SHENAO ZHANG

shenao@gatech.edu | shenao-zhang.github.io

EDUCATION

Georgia Institute of Technology *May 2020 - Feb. 2022*
M.S. in ECE (Electrical and Computer Engineering), GPA: 3.875/4.00 *Atlanta, GA*

South China University of Technology *Aug. 2016 - May 2020*
B.Eng. in EE (Electronic and Information Engineering, Innovation Class) *Guangzhou, China*

University of California, Berkeley *Jan. 2019 - May 2019*
Visiting student at Department of EECS, GPA: 3.90/4.00 *Berkeley, CA*

RESEARCH INTERESTS

My research centers around reinforcement learning (RL), especially model-based RL. I'm interested in developing and analyzing efficient RL algorithms with application to robotic systems.

SELECTED PUBLICATIONS

[1] **Shenao Zhang**, Boyi Liu, Yan Li, Zhaoran Wang, Tuo Zhao. Model-Based Reparameterization Policy Gradient Methods: Theory and Practical Algorithms. Preprint.
Paper link: shenao-zhang.github.io/RPgradRL/RPgrad.pdf

[2] **Shenao Zhang**. Conservative Dual Policy Optimization for Efficient Model-Based Reinforcement Learning. Accepted at *Neural Information Processing Systems (NeurIPS)*, 2022.
Paper link: arxiv.org/abs/2209.07676

[3] **Shenao Zhang**, Li Shen, Lei Han, Li Shen. Learning Meta Representation for Agents in Multi-Agent Reinforcement Learning. Accepted at *ICLR Workshop on Gamification and Multiagent Solutions*, 2022. Under review at *Machine Learning Journal*. Paper link: arxiv.org/abs/2108.12988

[4] **Shenao Zhang**, Li Shen, Zhifeng Li, Wei Liu. Structure-Regularized Attention for Deformable Object Representation. Accepted at *NeurIPS Workshop on Object Representations for Learning and Reasoning*, 2020. Paper link: shenao-zhang.github.io/StRA-2020/StRA.pdf

WORK IN PROGRESS

[5] **Shenao Zhang**, Wanxin Jin, Zhaoran Wang. Model-Based First-Order Policy Gradient for Contact Dynamics. Report link: https://shenao-zhang.github.io/contact/contact.pdf

RESEARCH EXPERIENCE

Northwestern University *Aug. 2022 - Present*
Research Intern. Advisor: Zhaoran Wang

- **First-Order Policy Gradient for Contact Dynamics** (in progress): We study the FOPG with complementarity-based models for robotics systems that experience hard contact. We show that the convergence and gradient variance of FOPG are closely related to the model stiffness, which is determined by the centering parameter μ when solving the complementarity problem. Therefore, we propose the Analytic Barrier Smoothing with a contact-aware centering parameter. By discovering its connection with randomized smoothing, we show that analytic smoothing is the best linear approximation of the LCP solution and establish the bias of smoothing the system.

Georgia Tech *Sep. 2020 - Aug. 2022*
Research Intern. Advisors: Tuo Zhao and Zhaoran Wang *Atlanta, GA*

- **Model-Based Reparameterization Policy Gradient Methods**: We establish the first convergence analysis result for model-based RP PGMs, and our theory identifies the smoothness of the function approximators as a major determining factor that affects the quality of gradient estimation. Based on our theory, we further propose a spectral normalization method, which can effectively mitigate the exploding variance due to long model unrolls. Experiments are provided to support our theory and method: With a proper normalization, we can significantly reduce the gradient variance of modelbased RP PGMs and improve their convergence, leading to equal or better performance than their counterparts based on other gradient estimators, e.g., Likelihood Ratio (LR) gradient estimator.
- **Conservative Dual Policy Optimization for Efficient MBRL**: Previous provable model-based RL achieves the global optimality by assuming that model families have a restricted complexity measure, which rarely holds for nonlinear models. We thus proposed *Conservative Dual Policy Optimization* (CDPO) which shelves the model sampling process with Referential Update and Constrained Conservative Update. We showed that CDPO not only has a monotonic improvement property, but also is asymptotically optimal with a $\widetilde{\mathcal{O}}(\sqrt{T})$ Bayes expected regret. Experiments on several MuJoCo tasks also validate the principled over-exploration issue and the superiority of CDPO.

Tencent AI Lab *Aug. 2019 - Sep. 2020*
Research Intern. Advisors: Li Shen, Lei Han and Li Shen *Shenzhen, China*

- **Generalizability of Multi-Agent RL**: To make RL algorithms generalizable in population-varying multi-agent systems, we proposed *Meta Representations for Agents* (MRA) that adopts multi-modal latent policies and a constrained mutual information maximization objective to discover the common strategic knowledge and diverse strategic modes. We proved that the learned policies can reach the Nash Equilibrium in every evaluation Markov game if with a sufficiently large latent space.
- **Visual Representation with Structured Data**: For structured visual tasks including person re-id and face recognition, we proposed to formulate feature interactions in a structured manner. Our *Structure-Regularized Attention* first captures informative patterns between neighbor nodes. Higher-level contextual information can then be accessed to enhance the desired features.

TEACHING EXPERIENCE

Head TA of CS 7648: Interactive Robot Learning (Fall 2021) at Georgia Tech.

SELECTED PROJECTS

Object Detection *May 2019 - Oct. 2019*
Project paper: Coarse-to-Fine Attention, advised by Bo Wu *Columbia University*

Cloth Simulation using OpenGL Shader *Jan. 2019 - May 2019*
Project website: ffjmmm.github.io/CS184-final/webpage, advised by Ren Ng *UC Berkeley*

Gaze Tracking Algorithms *Feb. 2018 - Jan. 2019*
Project paper: Gaze Tracking in Natural Light, advised by Huabiao Qin and Mingkui Tan *SCUT*

RELEVANT COURSES

Undergraduate Courses: Computer Graphics (Berkeley CS 184), Intro to AI (Berkeley CS 188), Algorithms (Berkeley CS 170), Machine Perception, Information Theory, Deep Learning.

Graduate Courses at Georgia Tech:

- Control Courses: Linear Systems and Controls (ECE 6550), Nonlinear Systems and Control (ECE 6552), Optimal Control and Optimization (ECE 6553), Autonomous Control of Robotic Systems (ECE 6562), Power Systems Control and Operation (ECE 6320).
- ML Courses: Statistical Machine Learning (ECE 6254), Mathematical Foundations of Machine Learning (ISyE 7750), Machine Learning Theory (CS 7545), Computational Data Analysis (CSE 6740).

PROFESSIONAL SERVICE

Conference Review: NeurIPS 2020/2021/2022, ICLR 2022/2023, AISTATS 2022/2023, RSS 2021, ICML 2022.
Journal Review: Neurocomputing.

HONORS AND REWARDS

NeurIPS Scholar Award	*2022*
Georgia Tech Level A Premier Merit-Based Scholarship	*2020-2021*
Second Prize in 2018 Undergraduate Electronics Design Contest	*2018*
Third Prize in 2018 Intel Undergraduate Embedded System Contest	*2018*
Outstanding Freshman Scholarship (Awarded to 30 among 6,500 students)	*2016*