



Learning useful representations to solve a place-odor association task

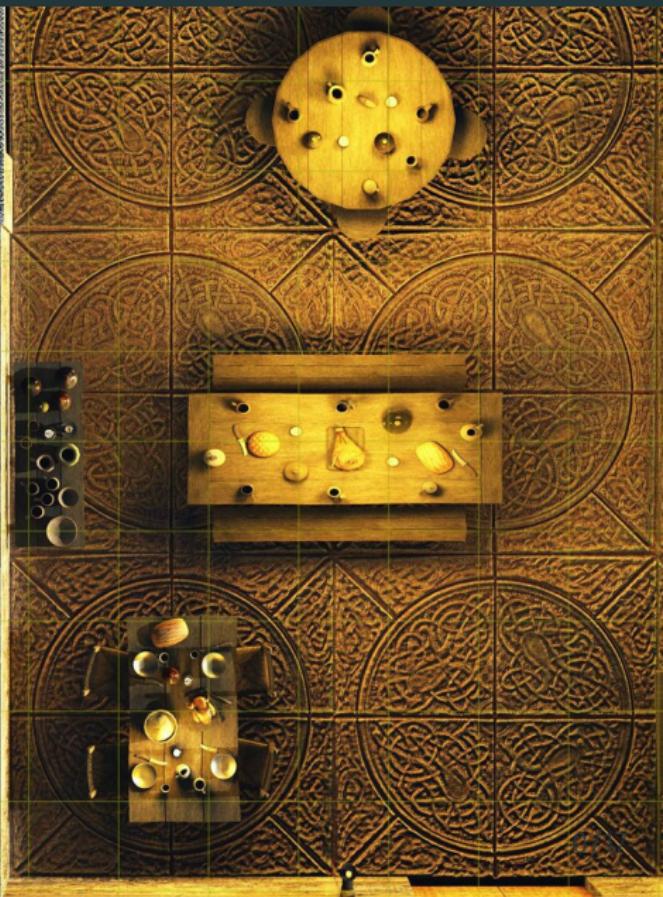
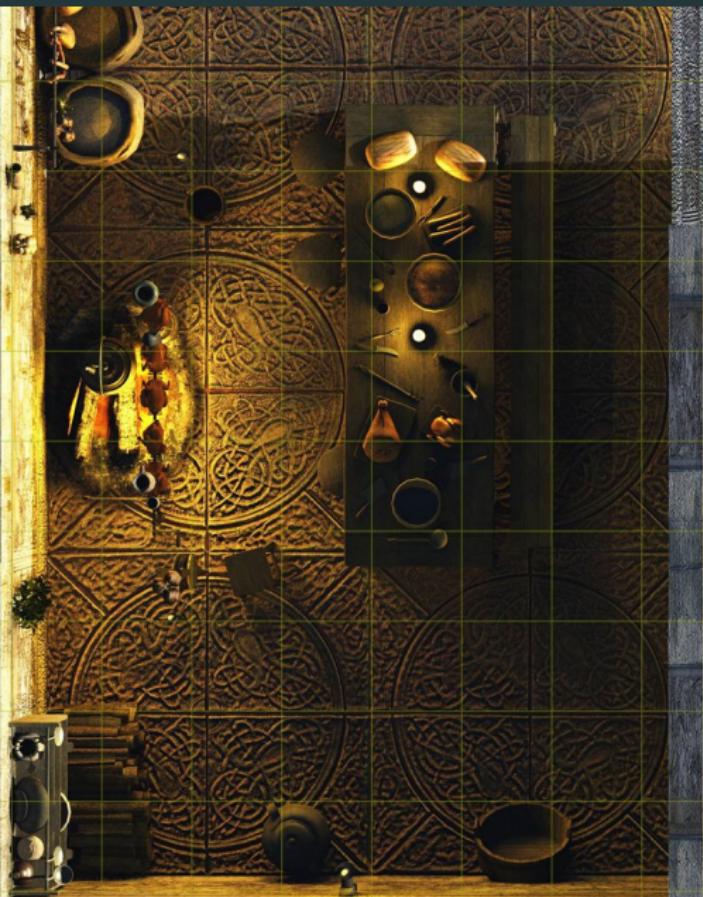
Andrea Pierré

April 4, 2023

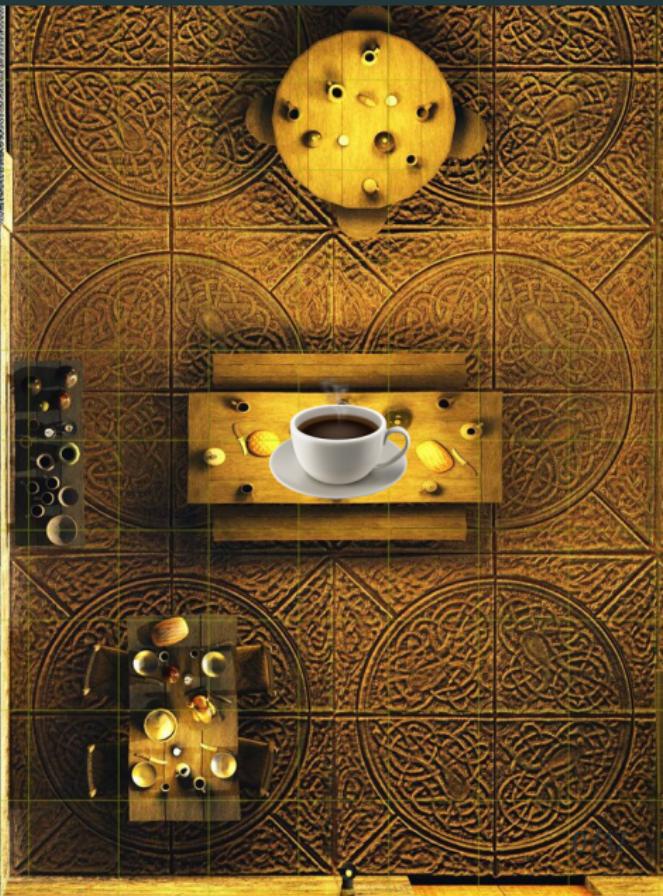
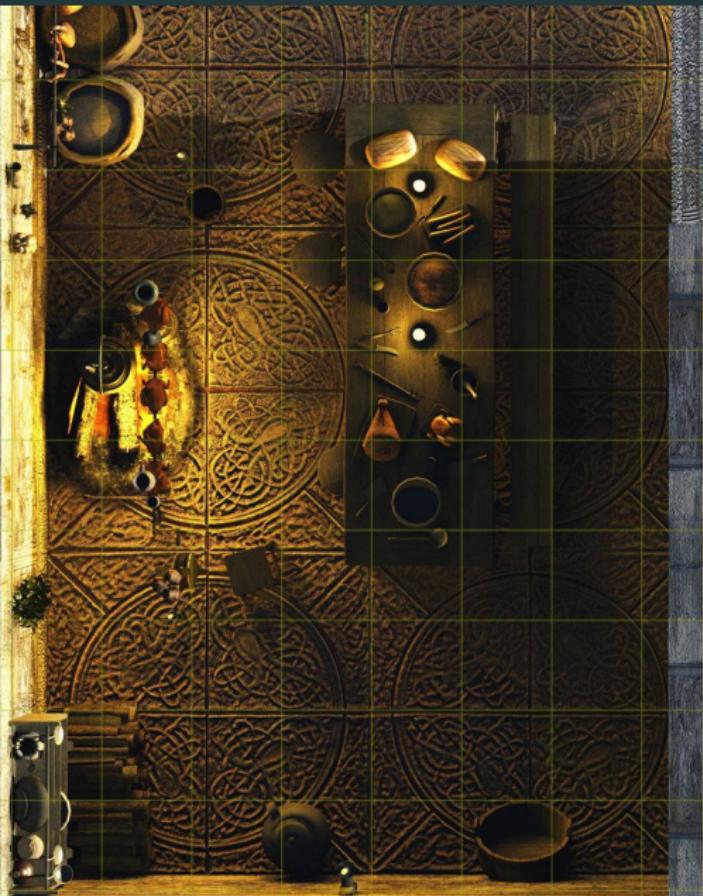
Fleischmann Lab



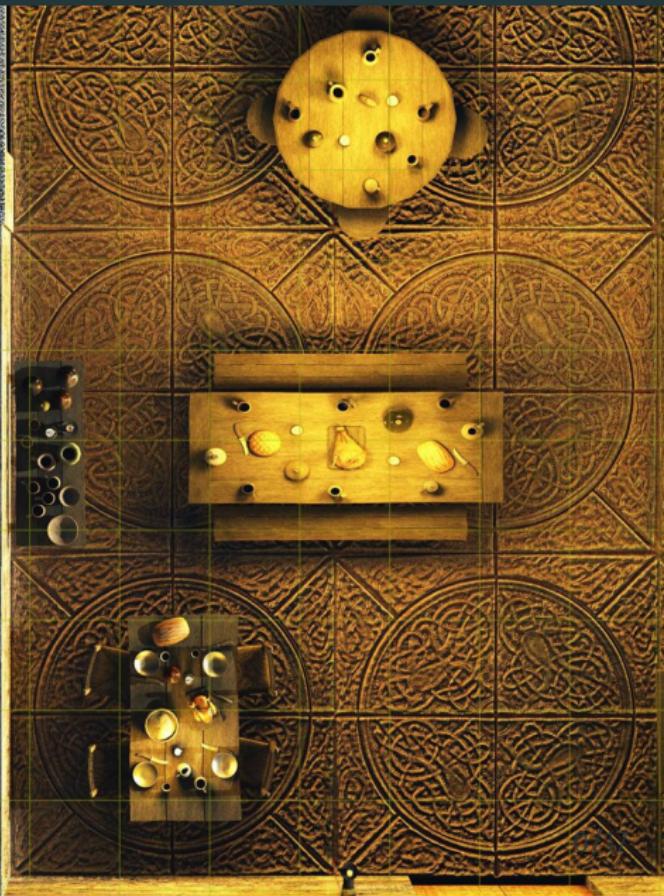
Odor-place association



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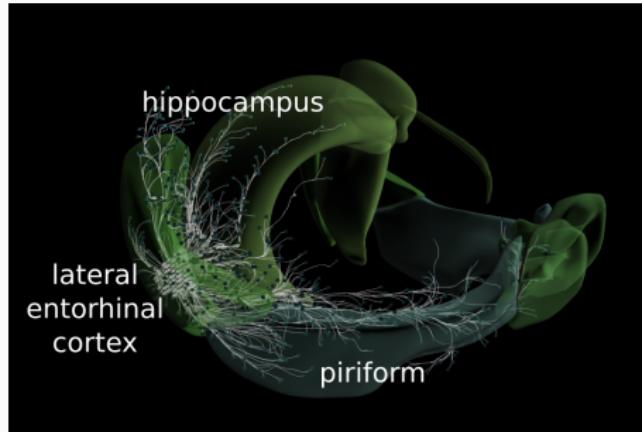


Odor-place association

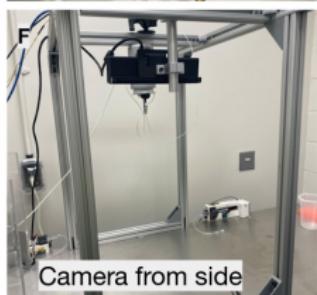
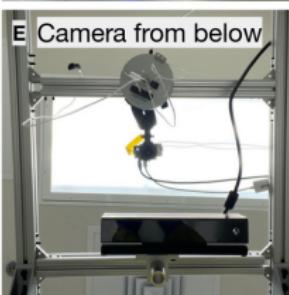
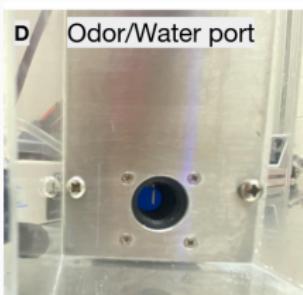
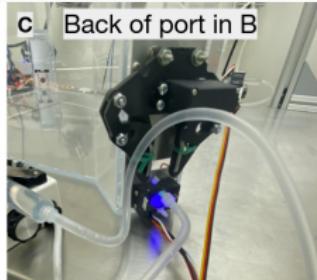
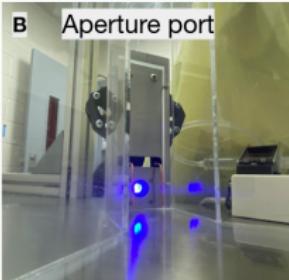
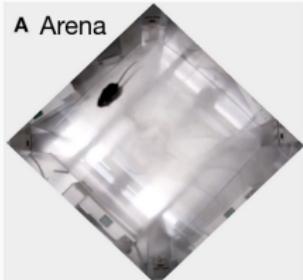


The LEC is key to sensory associations and spatial memory

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



Diamond arena experimental setup

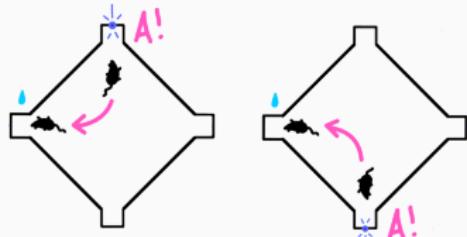


Olivia McKissick

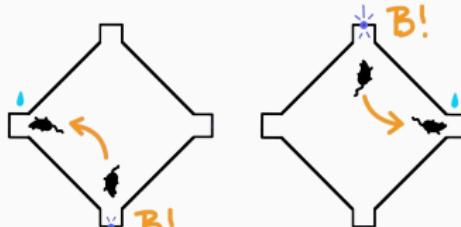
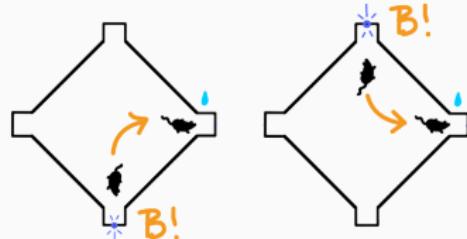
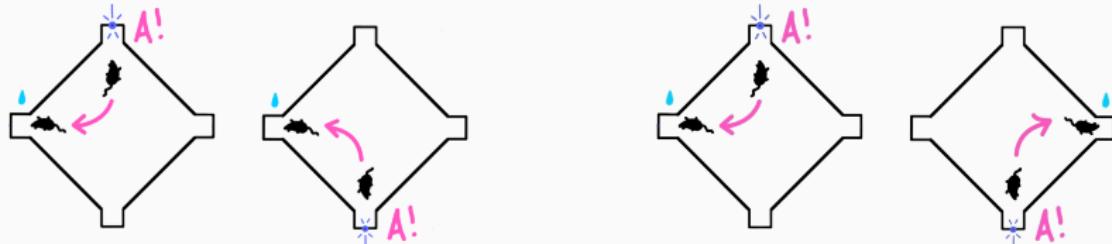
Diamond arena olfactory task



Allocentric
(go west/east)



Egocentric
(go right/left)

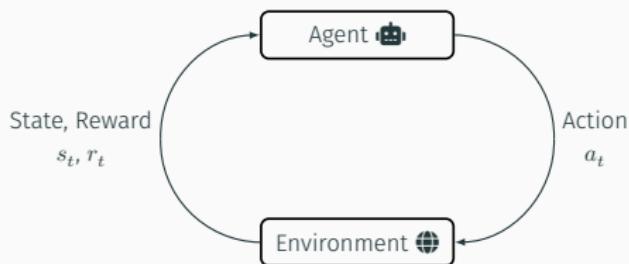


What is Reinforcement Learning and why use it ?



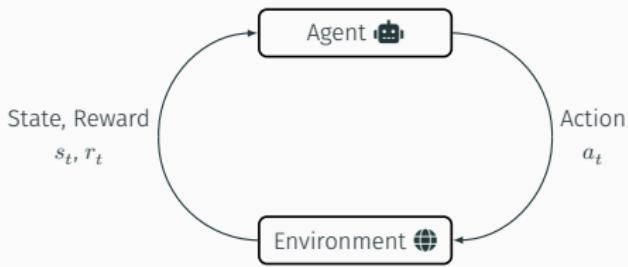
- Theoretical framework hypothesized to be implemented in the brain
- Tool to model behavior
- Goal of the agent: maximize rewards
- Natural fit for behavioral experiments involving rewards and learning

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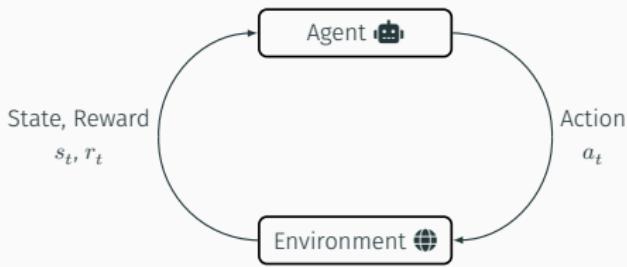
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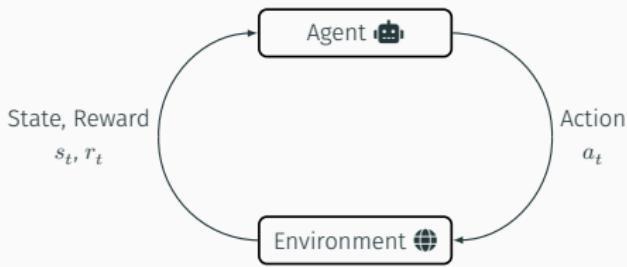
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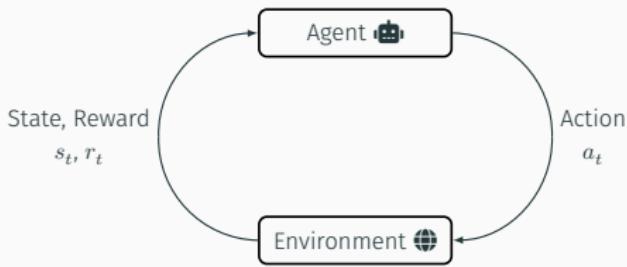
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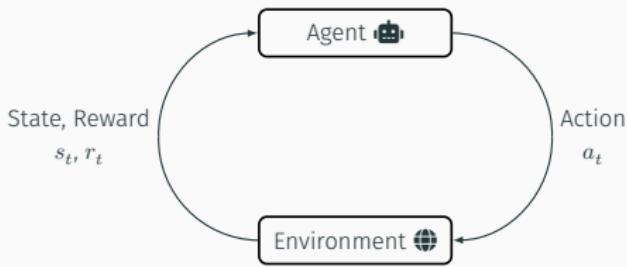
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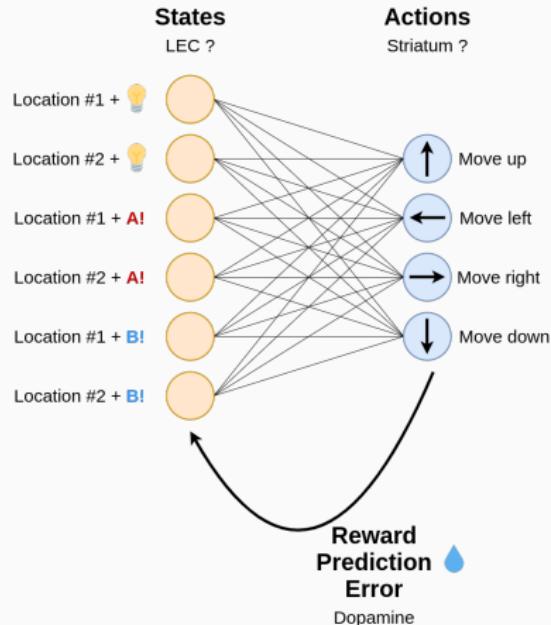
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RL maps states to optimized actions



$$Q^{new}(s_t, a_t) \leftarrow Q(s_t, a_t) + \frac{\alpha}{\text{learning rate}} \frac{\text{temporal difference}}{(\underbrace{r_t}_{\text{reward}} + \gamma \max_a Q(s_{t+1}, a)) - Q(s_t, a_t)}$$

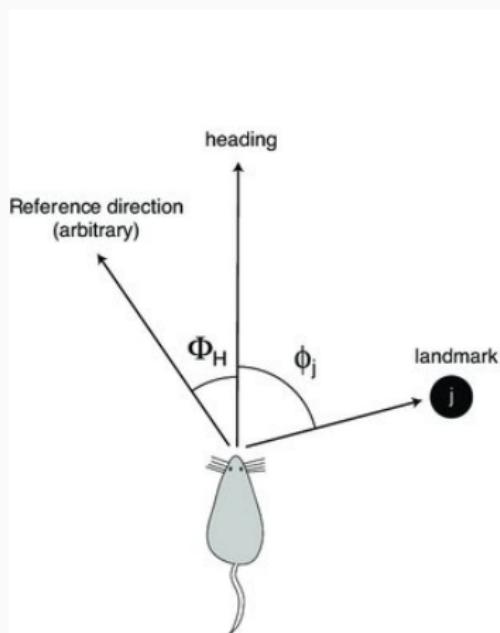
$$\mathbf{Q} = \mathbf{x} \cdot \mathbf{W}$$

Question

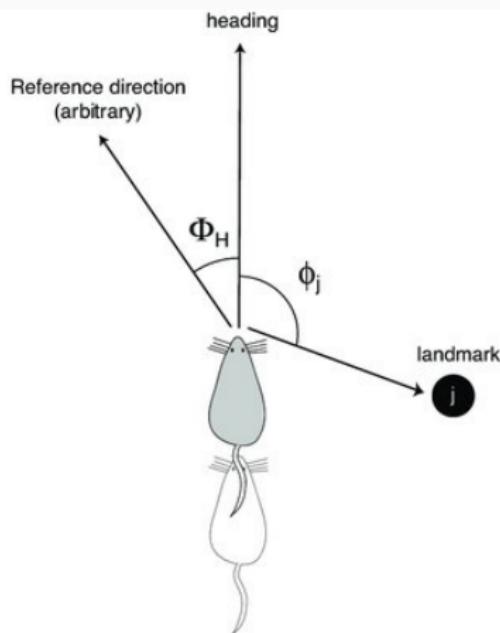
Which representations are needed by the brain to learn a place-odor association task ?

Allocentric vs. Egocentric

Allocentric

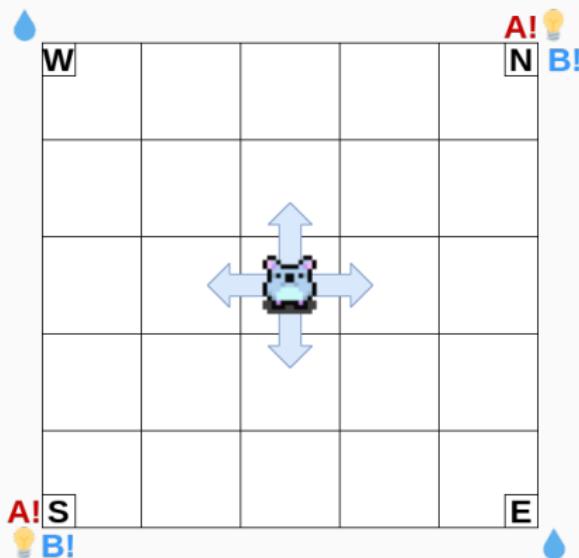


Egocentric



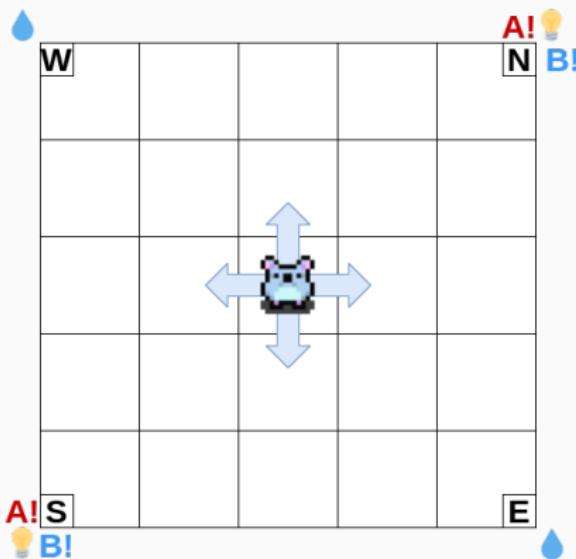
The model

Allocentric

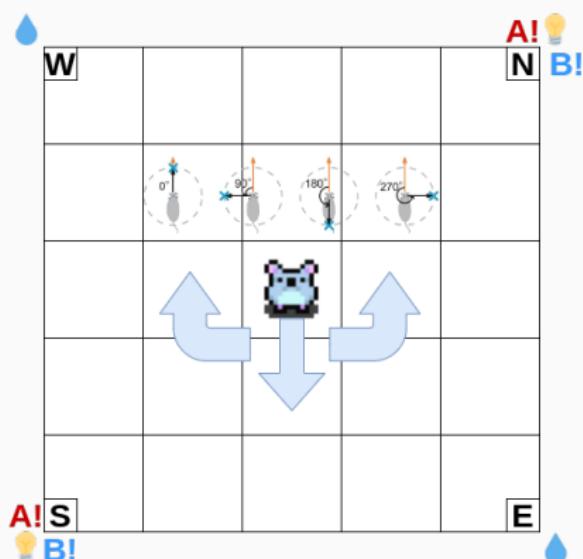


The model

Allocentric



Egocentric



The joint representation encodes odor + location

Location only

Location		
Odor	A!	
	B!	
X		
Y		

Odor only

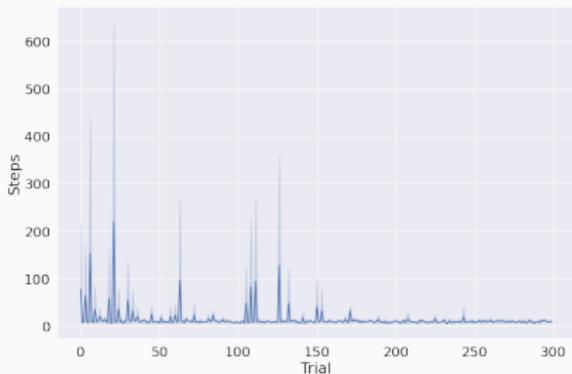
Location		
Odor	A!	
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X		
Y		

Joint

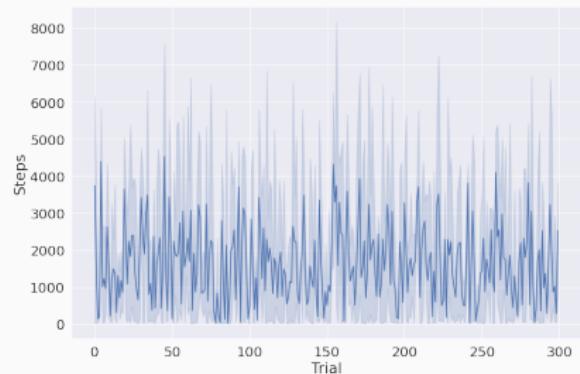
Location		
Odor	A!	
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X		
Y		

Minimizing the number of steps to solve the task

With joint representation



Without joint representation

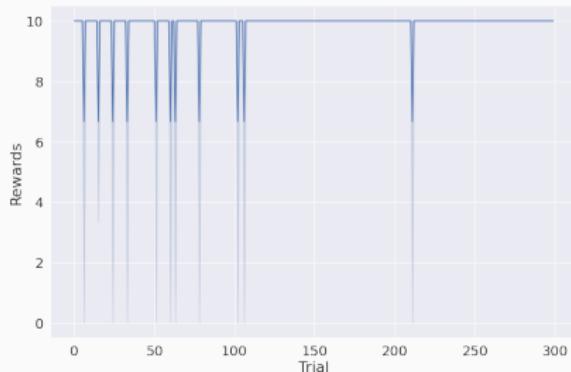


→ The agent learns to solve the task

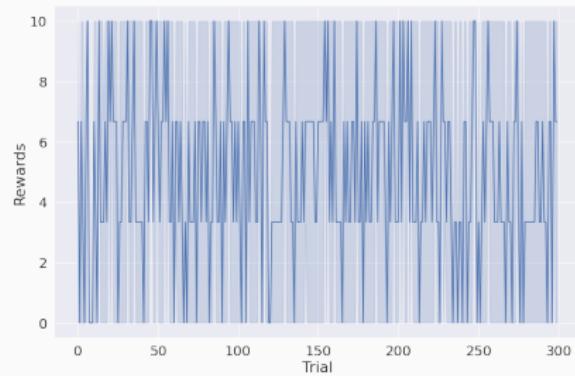
→ The agent doesn't learn

Maximizing rewards

With joint representation



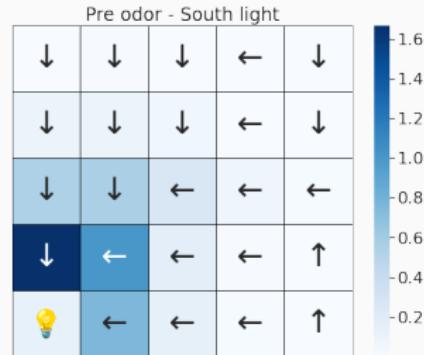
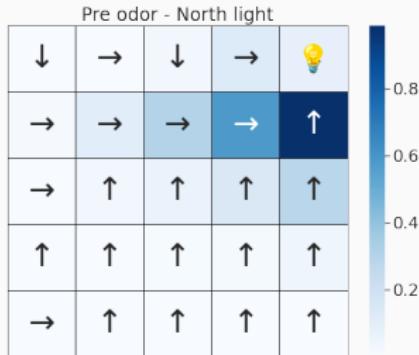
Without joint representation



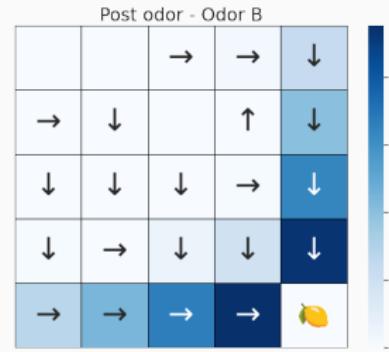
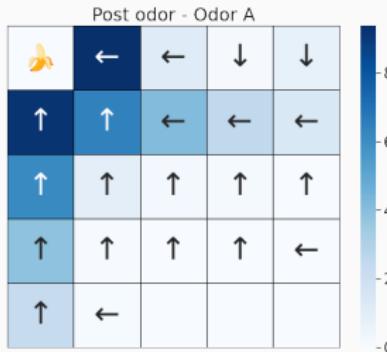
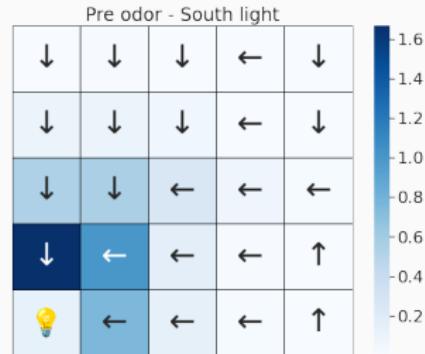
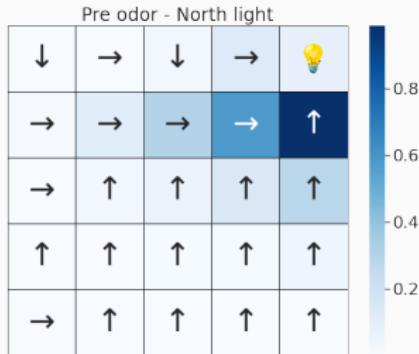
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What policy did the agent learned ?



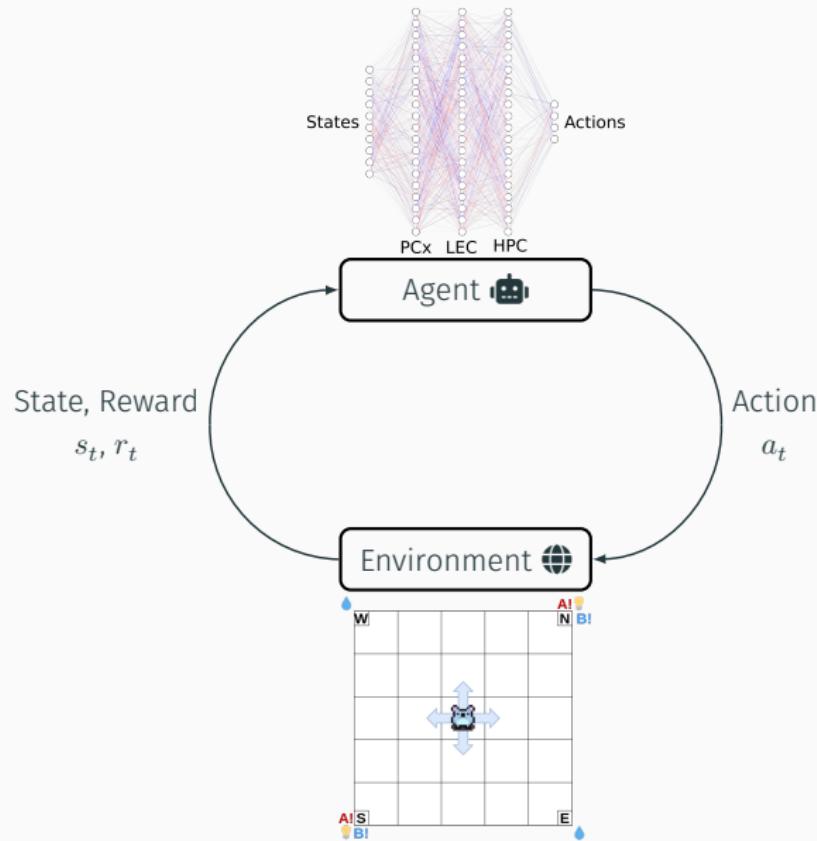
What policy did the agent learned ?



What we have done so far

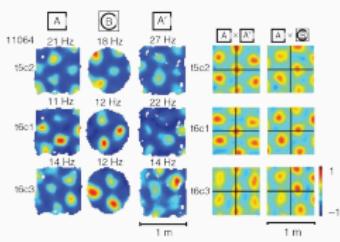


From tabular RL to deep RL



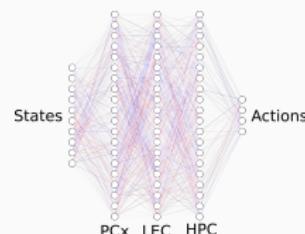
What types of representations are in use to solve the odor-place association task ?

Experiment



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

Simulation



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

Summary

- We record in the LEC which encodes spatial & olfactory information
- Reinforcement Learning can be a useful tool to model behavior involving rewards and learning
- The joint representation is needed to solve an odor-place location task

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Acknowledgments

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