Robotics and Embedded Systems

Human Brain Project

Master Thesis

Deep Spiking Q-Networks

BACKGROUND

Deep Q-Networks (DQN) is a popular reinforcement learning algorithm that has been shown to solve a diverse set of problems ranging from video games to robotic applications [1]. Spiking Neural Networks (SNN) are often referred to as the third generation of neural networks as they closely resemble biological neurons. They are less widespread than Artificial Neural Networks (ANN) mainly due to the lack of learning rules for this class of networks. Over the past few years, however, multiple efforts resulted in very close accuracy results from SNNs and ANNs on benchmark datasets [2]. The learning rules for Deep SNNs, however, have not been employed in the reinforcement learning domain. The successful implementation of state-of-the-art reinforcement learning algorithms with spiking neurons will open the door to the use of Neuromorphic Hardware in this domain, which will be a step towards a more efficient realization of such algorithms in the real world.

YOUR TASK

In this thesis, you will develop a Deep Spiking Q-Network (DSQN) to solve a robotic task (either grasping or navigation) in the Neurorobotics Platform (NRP) [3], an open-source cloud-based simulation platform tailored for connecting robots to SNNs. The results from training an agent with a DSQN should be compared with a standard DQN at the end.

Required Skills

- Good Knowledge of Python and Linux
- Basic Knowledge in Robotics
- Experience with Deep Learning frameworks and reinforcement learning is preferred

References

[1] V. Mnih *et al.*, “Human-level control through deep reinforcement learning,” *Nature*, vol. 518, 2015.

[2] M. Pfeiffer and T. Pfeil, “Deep Learning With Spiking Neurons: Opportunities and Challenges,” *Front. Neurosci.*, vol. 12, no. October, 2018.

[3] E. Falotico *et al.*, “Connecting artificial brains to robots in a comprehensive simulation framework: The neurorobotics platform,” *Front. Neurorobot.*, vol. 11, no. JAN, 2017.

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