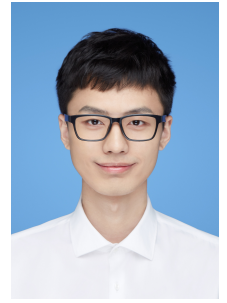# Yang Guan

Intelligent Driving Laboratory (iDLab)
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EDUCATION

Tsinghua University (THU)   *August 2017 - Present*
Doctor of Philosophy (PhD)
School of Vehicle and Mobility

Beijing Institute of Technology (BIT)   *July 2013 - June 2017*
Bachelor of Engineering
School of Vehicle Engineering   Ranking: 1/130

REASEARCH INTERESTS

Reinforcement Learning (RL), Autonomous Driving, Optimal Control, Machine Learning

RELEATED COURSES

Math: Calculus, Algebra, Probability, Real Analysis, Optimization Method, Functional Analysis
Machine Learning: Pattern Recognition, Signal Process, Deep Learning

PROJECTS

Interpretable Driving AI with Highly Efficient Online Computation and Self-evolution Ability
Leader of the technical team   *Sep. 2020 - Mar. 2021*
The project aims to build an interpretable self-learning driving system by RL, for the real-time decision and control of automated vehicles. My works: 1) Formulated a general integrated decision and control framework, which utilizes RL as a way to solve constrained optimal control problems (OCP), and thus makes the output interpretable in the sense that it is the approximate solution of the OCP. The framework is promising to promote RL applications in real-world autonomous driving tasks. 2) Proposed a model-based RL algorithm for approximately solving large-scale constrained OCPs, where a generalized exterior point method is employed to find a feasible neural solution. 3) Carried out experiments both in simulation and in real world, yielding the best performance in terms of computing efficiency ($10\times$) compared with baseline methods.

Development of RL Library with High-throughput and Scalable Learning Architecture
Leader (also the only team member)   *Mar. 2020 - Sep. 2020*
This project aims to develop a highly modularized and extensible RL library, with the ability of scaling to use hundreds of CPU cores for the high-throughput sampling, storing and updating. My works: 1) Summarised common procedures in different RL algorithms, according to that, abstracted the library by Worker, Learner, Buffer, Optimizer, Evaluator, Tester, and Trainer. Each has a certain functionality with clearly designed interface. 2) Proposed a general high-throughput and scalable learning architecture, which organizes arbitrary numbers of Workers, Learners, Buffers, and Evaluators in parallel, each with a CPU core, to enhance the sampling, learning, and replaying efficiency. 3) Developed the library by Tensorflow and Ray, which contains a cluster of state-of-the-art algorithm implementations, including MPG, DSAC, DDPG, ADP, TD3, SAC, PPO, TRPO.

Driving AI: Centralized Decision and Control for Multiple Vehicles at Crossroad by RL
Leader of the technical team   *Sep. 2019 - Mar. 2020*
This project aims to develop a centralized coordination scheme of automated vehicles at an intersection without traffic signals using RL to address low computation efficiency suffered by current centralized coordination methods. My works: 1) Proposed model accelerated proximal policy optimization algorithm, which incorporates a prior model into PPO to facilitate sample efficiency. 2) Designed state with minimal length, and simplified reward function under consideration of safety, efficiency and task completion. The computing efficiency and traffic efficiency are respectively 400 times and 4.5 times higher that those of the baseline method based on MPC.

PROGRAMMING

TensorFlow (expert); Python (expert); Ray (expert); PyTorch (intermediate); C/C++ (intermediate)

PUBLICATIONS

- **Guan Y.**, Ren Y., Li S. E., et al. Integrated Decision and Control: Towards Interpretable and Efficient Driving Intelligence (2021). in IEEE Cybernetics (under review). Available at https://arxiv.org/pdf/2103.10290.pdf

- **Guan Y.**, Ren Y., Li S. E., et al. Centralized cooperation for connected and automated vehicles at intersections by proximal policy optimization (2020). in IEEE TVT.

- **Guan Y.**, Li S. E., Duan J., et al. Direct and indirect reinforcement learning (2021). In IJIS.

- **Guan Y.**, Li S. E., Duan J., et al. Markov probabilistic decision making of self-driving cars in highway with random traffic flow: a simulation study (2018). In JICV.

- **Guan Y.**, Duan J., Li S. E., et al. Mixed policy gradient (2021). In TNNLS (under review). Available at https://arxiv.org/pdf/2102.11513.pdf

- Li S. E., **Guan Y.**, Hou L., et al. Key technique of deep neural network and its applications in autonomous driving (2019). In JASE.

- Duan J.*, **Guan Y.***, Li S. E. et al. Distributional soft actor-critic: Off-policy reinforcement learning for addressing value estimation errors (2020). In TNNLS (under review). Available at https://arxiv.org/pdf/2001.02811.pdf

- Kong Y.*, **Guan Y.***, Duan J., et al. Decision-Making under On-Ramp merge Scenarios by Distributional Soft Actor-Critic Algorithm (2021). In IEEE TVT (under review).
  Available at https://arxiv.org/pdf/2103.04535.pdf

- Ren Y., Duan J, Li S. E., **Guan Y.**, et al. Improving generalization of reinforcement learning with minimax distributional soft actor-critic: a simulation study (2020). In ITSC. **(Best student paper: 4/573)**

- Li J., Li S. E., **Guan Y.**, et al. Ternary Policy Iteration Algorithm for Nonlinear Robust Control (2021). In CDC (submitted). Available at https://arxiv.org/pdf/2007.06810.pdf

- Duan J., Li S. E., **Guan Y.**, et al. Hierarchical reinforcement learning for self-driving decision-making without reliance on labeled driving data (2020). In IET ITS.

- Peng B., Mu Y., **Guan Y.**, et al. Model-Based Actor-Critic with Chance Constraint for Stochastic System (2021). In CDC (submitted). Available at https://arxiv.org/pdf/2012.10716.pdf

- Xin L, Kong Y, Li S. E., Chen J., **Guan Y.** et al. Enable faster and smoother spatio-temporal trajectory planning for autonomous vehicles in constrained dynamic environment (2020). In JAE.

- Peng B., Mu Y., Duan J., **Guan Y.**, et al. Separated Proportional-Integral Lagrangian for Chance Constrained Reinforcement Learning (2021). In IV (submitted). Available at https://arxiv.org/pdf/2102.08539.pdf

- Tang K., Li S. E., Yin Y., **Guan Y.**, et al. Approximate Optimal Filter for Linear Gaussian Time-invariant Systems (2021). In IEEE CDC (submitted). Available at https://arxiv.org/pdf/2103.05505.pdf

- Zhang Y., Mu Y., Yang Y., **Guan Y.**, et al. Steadily Learn to Drive with Virtual Memory (2021). In IV (submitted). Available at https://arxiv.org/pdf/2102.08072.pdf

- Ma H., Chen J., Li S. E., Lin Z., **Guan Y.**, et al. Model-based Constrained Reinforcement Learning using Generalized Control Barrier Function. In IROS (submitted). Available at https://arxiv.org/pdf/2103.01556.pdf

AWARDS

Best student paper in IEEE ITSC (Ranking: 4/573)	2020
Second-class scholarship for comprehensive excellence in Tsinghua University	2018
Outstanding Graduates of Beijing	2017
National Scholarship for two consecutive years	2014-2016
Pacemaker to Merit Student for three consecutive years	2014-2016