RL for Science): Stefan Dragos (St. Augustine Preparatory School): RL for robotic navigation, (Summer'24) Weisheng Jin (Duke): LLM with RL for robotics (Fall'23-Spring'24), Yang Chen (UC Berkeley): safe surgical robotics (Fall'23), Alexander Wang (West Windsor Plainsboro High School North): fake news detection (Fall'23), Nirav Jaiswal (Foothill High School): cloud computing (Summer'23), Indu Arimilli (Redmond High School): diagnosis prediction (Summer'23), Ian Choe (St. Mark's School): deep brain stimulation (Summer'23)

Talks & Presentations

AFOSR Center "Assured Autonomy in Contested Environments" (Oral)

May 2024

Robust Control via Adversarial Training

AFOSR Center "Assured Autonomy in Contested Environments" (Poster)

Dec. 2023

Robust Reinforcement Learning with Structured Adversarial Ensemble

NCTPASS 2022 Annual Symposium (Young Scholar Presentation)

Nov. 2022

AI for Dynamical and Safety-critical Systems

Curai Health ML paper club (Invited Talk) <i>Possible Reinforcement Learning Approaches to History Taking</i>	Jul. 2022
Georgia Tech Robotics Research Showcase (Poster) <i>Improving Safety in Deep Reinforcement Learning Using Unsupervised Action Planning</i>	Mar. 2022
Artificial Intelligence Medicine Organization weekly webinar (Invited Talk) <i>Applications of Reinforcement Learning in healthcare and power grid control</i>	Mar. 2021
Prof. Constantine Dovrolis's research group (Invited Talk) <i>Individual Difference in Humans' Brains from Functional Connectivity for Working Memory</i>	Feb. 2021

Technical Skills

Programming: Python, MATLAB, C++, C#, Julia, VBA

Software: AutoCAD, SolidWorks, Creo Parametric, ABAQUS, Qblade

OS: Linux (Ubuntu), Microsoft Windows, iOS

ML: Tensorflow, PyTorch, Keras, Scikit-learn, PyTorch Lightning

Simulation Environment: OpenAI Gym, Mujoco