Safe Multi-Agent Reinforcement Learning with Control Theory

Description

Developing reinforcement learning (RL) algorithms that satisfy safety constraints is becoming increasingly important in real-world applications [2]. How to ensure safety during RL applications is a challenging problem, which has received substantial attention in recent years. A Safe RL problem can be seen as a Constrained Markov Decision Process (CMDP) problem, which has been widely adopted in the field of Safe RL. There are lots of methods and algorithms that have been proposed and developed for Safe RL based on CMDP optimization.

Research on robot control has a long tradition [1, 3]. A challenging problem arising in this domain is how to control multiple robots safely in real-world applications. In this study, we investigate safe MARL for multi-robot control on cooperative tasks, in which each individual robot has to not only meet its own safety constraints while maximising their reward, but also consider those of others to guarantee safe team behaviours.

Three Safe MARL Benchmarks.

Tasks

- Develop Safe MARL algorithms with control theory (I will provide the basic code for you).
- Analyse the stability of multi-agent systems.
- Control robots safely by leveraging safe MARL algorithms.
- *Optional:* Analyse the convergence and sample complexity.

References

[1] Yinlam Chow, Ofir Nachum, Edgar Duenez-Guzman, and Mohammad Ghavamzadeh. A lyapunov-based approach to safe reinforcement learning. *Advances in neural information processing systems*, 31, 2018.

[2] Shangding Gu, Jakub Grudzien Kuba, Munning Wen, Ruiqing Chen, Ziyan Wang, Zheng Tian, Jun Wang, Alois Knoll, and Yaodong Yang. Multi-agent constrained policy optimisation. *arXiv preprint arXiv:2110.02793*, 2021.

[3] Brett T Lopez, Jean-Jacques E Slotine, and Jonathan P How. Dynamic tube mpc for nonlinear systems. In *2019 American Control Conference (ACC)*, pages 1655–1662. IEEE, 2019.

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Research project:
Safe RL

Type:
BA/MA

Research area:
Safe Reinforcement Learning, Robot Control, Multi-Agent Systems

Programming language:
Python

Required skills:
Very good mathematical background, programming in Python

Language:
English

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