Lab meeting

Robust representations for olfactory-spatial association learning

Andrea Pierré

March 11, 2025

Outline

1. Project recap

2. Cartesian/polar duplicated coordinates experiment

3. What does the network learn?

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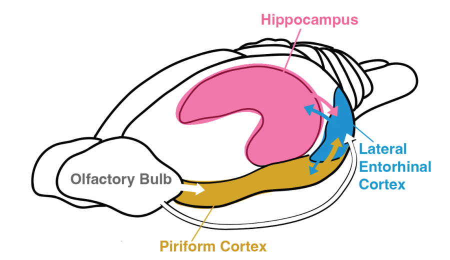
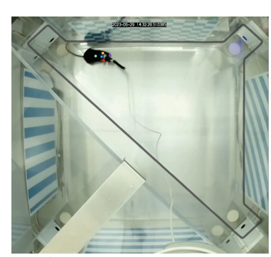
The LEC is key to sensory associations and spatial memory

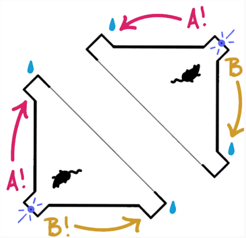
- Piriform Cortex encodes olfactory information
- Hippocampus encodes spatial information
- Lateral Entorhinal Cortex (LEC) encodes both olfactory & spatial information

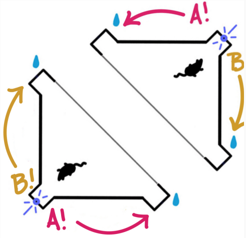


Poo et al., 2022
Bitzenhofer et al., 2022
Lee et al., 2021

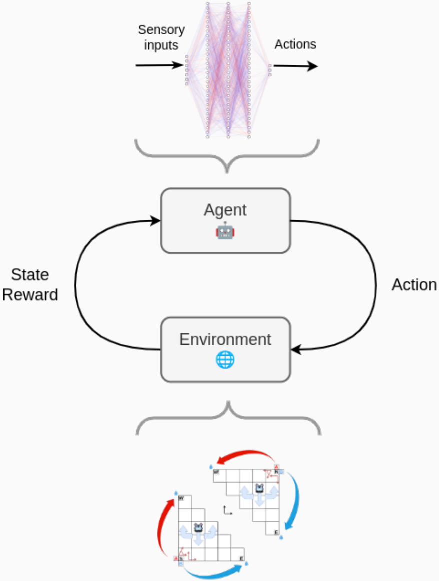
Half triangle task for olfactory-spatial association learning







Deep Reinforcement Learning model



Sensory inputs

Actions

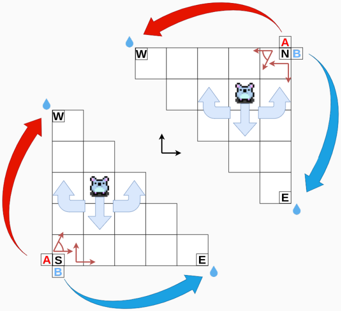
Agent 🤖

State
Reward

Action

Environment 🌐

Cartesian/polar duplicated coordinates experiment



- 3 actions: ⇐ ⇑ ⇒
- Duplicated coordinates inputs:
  - Cartesian coordinates from north & south port
  - Polar coordinates from north & south port

Questions & Hypothesis

Questions

- What function does the network learn?
- How the constrains of the task affect learning & the representations learned?
- How do the representations learned compare between the *in vivo* and the *in silico* neurons?

Hypothesis

- The network will use the most efficient coordinate information based on the task
- The structure of the network's weights will reflect this prioritization of information

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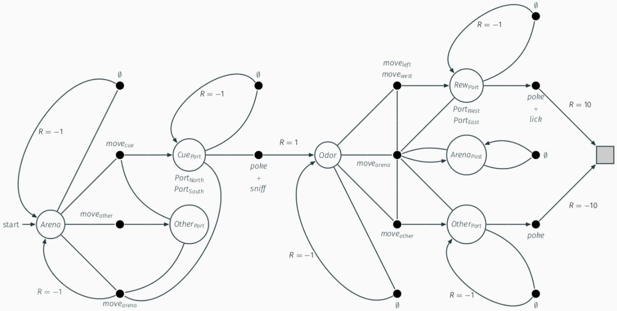
Looking back...



1. Try to define the Olivia’s experiment as a Markov Decision Process (MDP) in Julia
2. 2D gridworld in Python/NumPy
3. Duplicated coordinates in Python/PyTorch

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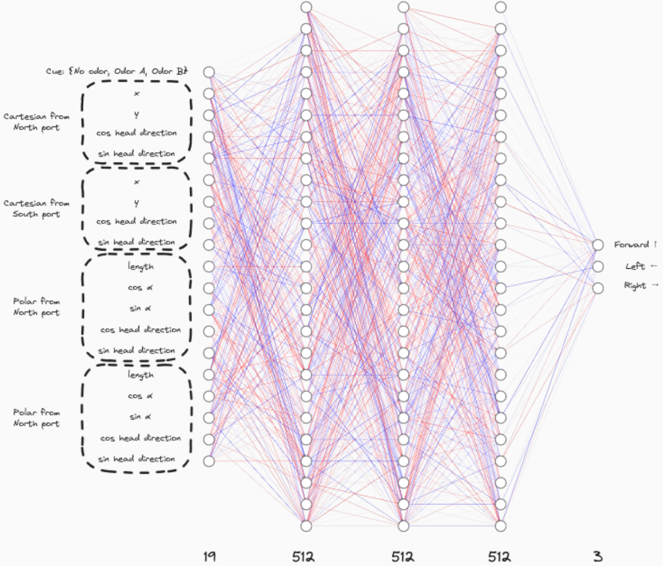
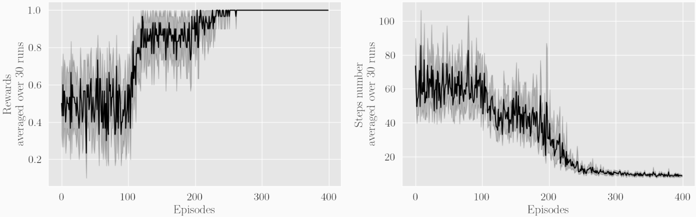
State space & network architecture

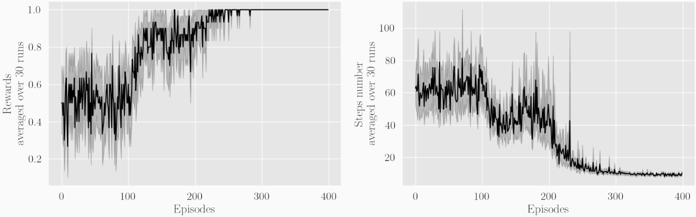


Training

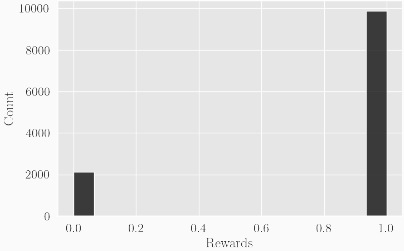
East/West

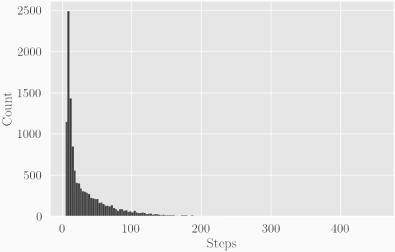


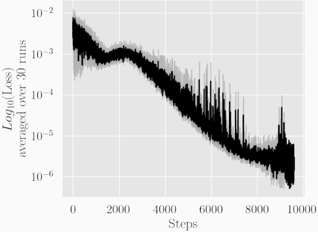
Left/Right

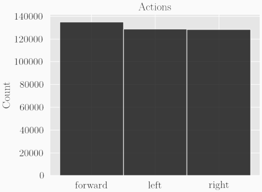


Training checks - East/West

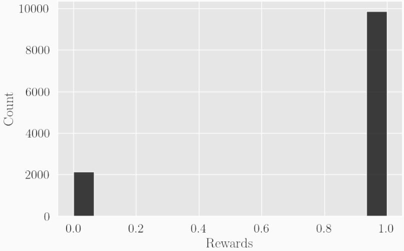


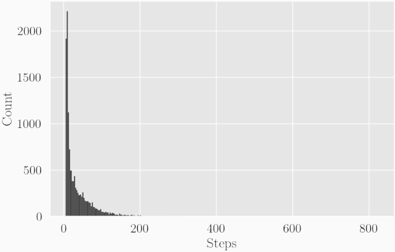


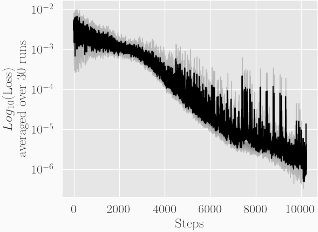


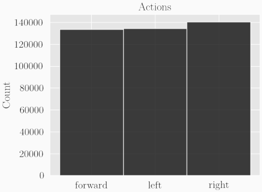


Training checks - Left/Right

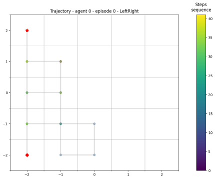


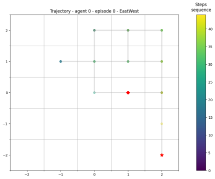


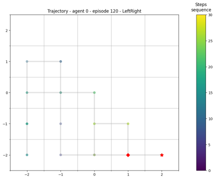


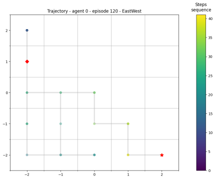


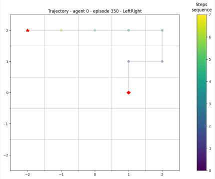
Agent behavior

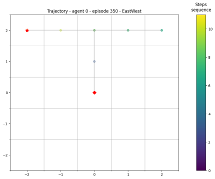












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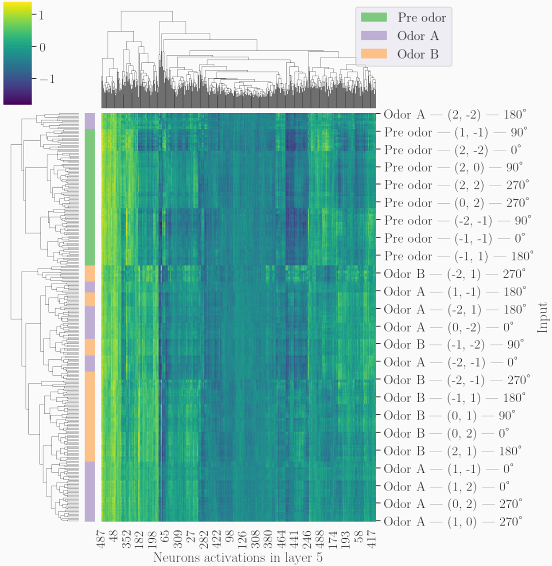
Activations learned - East/West



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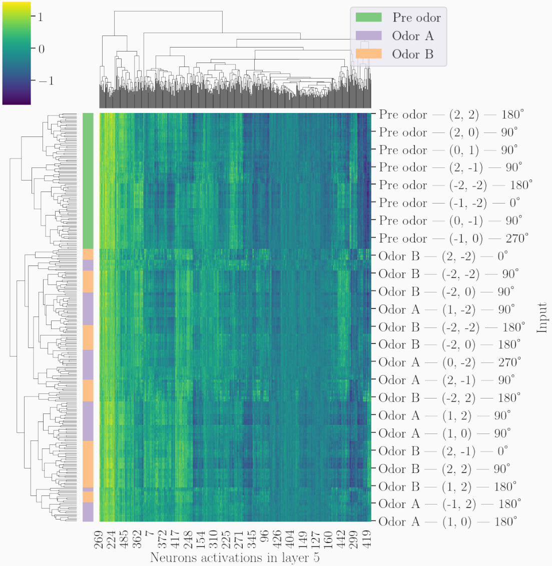

Cluster by action space

Other clustering method

Use the behavior as proxy – Perturbation experiment

- Perturb the Cartesian/polar part of the input on a trained agent and look at how the agent behaves (x4 experiments)
- Expectation:
    - Left/right task:
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    - Simulation does not end → haven't figured out why yet

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Next steps

Questions ?