Technische Universität München
Neurowissenschaftliche Systemtheorie

Project Laboratory Computational Neural Engineering

Control of robotic arm with spiking neural networks

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Problem description:

Various successful applications of Q-learning [1] in robotics have been demonstrated recently [2,3], which include spiking neural networks (SNN) due to their favorable scaling properties on neuromorphic hardware. Especially when addressing control of larger robotic systems with multiple sensors and actuators, such distributed large neuro-computing systems are required for real-time execution.

In this project laboratory, a simple robotic arm should be trained to reach a desired position in a 2D space without using a pre-specified kinematic model in simulation. Q-learning will be utilized in SNN to learn a mapping between the arm's joint positions and the desired Cartesian target positions. The SNN will be built using Nengo [4] and the model will communicate with the robotic arm in simulation. A simple simulation environment that is created for previous projects can be used to simulate the robot arm. The performance of the SNN model should be evaluated in terms of accuracy, success rate, scalability and training time comparing with existing methods such as Q-learning and an inverse kinematics method.

Task:

- Get familiar with basic neural modelling in Nengo
- Adapt and improve the existing algorithm for Q-learning in SNN
- Test and validate the developed algorithm with the simulator
- Evaluate the performance of the network
- Prepare the documentation and the report.

Optional:

- Test the developed algorithm on NST Omnibot with Robot Arm [5]

References:

[1] Sutton, Richard S., and Andrew G. Barto. *Reinforcement learning: An introduction*. Vol. 1. No. 1. Cambridge: MIT press, 1998.

[2] Kober, Jens, J. Andrew Bagnell, and Jan Peters. "Reinforcement learning in robotics: A survey." *The International Journal of Robotics Research* 32.11 (2013): 1238-1274.

[3] Ansari, Yasmin, et al. "A Multiagent Reinforcement Learning approach for inverse kinematics of high dimensional manipulators with precision positioning." *Biomedical Robotics and Biomechatronics (BioRob), 2016 6th IEEE International Conference on*. IEEE, 2016.

[4] Bekolay, Trevor, et al. "Nengo: a Python tool for building large-scale functional brain models." *Frontiers in neuroinformatics* 7 (2014): 48.

[5] http://www.nst.ei.tum.de/forschung/neuromorphic-systems/#c1004

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