Navigation Neural Model Implemented in NRP

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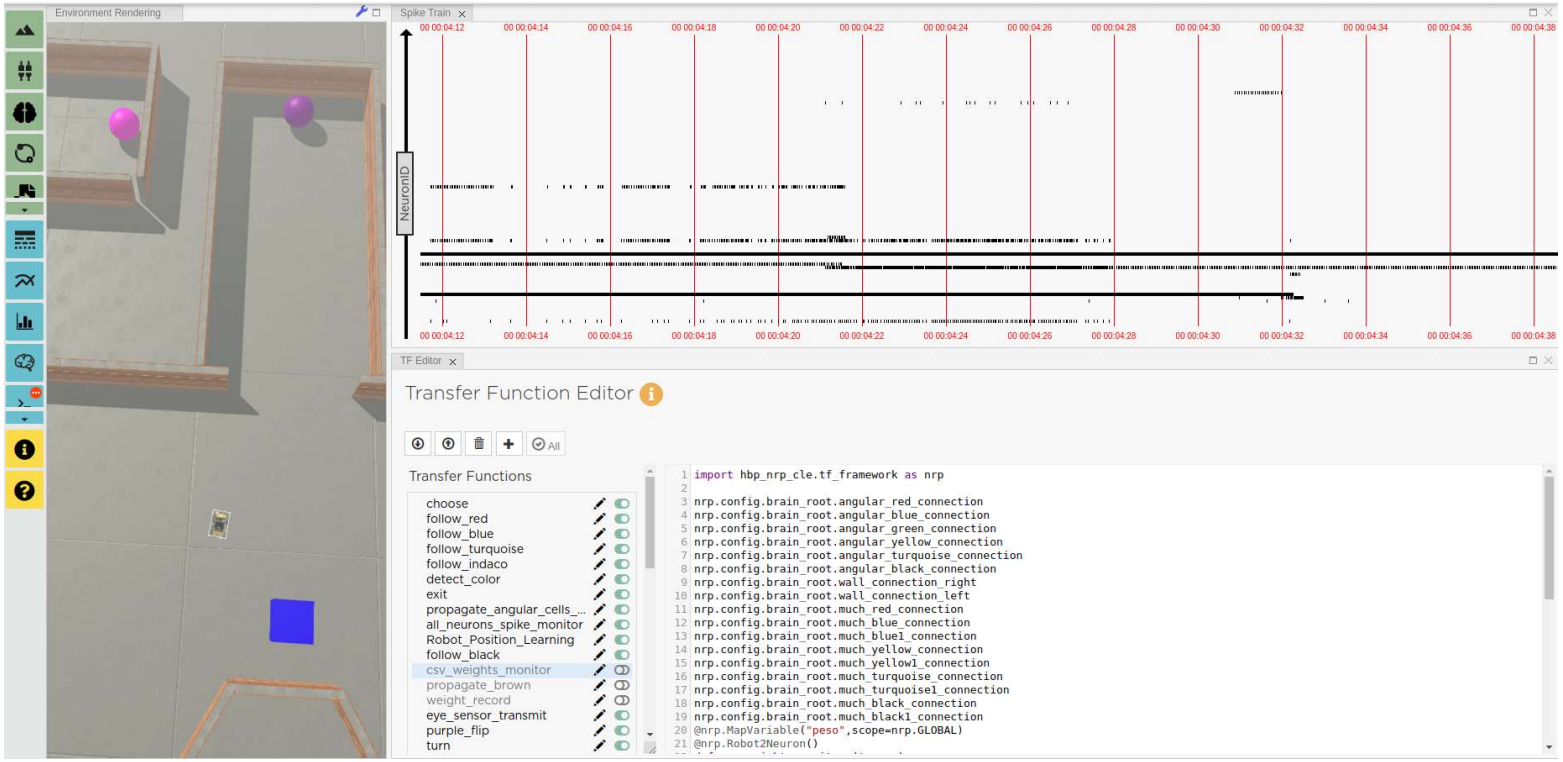
NEUROROBOTICS PLATFORM

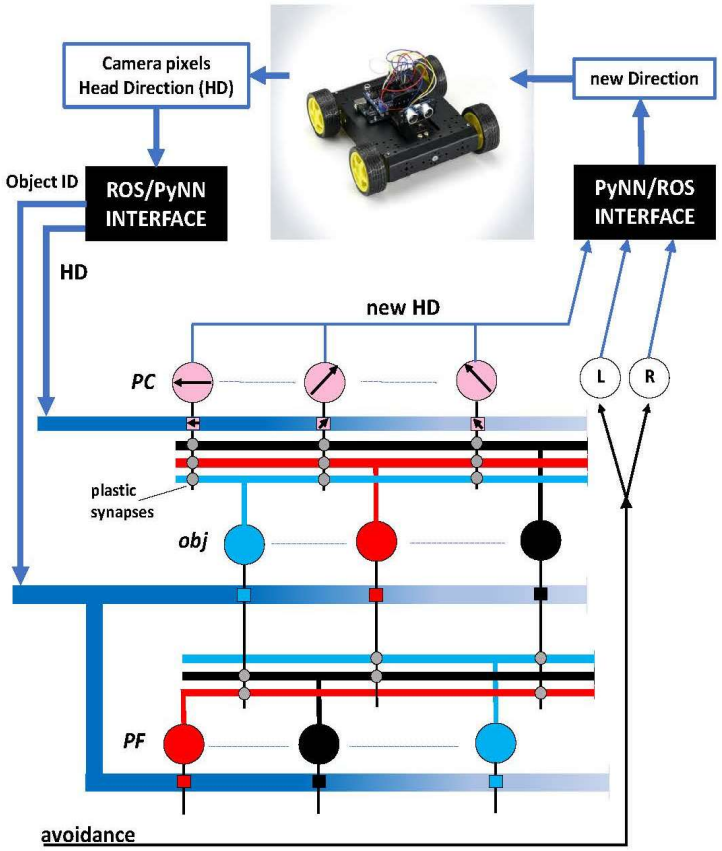
- Integrates robot and spiking neural networks.
- Fully Customizable
- Supports a wide range of brain simulator (PyNest, Nengo…)
- Integration with Gazebo
- Available at: https://neurorobotics.net/



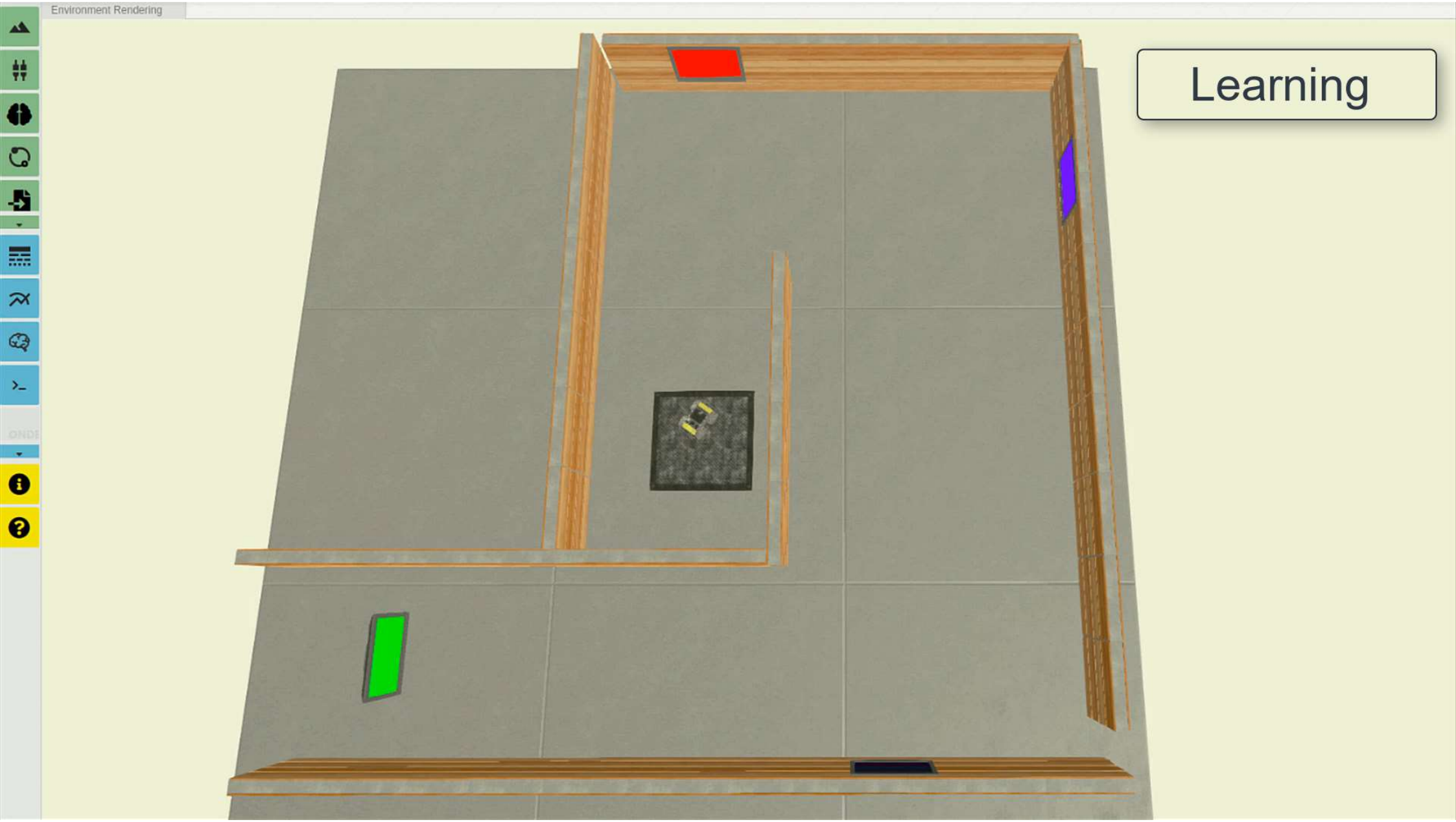
BACKGROUND

- Autonomous robot navigation is a current challenge.
- In literature there are algorithms for robot navigation also using artificial neural networks.
- However, classic neural networks have a problem in the long training time.
- Mammals, instead, are able to explore complex environment in a short time.
- The idea behind the model is to translate these inner connections into a neural network.
- To achieve this result we needed to use spiking neural networks because more adherent to biology.

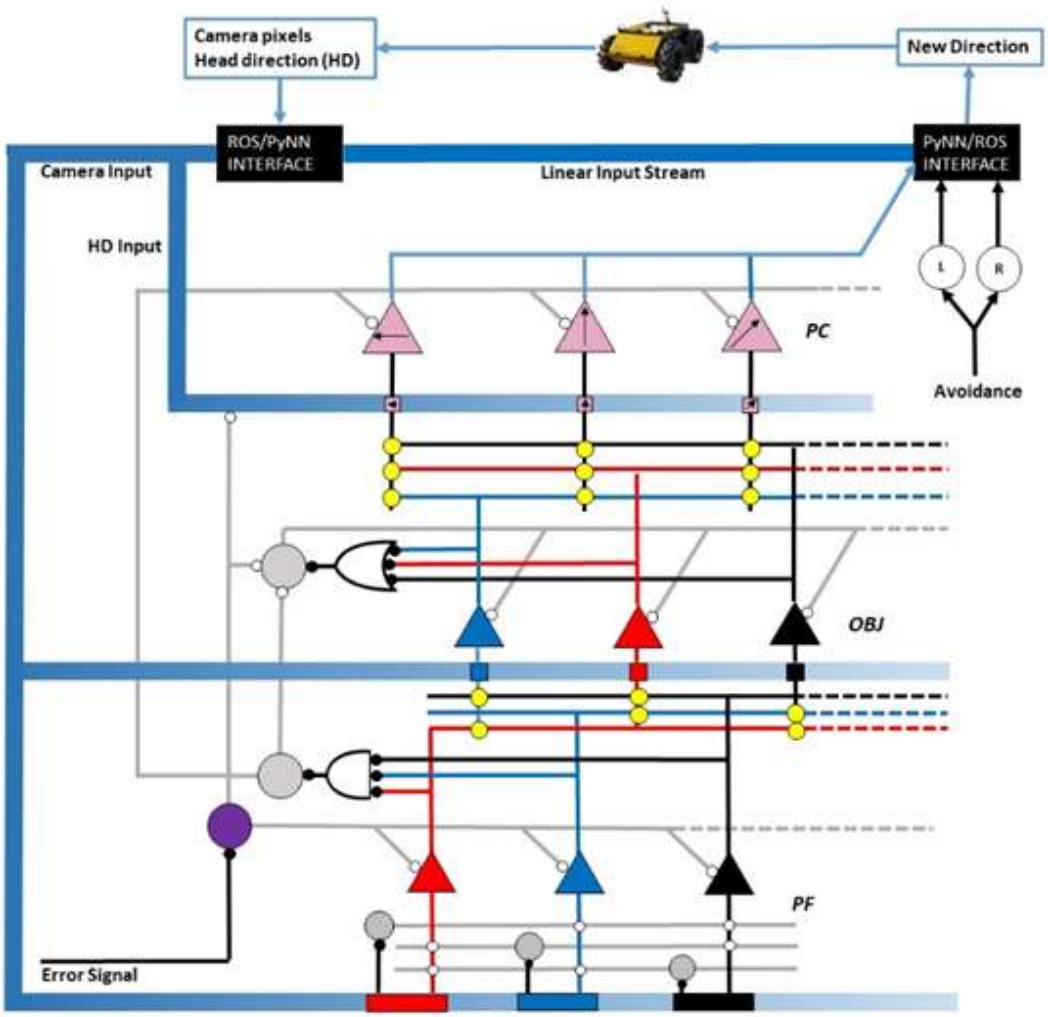
MODEL NETWORK FOR PROOF OF PRINCIPLE



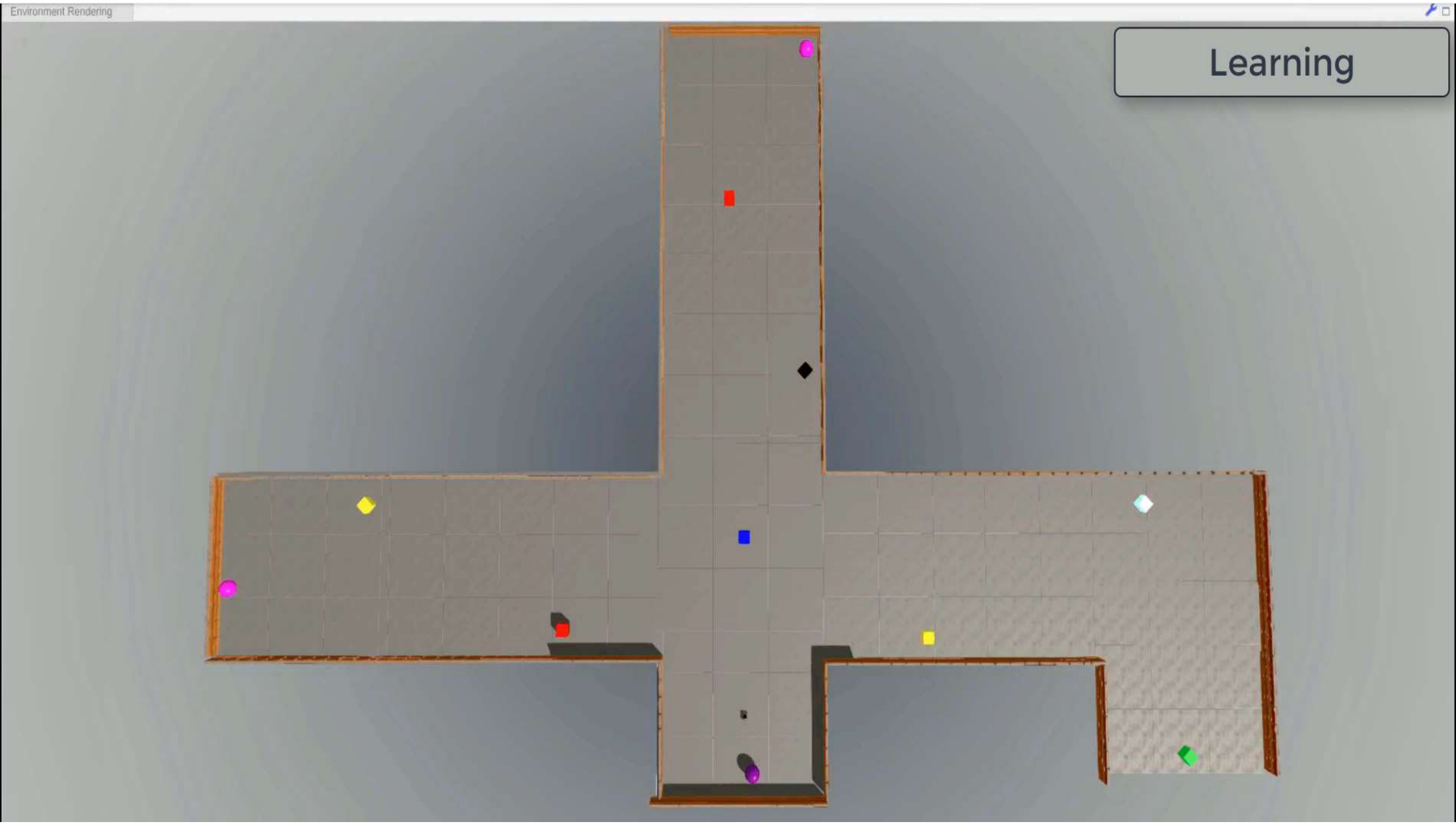
- Implemented in PyNN
- LIF neurons with the same properties
- Implements some structures in Hippocampus involved in spatial navigation, such as: Place Cells, Head Direction Cells, and Persistent Firing neurons
- Input comes from robot's camera and is processed by custom ROS/Python functions
- Learning occurs through STDP rule
- Principal result: network is able to learn an arbitrary long sequence of objects in a single learning phase.


Environment Rendering
Learning

TOWARDS A NETWORK FOR REAL-WORLD APPLICATIONS



- Same overall architecture.
- Added interneurons generating feedback and lateral inhibition.
- Asymmetric STPD rule to facilitate synaptic depression.
- Now network is able not only to learn the correct sequence but also forget wrong pathways, during a single exploration of environment.
- We are also working on physical robot for real-world simulation.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FINAL INFORMATION

I'm working in Michele Migliore's lab at the Institute of Biophysics of the Italian National Research Council, Palermo (Italy).

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For more information: **S. Coppolino, G. Giacopelli and M. Migliore**, *Sequence Learning in a Single Trial: A Spiking Neurons Model Based on Hippocampal Circuitry,* IEEE Transactions on Neural Networks and Learning Systems,
doi: 10.1109/TNNLS.2021.3049281.
For the code: https://senselab.med.yale.edu/ModelDB/ShowModel?model=266849