Chih-Fan Rich Pai

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Summary

PhD in Control, Learning, and Optimization: Over 3 years of deep expertise in related research and problem-solving
Technical Proficiency: Design and analysis of algorithms for optimization/control/reinforcement learning/game theory

Education

University of California, San Diego (UCSD) GPA: 4.0/4.0 — La Jolla, CA
Ph.D. in Electrical and Computer Engineering (Machine Learning and Data Science Track) — *2021 - Sept. 2026 (expected)*

- **Research interest:** Optimization, control, online learning, and sequential decision-making
- **Course:** Machine Learning, Statistical Learning, Planning & Learning in Robotics, Probabilistic Reasoning & Learning, Semidefinite & Sum-of-Squares Optimization, Continuous Optimization, Stochastic Approximation, Information Theory

National Taiwan University (NTU) GPA: 3.99/4.3 — Taipei, Taiwan
M.S. in Communication Engineering (EECS Collage, Signal Processing for Communication Group) — *Feb. 2018 - June 2020*

- **Course:** Machine Learning, Deep Learning for Computer Vision, Matrix Computations, Convex Optimization, Design and Analysis of Algorithms, Adaptive/Multirate Signal Processing, Digital Communication

National Chiao Tung University (NCTU) GPA: 4.14/4.3 (Rank: top 3%) — Hsinchu, Taiwan
B.S. in Electrical and Computer Engineering (Graduated early for academic excellence) — *Sept. 2014 - Jan. 2018*

Research Experience

Online learning and (non)stochastic control — Sept. 2024 -
Research Assistant, supervised by Prof. Yang Zheng

- Explored **instance-wise optimality** of **online nonstochastic control** in both static and non-stationary environments
- Analyzed **dynamic regret** for online LQ control (with predictions) and its relationship with model predictive control

Nonconvex (non)smooth policy optimization for optimal and robust control — Apr. 2023 -
Research Assistant, supervised by Prof. Yang Zheng

- Investigated **optimization landscapes** and **model-free** policy optimization methods for partially observed optimal control
- Developed a unified framework, ***Extended Convex Lifting***, to analyze various nonconvex nonsmooth control problems
- Certified **global optimality**, analyzed **solvability**, and proposed a **policy iteration approach** for mixed $\mathcal{H}_2/\mathcal{H}_\infty$ control
- Analyzed classical optimal control results through a **primal-dual lens** using semidefinite programming formulations

Reinforcement learning and general sequential decision-making — June 2022 - March 2023
Research Assistant, supervised by Prof. Tara Javidi and Prof. Yian Ma

- Designed algorithms for **reward-free exploration** in RL, focusing on active model estimation for Markov decision processes

Signal processing for communication — June 2018 - Oct. 2020
Research Assistant, supervised by Prof. See-May Phoong

Publications

- **C. Pai** and Y. Zheng. Nonconvex Optimization in Static Output Feedback: Connectivity, Coerciveness, and Stationary Points[1]
- **C. Pai**, Y. Tang, and Y. Zheng. Policy Optimization of Mixed $\mathcal{H}_2/\mathcal{H}_\infty$ Control: Benign Nonconvexity and Global Optimality[1]
- Y. Watanabe, **C. Pai**, and Y. Zheng. Semidefinite Programming Duality in Infinite-Horizon Linear Quadratic Differential Games, arXiv Preprint 2025
- Y. Zheng, **C. Pai** and Y. Tang. Extended Convex Lifting for Policy Optimization of Optimal and Robust Control. To appear in L4DC 2025
- Y. Zheng, **C. Pai**, and Yujie Tang. Benign Nonconvex Landscapes in Optimal and Robust Control, Part I: Global Optimality and Part II: Extended Convex Lifting. arXiv Preprints, 2023/2024.
- **C. Pai** and S. Phoong, Low Complexity Estimation of Time-Varying Channels for OFDM Systems with Uniformly Spaced Pilots. 32nd European Signal Processing Conference, IEEE, 2024.
- **C. Pai**, T. Hung, and S. Phoong, Depth-L Nyquist (M) Filters and Biorthogonal Partners. IEEE Access, Apr. 2020.

[1] Under preparation and will be out soon

Honors

- **J. Yang Scholarship** from UCSD — Sep. 2021
- **Best Master Thesis Award** from National Taiwan University — Jan. 2021
- **Youth Thesis 1st Award** from Chinese Institute of Electrical Engineering — Jan. 2021
- **NCTU Academic Excellence Award**: 3 times (top 3%) — Sept. 2014 - Jan. 2018

Teaching Experience

UCSD ECE: Semidefinite & SOS Optimization, Linear Systems Fundamentals, Linear Control System Theory — Sept. 2023 -

- Designed and led weekly discussion sessions using self-prepared instructional materials
- Received highly positive feedback in student evaluations, highlighting clarity and engagement

NTU: Linear Algebra, Calculus, Digital Signal Processing, and Multirate Signal Processing — June 2018 - June 2020

Selected Project

Algorithmic Game Theory and Multi-objective Optimization Reading Group — Feb. 2022 - Jan. 2023

- Explored mechanism design, equilibrium computation, convergence behavior of learning dynamics, multi-objective optimization, multi-agent and multi-objective reinforcement learning

Theory and Practice of Machine Learning — June 2019 - Apr. 2020

- Explored **why gradient descent almost always avoid saddle points** in minimizing non-convex functions; also explored **surrogate risk minimization** algorithms for SVM, AdaBoost, logistic regression.
- Implemented **regression** for PM2.5 prediction, **probabilistic generative model**, **CNN** for human sentiment classification, and **RNN** for malicious comments identification
- **Ranked 2** in Kaggle among 120 NTU students by applying BERT to **dialogue modeling transfer learning** task

Visualization and Implementation of Deep Learning for Computer Vision — Sept. 2019 - Apr. 2020

- Visualized **what deep CNN learn** with saliency map, deconvolutional network, and deep generator network
- Implemented image reconstruction, clustering and classification using **dimensionality reduction**, e.g., autoencoder, PCA, K-Means, t-SNE; implemented **semantic segmentation** with ResNet50, **GAN** for producing human faces, **DANN** for **transfer learning**, and **LSTM**, **Seq2seq** for video action recognition and segmentation

Programming languages

C, C++, Python, MATLAB, PyTorch, Tensorflow, Scikit-learn, NumPy, Pandas