Rogues Gallery – RatSLAM Team (Fall 2022)

Hiren Kumawat, Colten Webb, Kartik Sinha, Yesha Thakkar

Introduction & Goals

Introduction

The Neuromorphic Team specializes in neuromorphic, also known as brain-inspired, computing applications. This semester, most of our efforts have been centered on the RatSLAM algorithm and our proposed variation of it, as well as investigating existing neuromorphic frameworks and hardware.

Semester Goals

- Introduce new members to critical neuromorphic concepts, architectures, and literature, with an emphasis on RatSLAM functionality.
- Use Lava packages to experiment with SNN implementation, primarily as it pertains to RatSLAM.

Key Concepts & Results

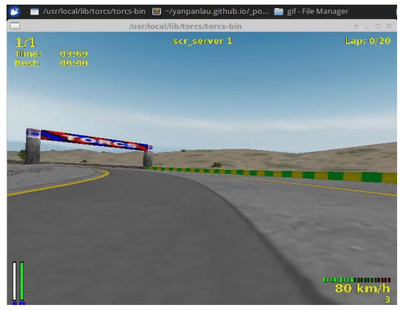
Overview

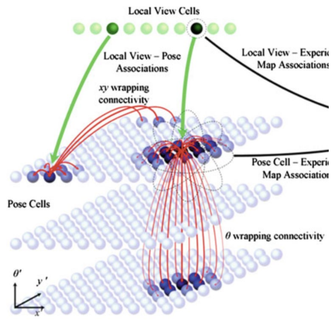
- To meet the resource constraints of the NeuroCar, we are seeking to develop an autonomous navigation system using RatSLAM and DDPG.
- The goal is to have an end-to-end system for obtaining vision and odometric input, processing it to create a map of the environment and track the agent's orientation and location within it, and to produce a stream of acceleration and steering values to efficiently navigate between two landmarks on the map.

DDPG

(Deep Deterministic Policy Gradient)

- Takes in SLAM data and makes throttle / steering decisions.
- Training method involves the use of two pairs of networks, in order to stabilize learning.



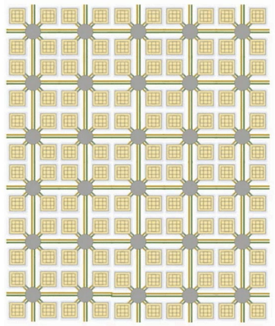


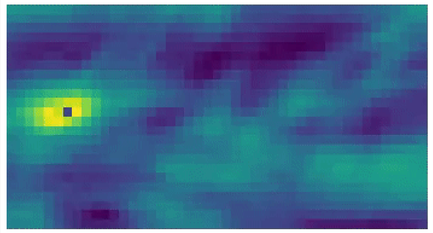
Pose Cells and SNNs

- The original ratslam paper uses a pose cell network that is similar in structure to an SNN. By replacing parts of the system with SNN we can reduce power consumption of the algorithm.

Loihi

- Loihi is Intel's neuromorphic chip that is capable of running SNNs natively, drastically reducing power consumption. Combined with Lava, it is an ideal candidate to run neuro-inspired algorithms.



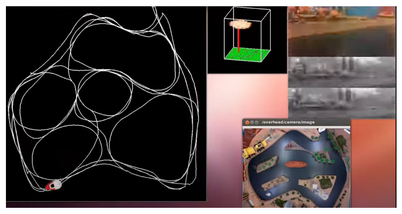


Lava, Lava-dnf

- Lava is a python library and framework for building applications that have CPU and Loihi components, allowing them to interoperate.
- Lava-dnf lets you define a dynamic neural field and run it on Loihi as an SNN.

rg-ratslam

- Our implementation of RatSLAM. Starting from a CPU-based implementation, we incrementally replace components with algorithms that can be run on Loihi.



Challenges & Next Steps

Challenges

- The dataset provided with the RatSLAM paper has dozens of parameters tuned to its algorithm, we need to change them so it performs well with the changes we have made to the components.

Next Steps

- Begin implementing other components of the RatSLAM pipeline with our Lava DNF API for spiking neural networks.
- Generate comparison data between neuromorphic and non-neuromorphic SLAM algorithms, particularly on the basis of latency, efficiency, and accuracy..
- Explore execution on NeuroCar and/or Loihi next semester.