SHENAO ZHANG

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EDUCATION

Georgia Institute of Technology *May 2020 - Dec. 2021*
M.S. in ECE (Electrical and Computer Engineering), GPA: 3.875/4.00 *Atlanta, GA*

Georgia Institute of Technology *Jan. 2021 - Present*
M.S. in CSE (Computational Science and Engineering), GPA: 4.00/4.00 *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 interests lie in reinforcement learning (RL) and robotics. I'm interested in developing theoretically efficient algorithms with application to robotic systems and interactive learning algorithms.

PUBLICATIONS

[1] **Shenao Zhang**, Evangelos Theodorou. Dual Conservative Policy Update for Efficient Model-Based Reinforcement Learning. Accepted at *ICLR GroundedML Workshop*, 2022. Under review at *Robotics: Science and Systems (RSS)*, 2022. Paper link: shenao-zhang.github.io/DCPU-2021/DCPU.pdf

[2] **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/pdf/2108.12988.pdf

[3] **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

[4] Dazheng Hu, Huabiao Qin, **Shenao Zhang**, Hongmei Liu. Gaze Tracking Algorithm Based on Projective Mapping Correction and Gaze Point Compensation in Natural Light. Accepted at *International Conference on Control and Automation (ICCA)*, 2019. Paper link: ieeexplore.ieee.org/document/8899597

WORK IN PROGRESS

Learning Value Equivalent Models in Policy Improvement Path for Efficient MBRL. Report link: shenao-zhang.github.io/MBPG-2021/MBPG.pdf

RESEARCH EXPERIENCE

Georgia Tech *Sep. 2020 - Present*
Student Researcher. Advisors: Evangelos Theodorou, Tuo Zhao and Zhaoran Wang *Atlanta, GA*

- **Learning Value Equivalent Model on Policy Improvement Path**, (co-advised by Tuo Zhao and Zhaoran Wang): We study the value equivalent model learning and investigate the smallest policy sets for characterizing an effective VE model. We show that the long-term performance of VE-based planning is only affected by the model's ability to approximate policy values in its policy-improvement path. We establish the total order property of the VE loss functions, which leads to an objective that only depends on a single trajectory. By further casting the model learning problem to an online learning process, we show that the policy set can be updated sequentially for future improvement path prediction based on past policies. We also study the convergence rate in two MBRL settings

including sample-based policy search and model-based planning. We show that the global convergence rate depends on the Rademacher complexity of the VE model loss, for which we design several online learners and show a $T^{-\frac{1}{2}}$ rate of convergence. We also provide a case study of MuZero, suggesting the benefit of an online model learner with sublinear regret. Besides, we prove the approximate local optimality with an online model learner in more general VE-based planning algorithms.

- **Over-exploration and sample efficiency of model-based RL**, (advised by Evangelos Theodorou): Previous model-based Bayesian RL algorithms achieve the asymptotic optimality by assuming that model families have a restricted complexity measure. However, it is not polynomially bounded for nonlinear models, *i.e.*, only an exponentially small portion of uncertainty is eliminated per step. We thus proposed *Dual Conservative Policy Update* (DCPU) which shelves the model sampling process to avoid aggressive policy update. We showed that DCPU 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 DCPU.

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

- **Generalizability of multi-agent RL algorithms**: 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 tasks 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.

South China University of Technology *Sep. 2017 - Jan. 2019*
Research Assistant. Advisors: Huabiao Qin and Mingkui Tan *Guangzhou, China*

- **Gaze tracking algorithms**: We proposed a gaze tracking algorithm based on projective mapping correction and gaze point compensation in natural light.
- **Perception for mobile robot navigation**

TEACHING EXPERIENCE

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

SELECTED PROJECTS

Object Detection *May 2019 - Aug. 2019*
Project paper: shenao-zhang.github.io/CFA-2019/CFA.pdf, 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*

RELEVANT COURSES

Undergraduate courses: Computer Graphics (CS 184 at UC Berkeley), Intro to AI (CS 188 at UC Berkeley), Algorithms (CS 170 at UC Berkeley), 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).
- 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 ACTIVITIES

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

HONORS AND REWARDS

Georgia Tech's Level A Premier Merit-Based Scholarship	*2020*
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*