



Learning useful representations to solve a place-odor association task

Andrea Pierré

April 4, 2023

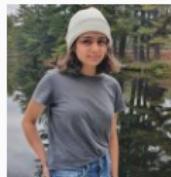
Fleischmann Lab



Collaborators



Matt Nassar



Niloufar Razmi



Jason Ritt

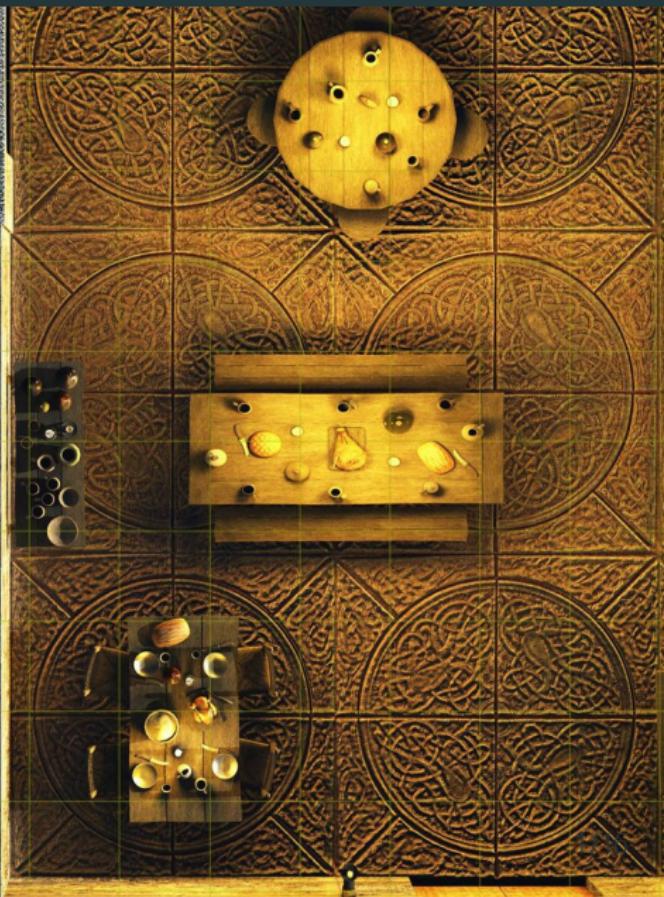
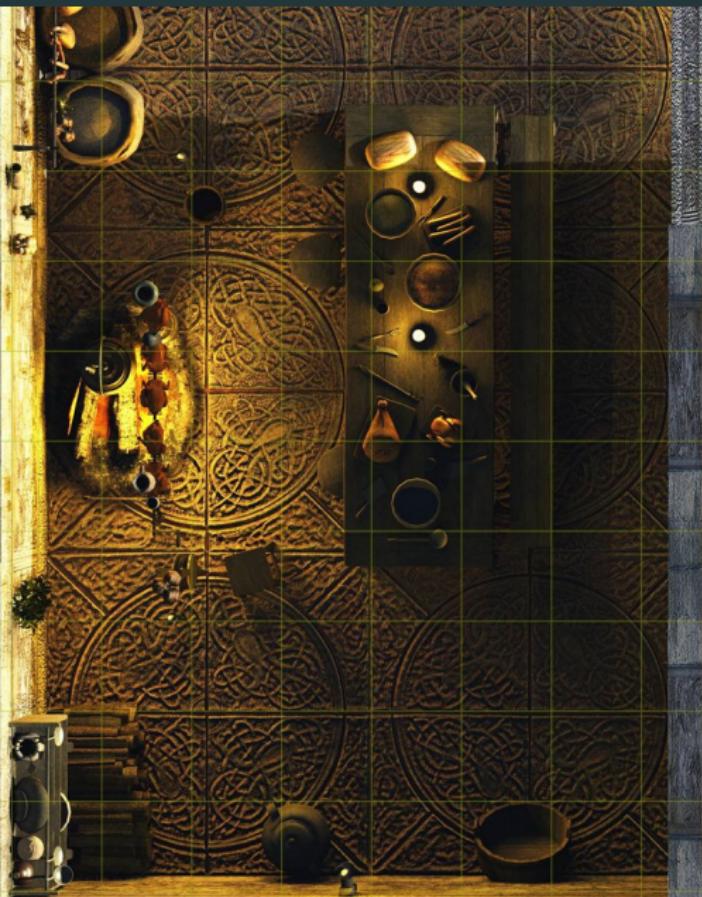


Olivia McKissick

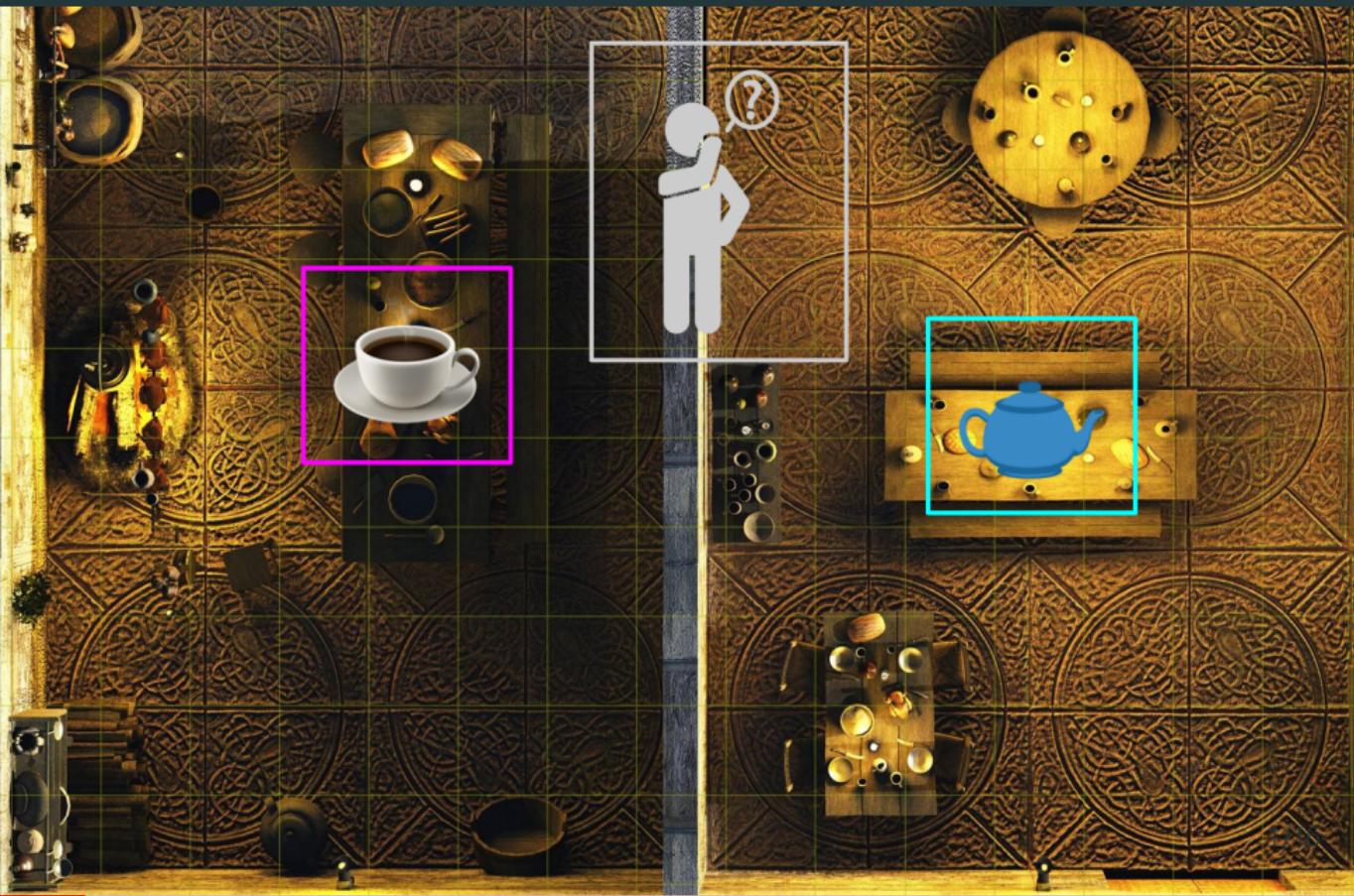


Alex
Fleischmann

Odor-place association

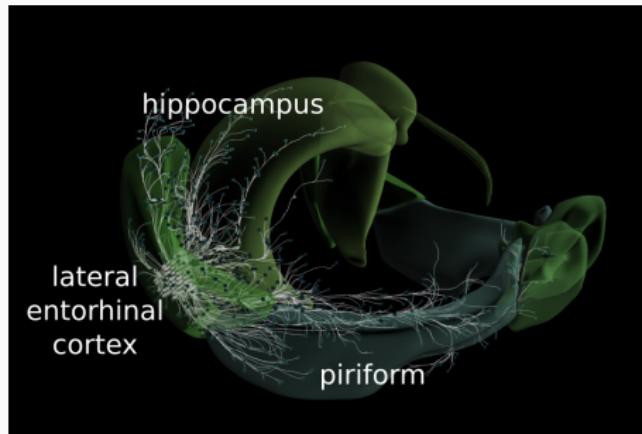


Odor-place association



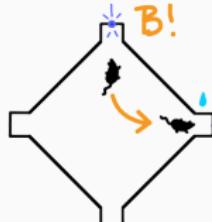
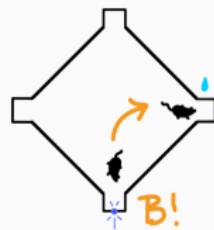
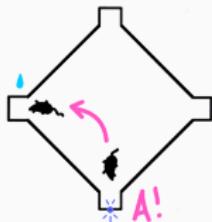
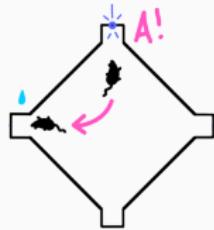
The LEC is key to sensory associations and spatial memory

- **Piriform** encodes olfactory information
- **Hippocampus** encodes spatial information
- **LEC** encodes both olfactory & spatial information

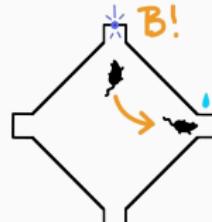
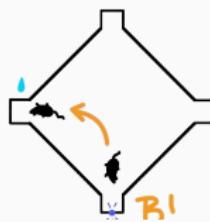
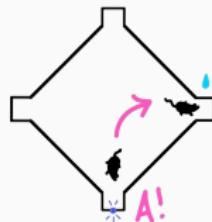
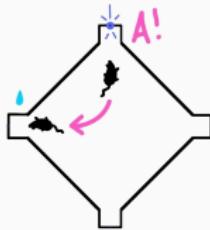


Diamond arena olfactory task

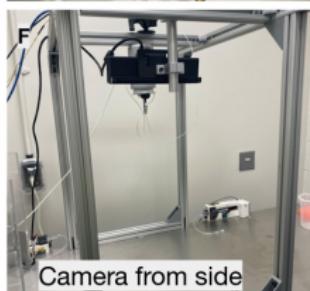
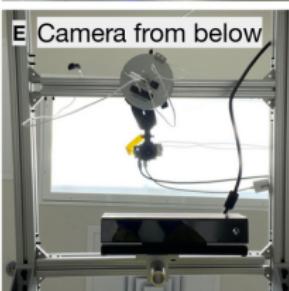
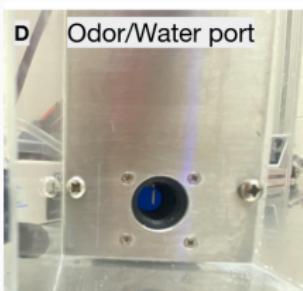
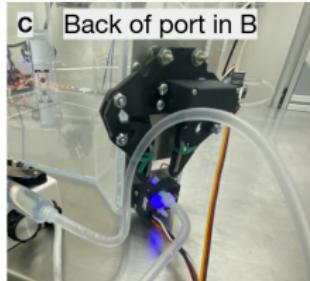
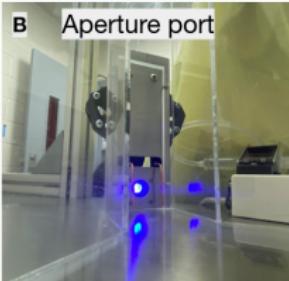
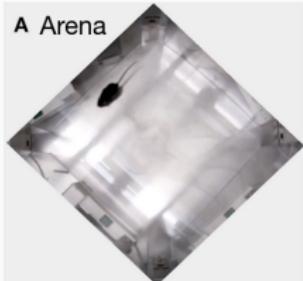
Allocentric
(go west/east)



Egocentric
(go right/left) Olivia McKissick



Diamond arena experimental setup



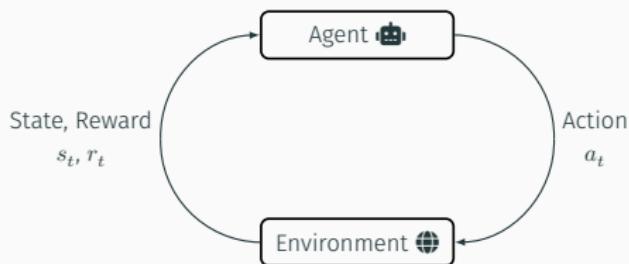
Olivia McKissick

What is Reinforcement Learning and why use it ?



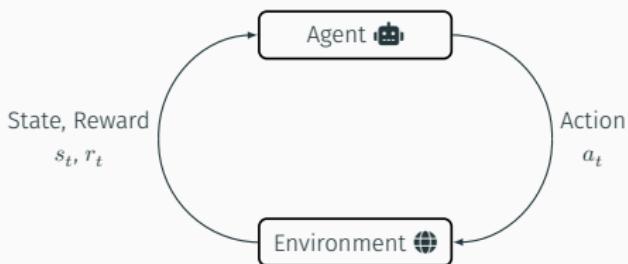
- Theoretical framework hypothesized to be implemented in the brain
- Tool to model behavior
- Goal of the agent: maximize rewards
- Natural fit for behavioral experiments involving rewards and learning

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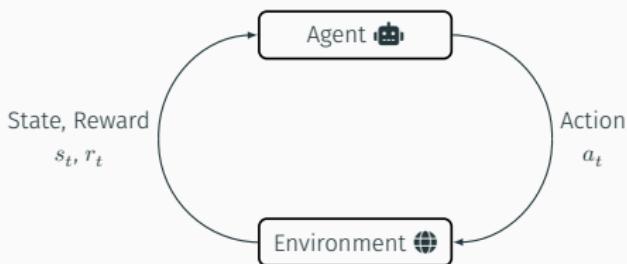
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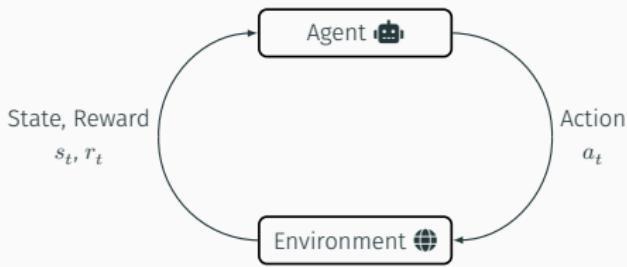
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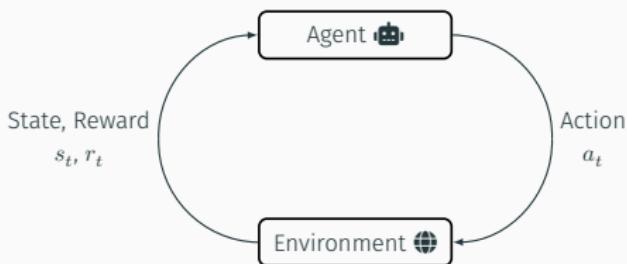
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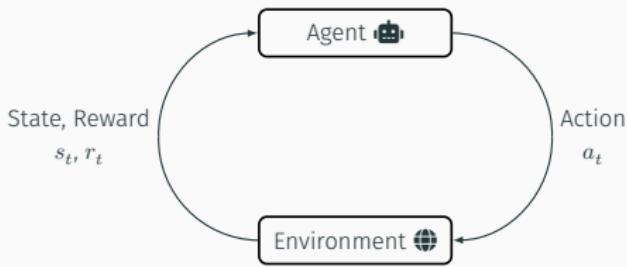
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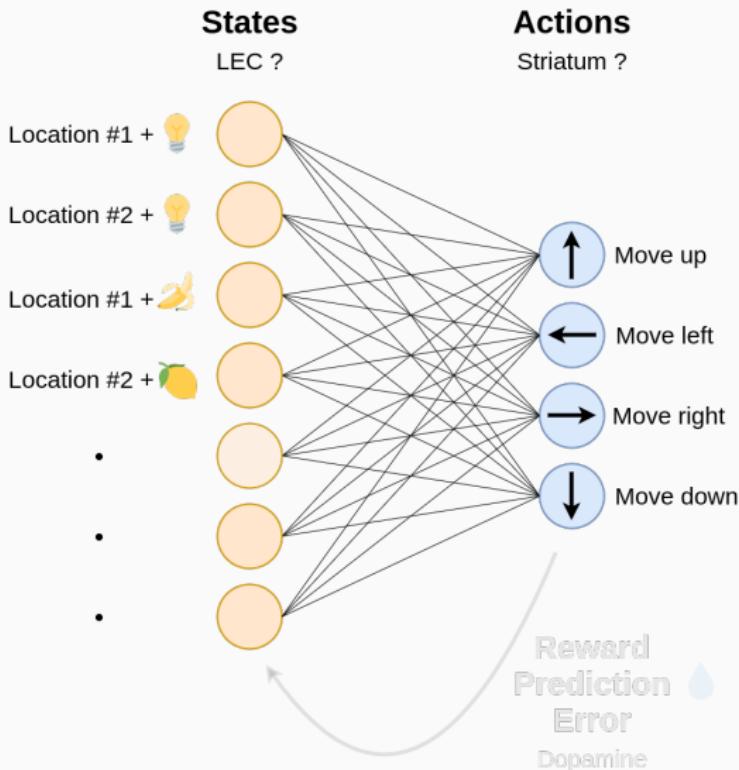
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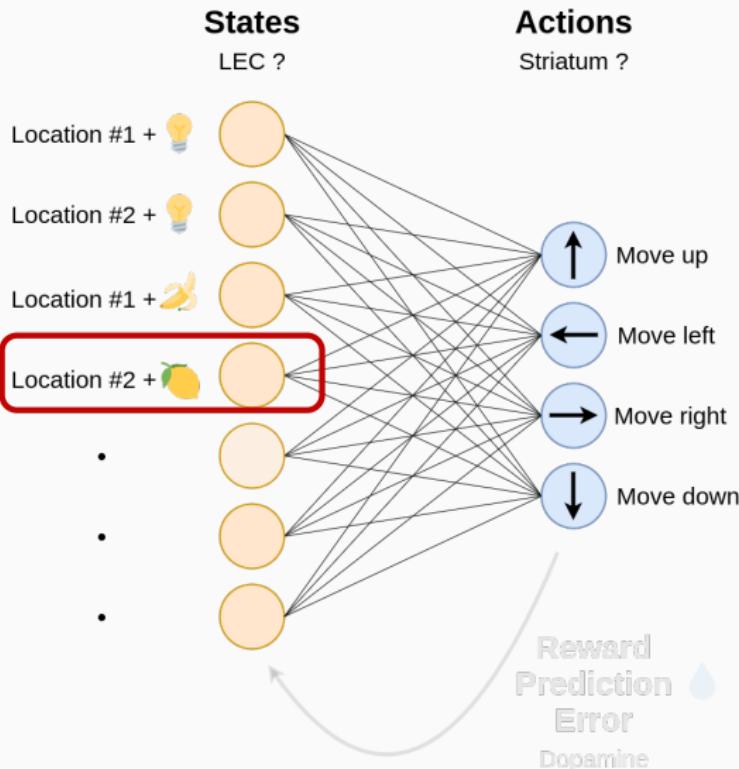


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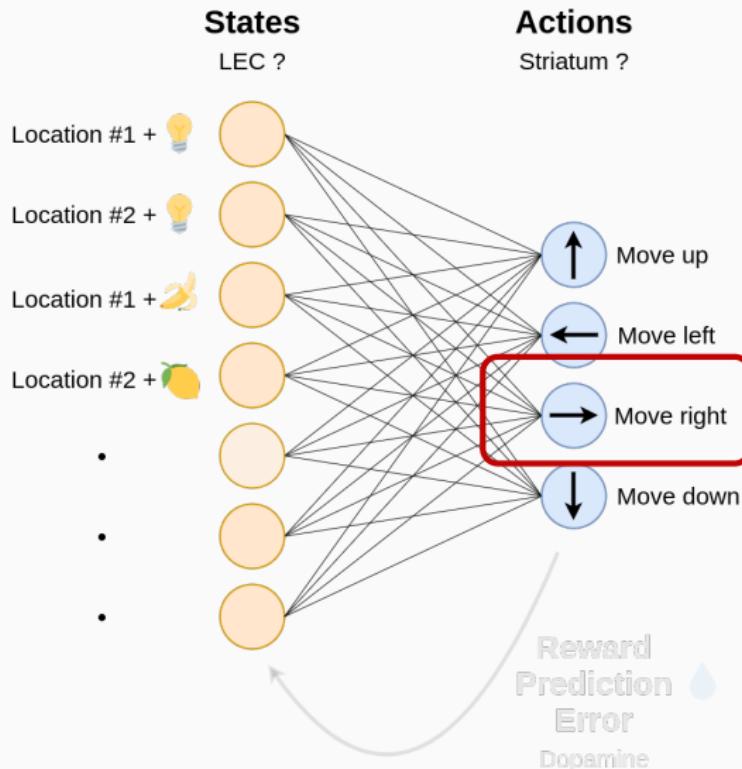
RL maps states to actions



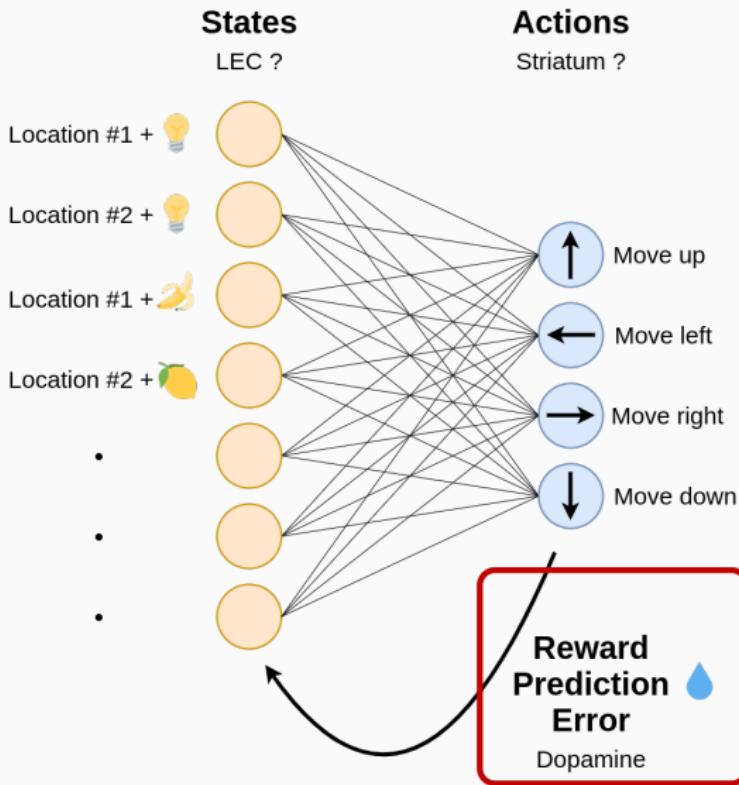
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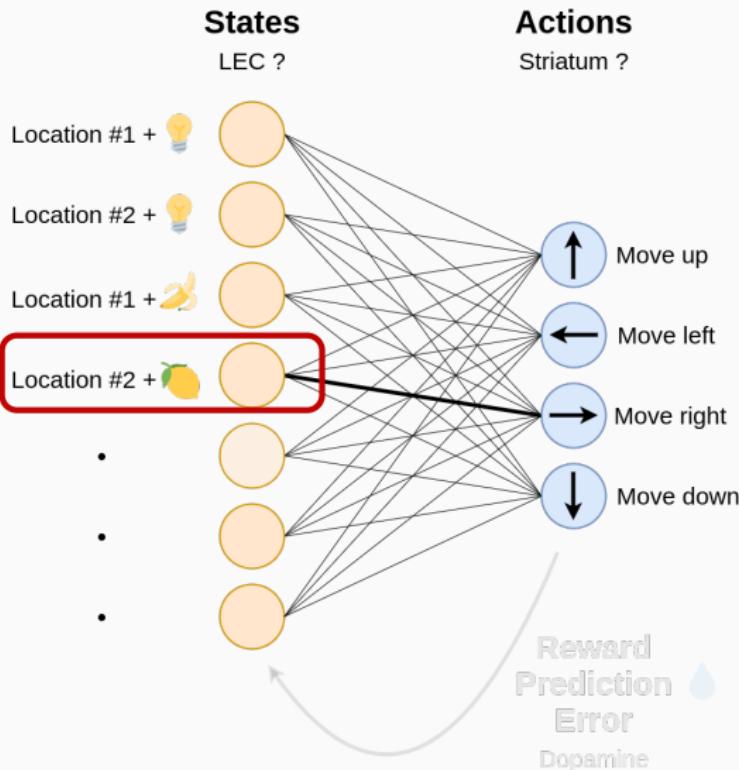
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The joint representation encodes odor + location

Location only

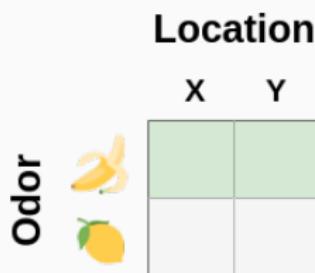


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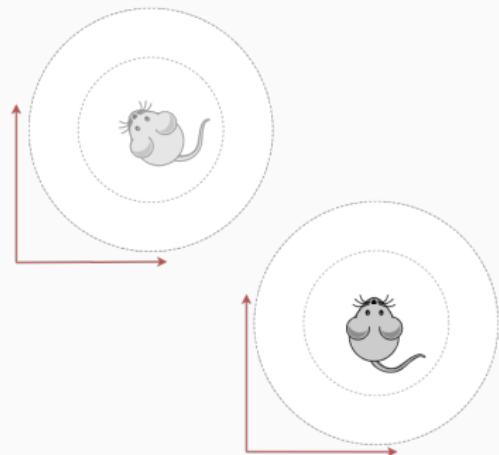
Joint



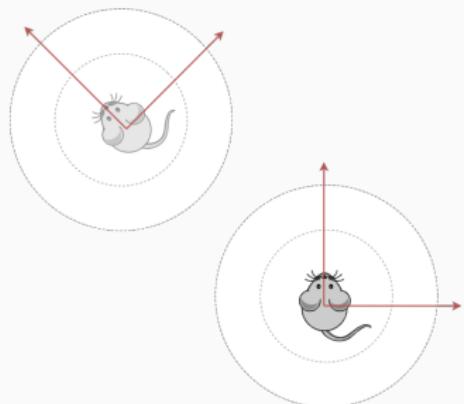
Which representations are needed by
the brain to learn a place-odor
association task ?

Allocentric vs. Egocentric

Allocentric

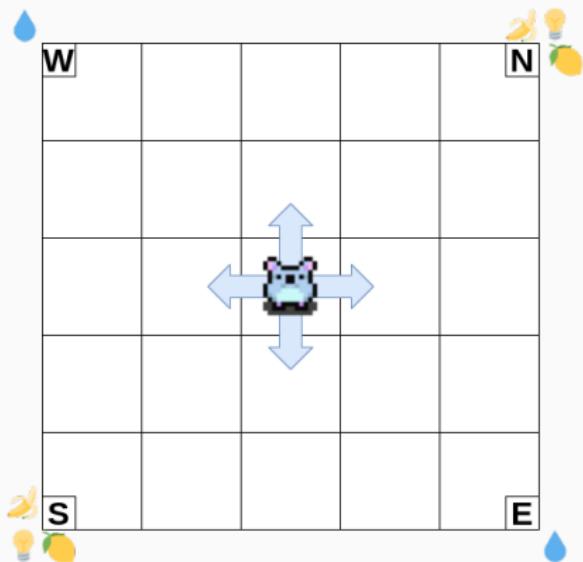


Egocentric



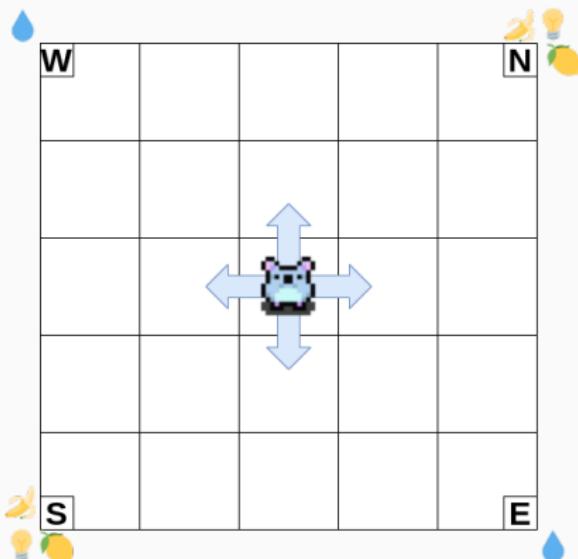
The model

Allocentric

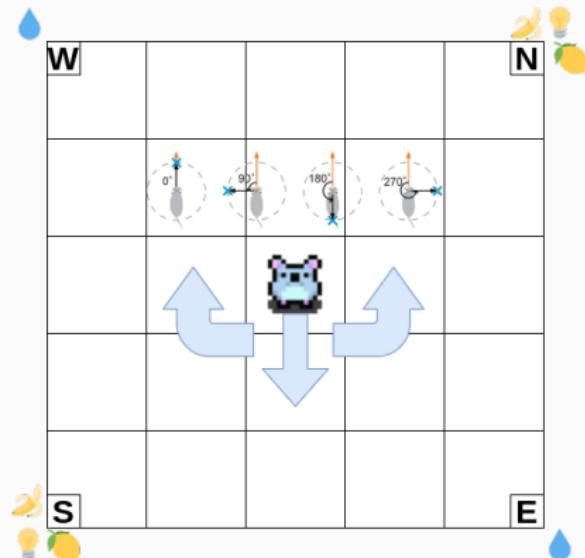


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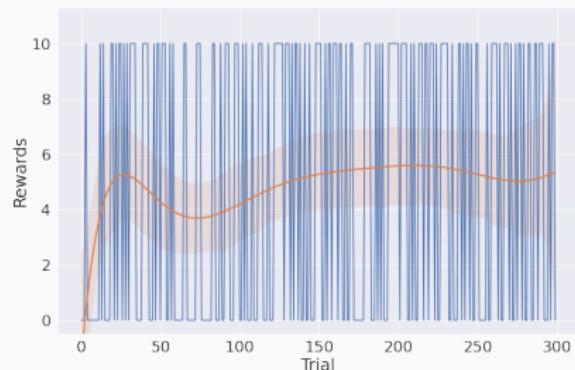


Egocentric

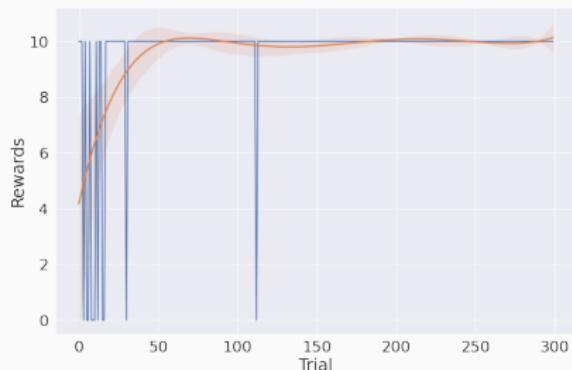


Maximizing rewards

Without joint representation



With joint representation

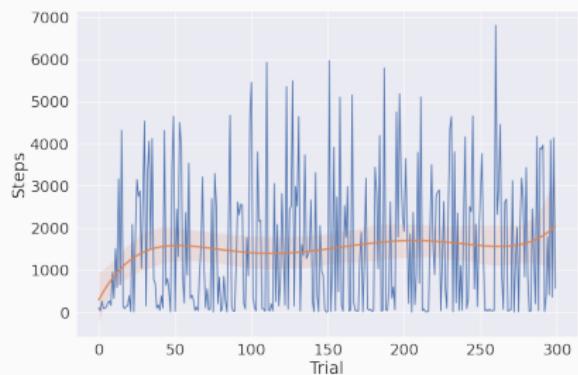


→ The agent doesn't learn

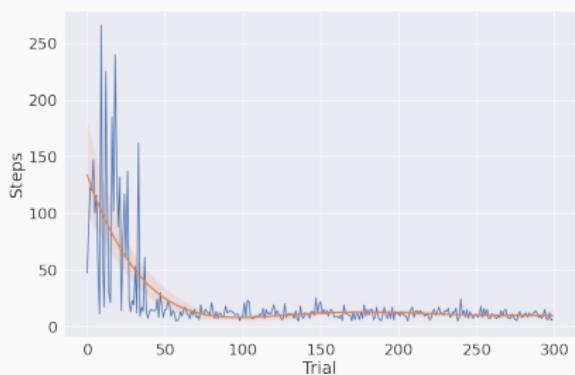
→ The agent learns to solve the task

Minimizing the number of steps to solve the task

Without joint representation



With joint representation



→ The agent doesn't learn

→ The agent learns to solve the task

What policy did the agent learned ?



What policy did the agent learned ?

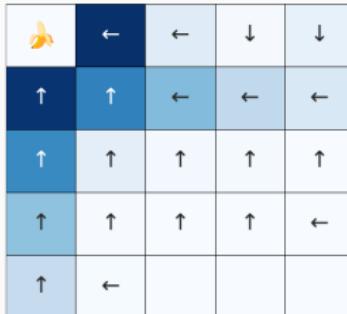
Pre odor - North light



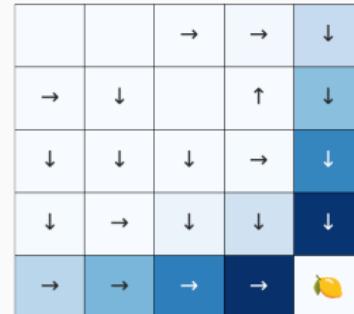
Pre odor - South light



Post odor - Odor A



Post odor - Odor B

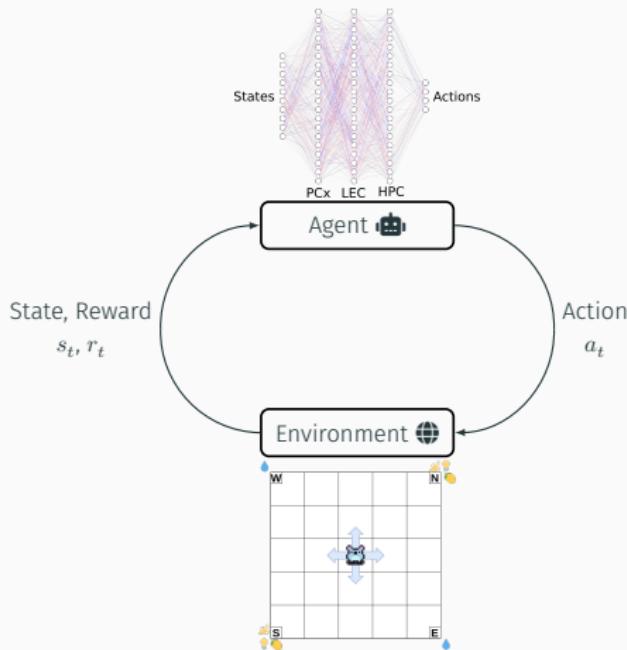


What we have done so far



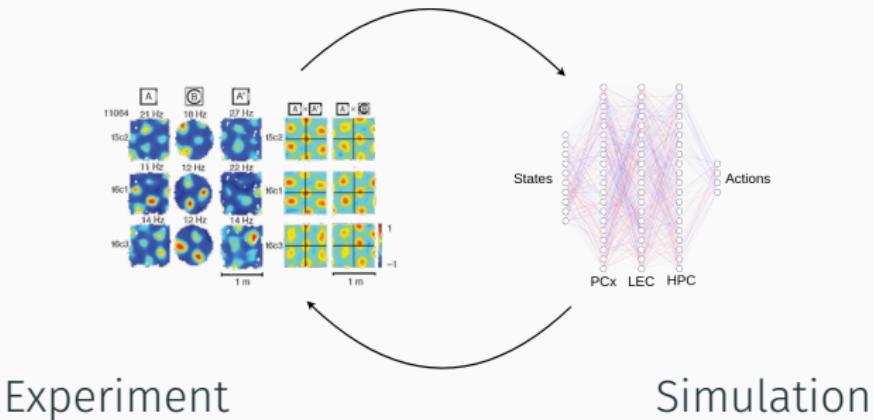
- Behavioral model only
- Tabular model that maps states to actions
- All states need to be visited by the agent to propagate the prediction of getting a future reward
→ not what happens in the brain

From tabular RL to deep RL



- Behavioral + neural model
- Neural network that maps states to actions
- Extract features from the simulation data
- Not all states need to be visited by the agent to propagate the prediction of getting a future reward
→ closer to the brain

What types of representations are in use to solve an odor-place association task ?



→ Look for candidate patterns in the data: place cells, grid cells,...?

→ Compare the data with the representations learned from scratch by the neural network

Summary

- We record in the LEC because it encodes spatial & olfactory information
- Reinforcement Learning is a useful framework to model behavior involving rewards and learning
- The joint representation is needed to solve an odor-place association task
- We hope to use Deep Reinforcement Learning to better understand the representations that are at play in this type of task

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Acknowledgments

Fleischmann lab

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- Camille Donoho
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- Matt Nassar
- Jason Ritt
- Niloufar Razmi



Egocentric policy

