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Bachelor's/ Master's Thesis

Byzantine Fault-Tolerant Federated Reinforcement Learning

Abstract

The expansion of Federated Learning (FL) has led to increasing research interest in Federated Reinforcement Learning (FRL). FRL seeks to enable multiple agents to collaboratively develop a better decision-making policy without sharing raw data. A significant challenge in practical edge computing environments for both FL and FRL is the Byzantine Fault, where agents may be compromised by an adversary and send faulty or no messages to disrupt learning. Byzantine fault-tolerance is crucial for the practical deployment of FRL algorithms.

Content

This thesis aims to develop a Byzantine Fault-tolerant Federated Reinforcement Learning (FRL) algorithm inspired by the UCRL framework. To tackle the Byzantine Fault, we will devise a robust mean estimation method for each action-state pair, which will be instrumental in formulating the decision-making policy. Notably, this will be accomplished under broader assumptions than those employed in prior research. We will furnish comprehensive theoretical guarantees for our proposed algorithms, and their performance will be assessed through various numerical experiments.

Requirements

- Interests in reinforcement learning (RL) and distributed computing.
- A basic understanding of fundamental Reinforcement Learning (RL) concepts and algorithms, along with knowledge of probability and statistics, is essential.
- Familiarity with statistical estimation theory is beneficial but not mandatory.
- Experience in Python for numerical experiments.

Literature

- Agarwal, M., Ganguly, B., & Aggarwal, V. (2021, December). Communication efficient parallel reinforcement learning. In Uncertainty in Artificial Intelligence (pp. 247-256). PMLR.
- Fan, X., Ma, Y., Dai, Z., Jing, W., Tan, C., & Low, B. K. H. (2021). Fault-tolerant federated reinforcement learning with theoretical guarantee. Advances in Neural Information Processing Systems, 34, 1007-1021.
- Chen, Y., Zhang, X., Zhang, K., Wang, M., & Zhu, X. (2023, April). Byzantine-robust online and offline distributed reinforcement learning. In International Conference on Artificial Intelligence and Statistics (pp. 3230-3269). PMLR.

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