Joint RL meeting

Andrea Pierré

November 18, 2023

Brown University

Outline

1. Context
2. Deep RL on toy task
3. Deep RL on half triangle task
4. Next steps brainstorming

Outline

1. Context
2. Deep RL on toy task
3. Deep RL on half triangle task
4. Next steps brainstorming

Context

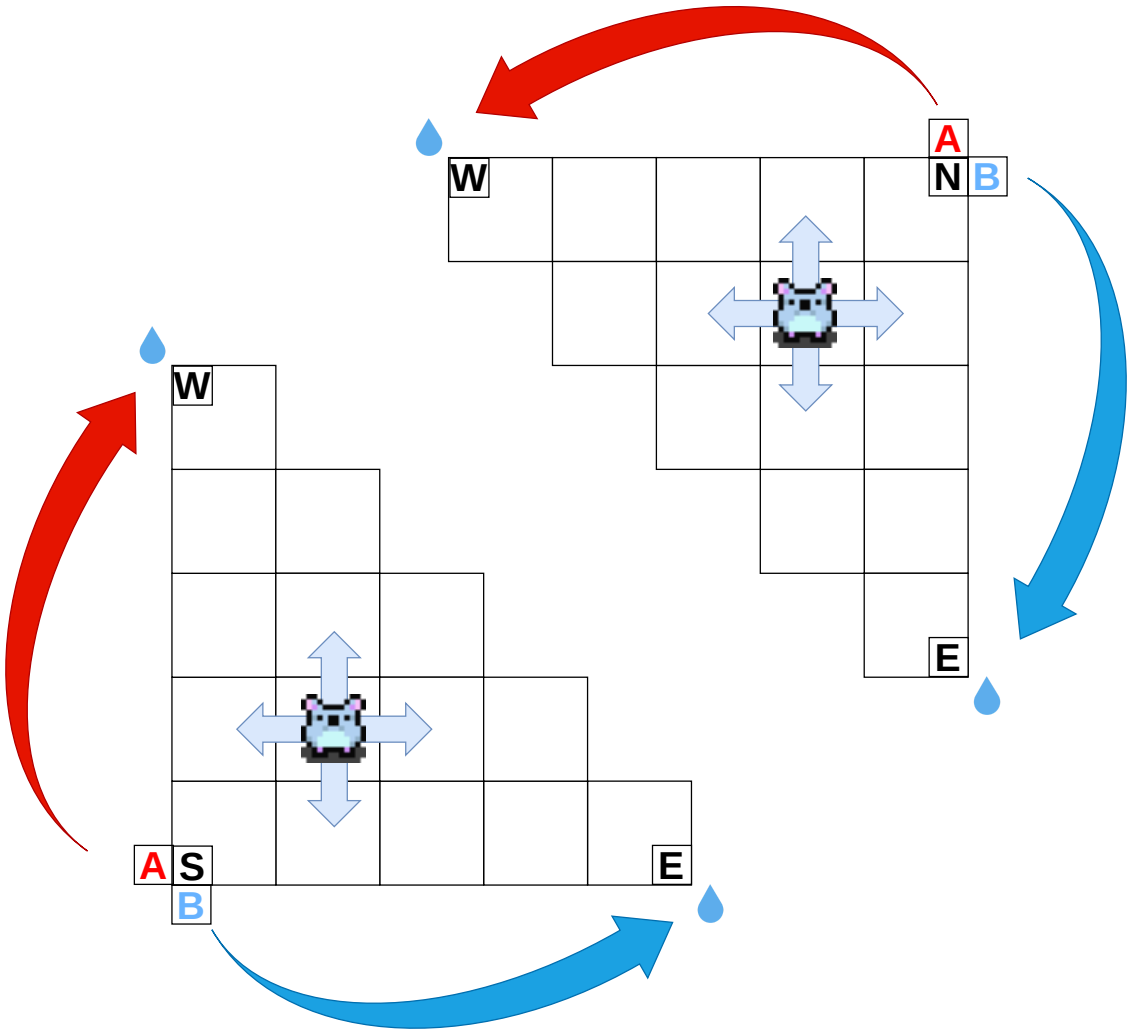
Question

What are the representations needed to solve a spatial olfactory task?

Hypothesis

Both the agent & the animal need a conjuctive representation of {location + cue} to solve the task

Half triangle task



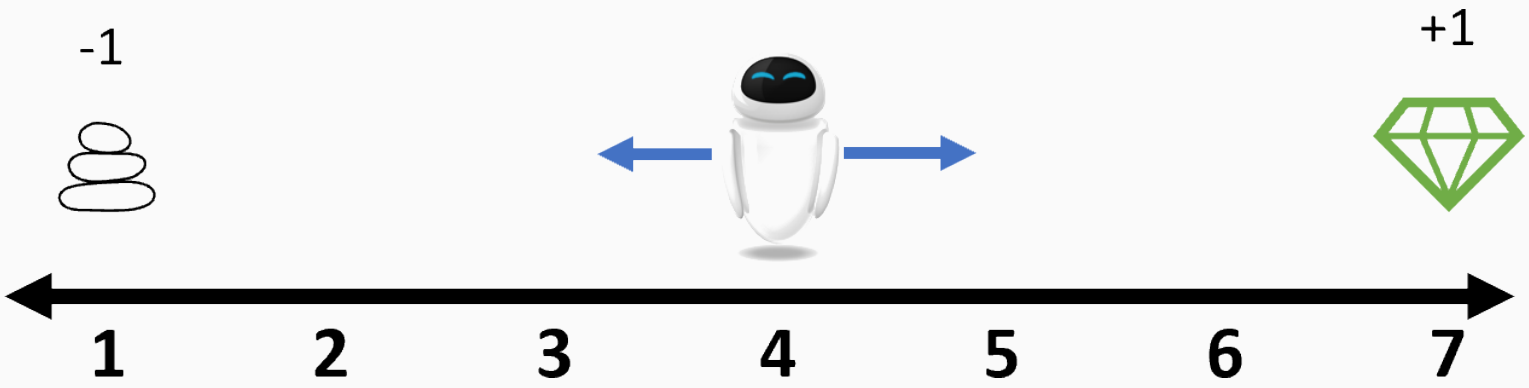
Paths followed until today...

1. RL package in Julia
2. Rewrite everything in Python and do backprop by hand
3. Rewrite in PyTorch
    3.1 Run on GPU on Oscar
    3.2 Downscaled task to run on CPU

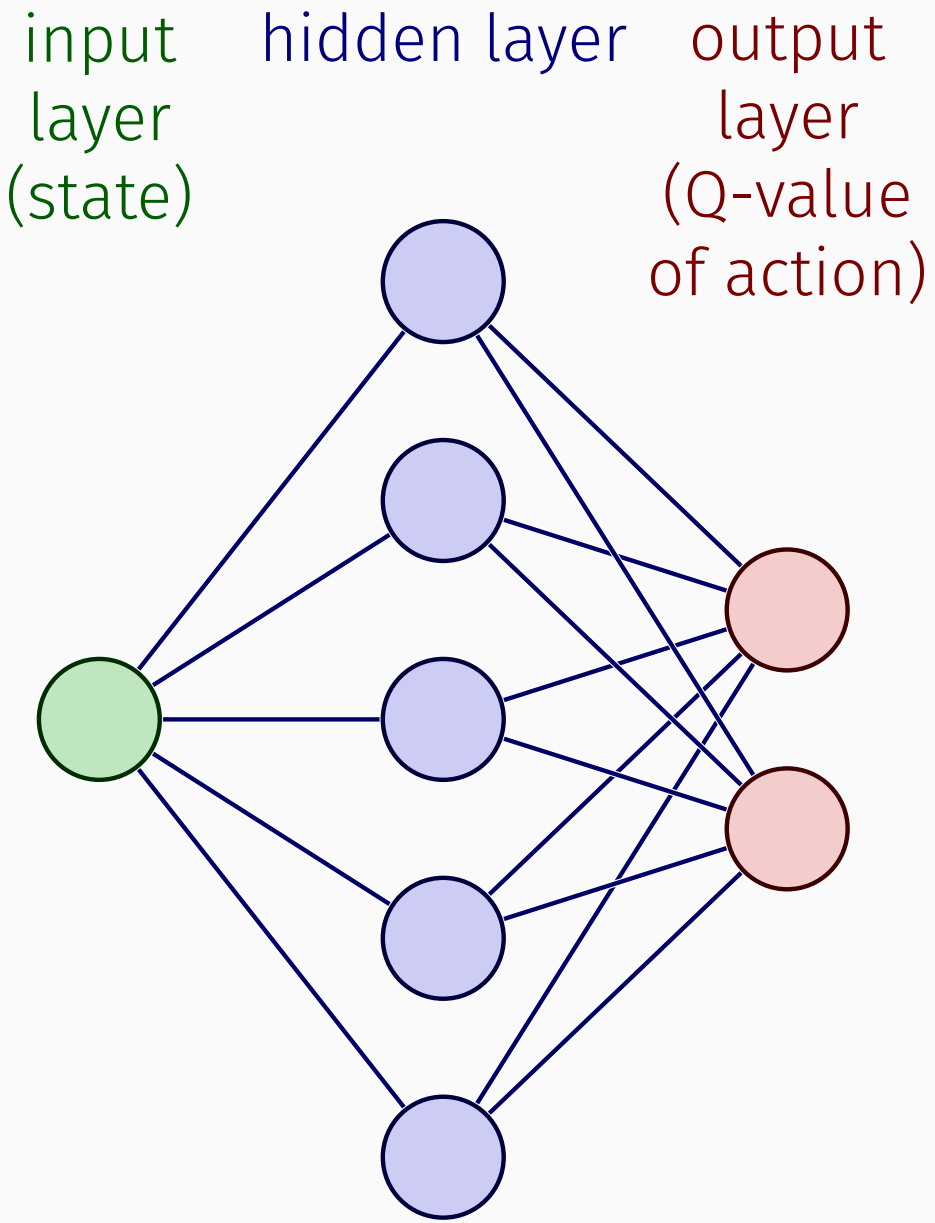
Outline

1. Context
2. Deep RL on toy task
3. Deep RL on half triangle task
4. Next steps brainstorming

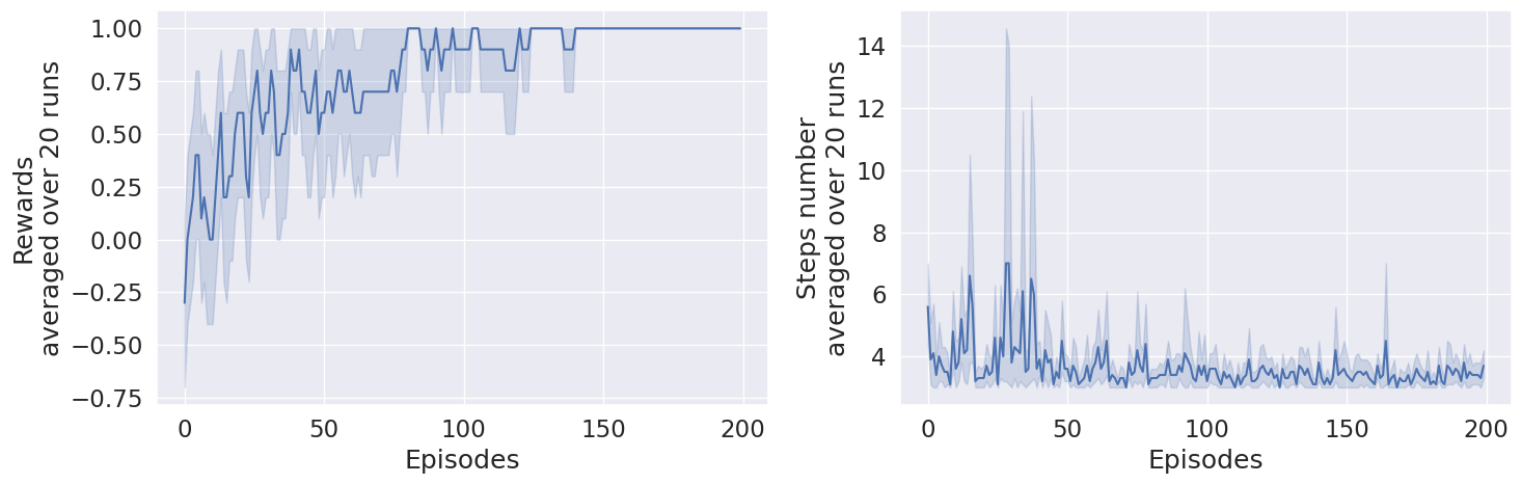
Toy task : Random Walk 1D



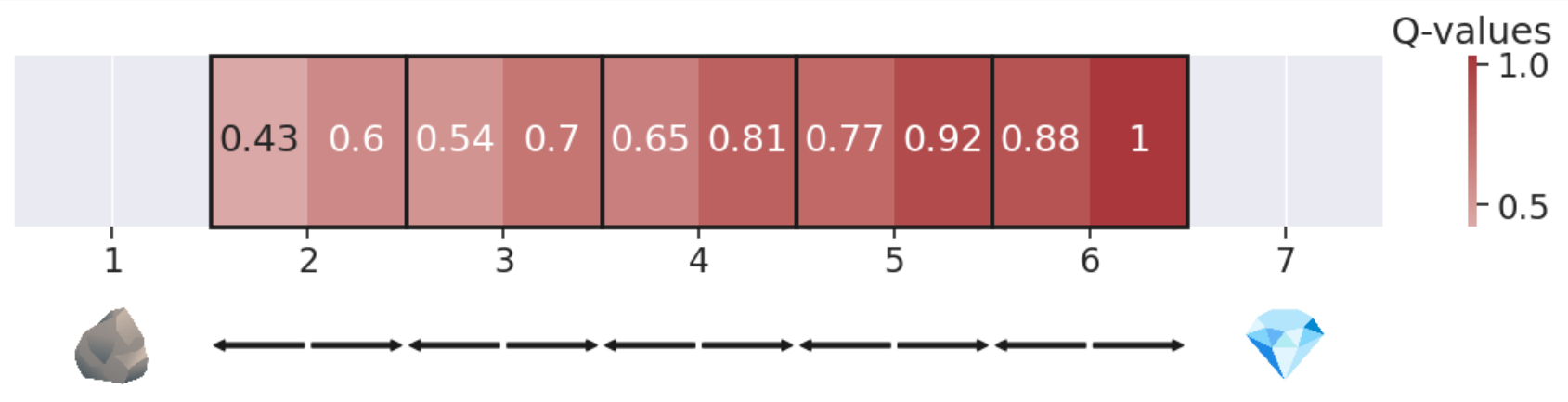
Network used



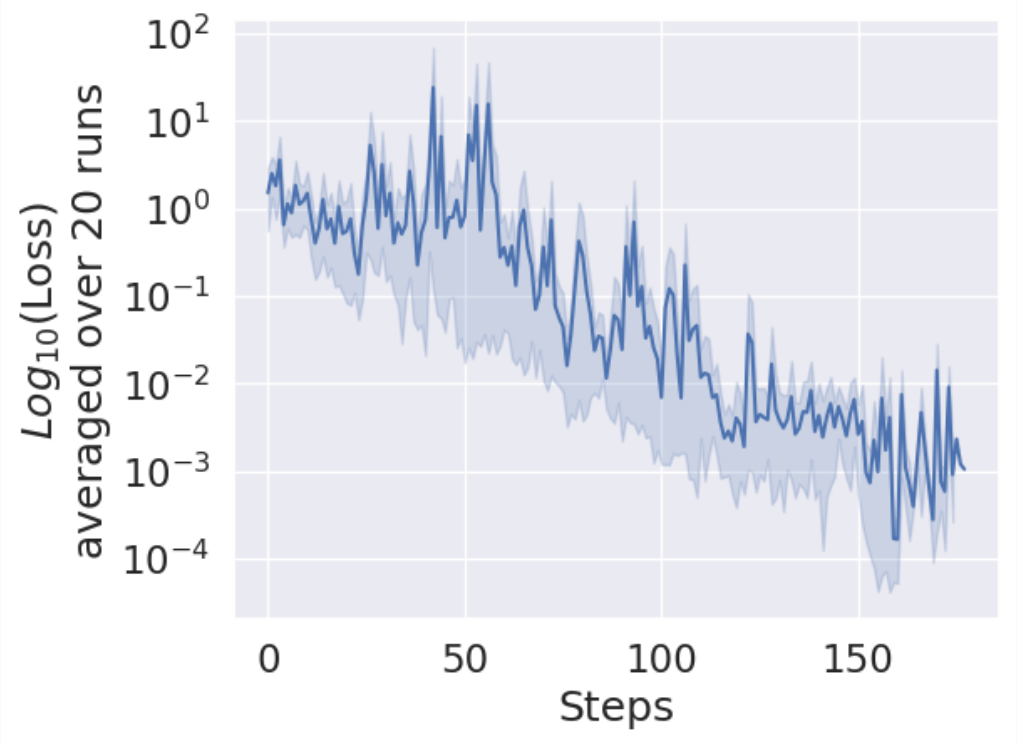
Rewards and steps



Policy learned



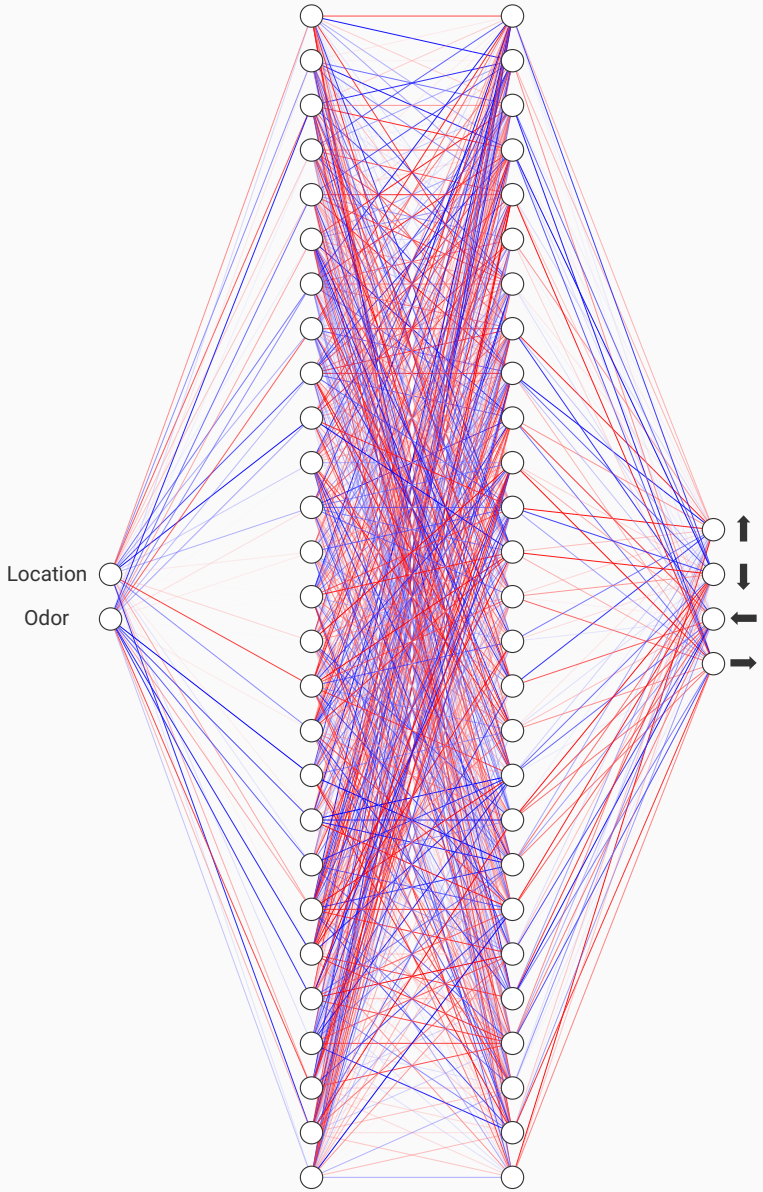
Cost function



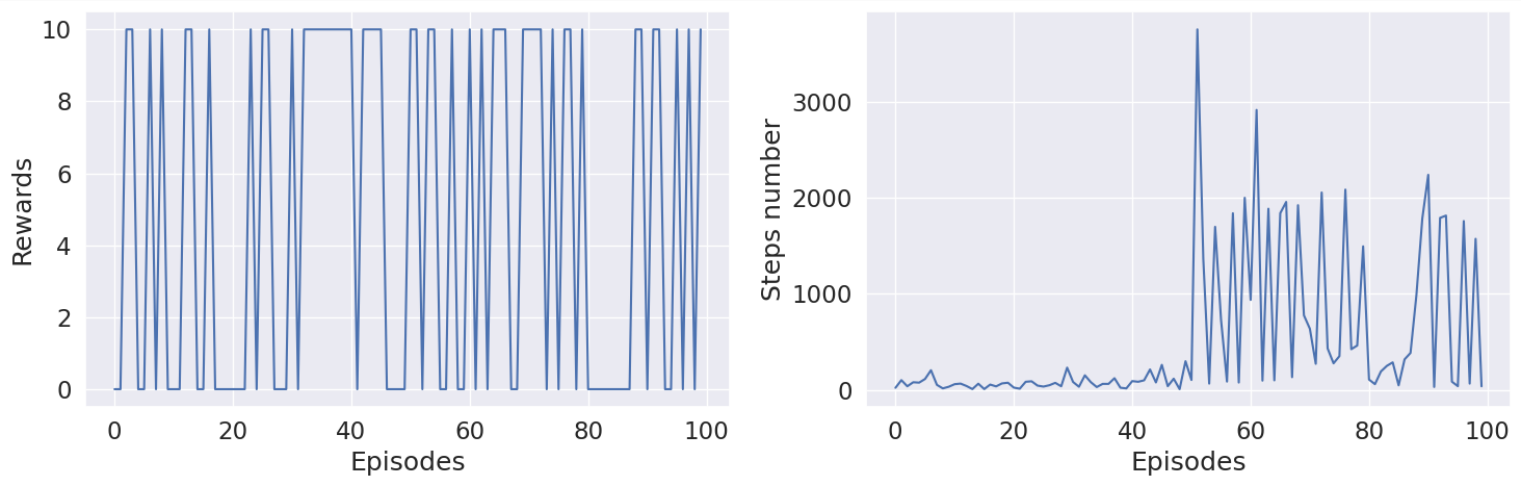
Outline

1. Context
2. Deep RL on toy task
3. Deep RL on half triangle task
4. Next steps brainstorming

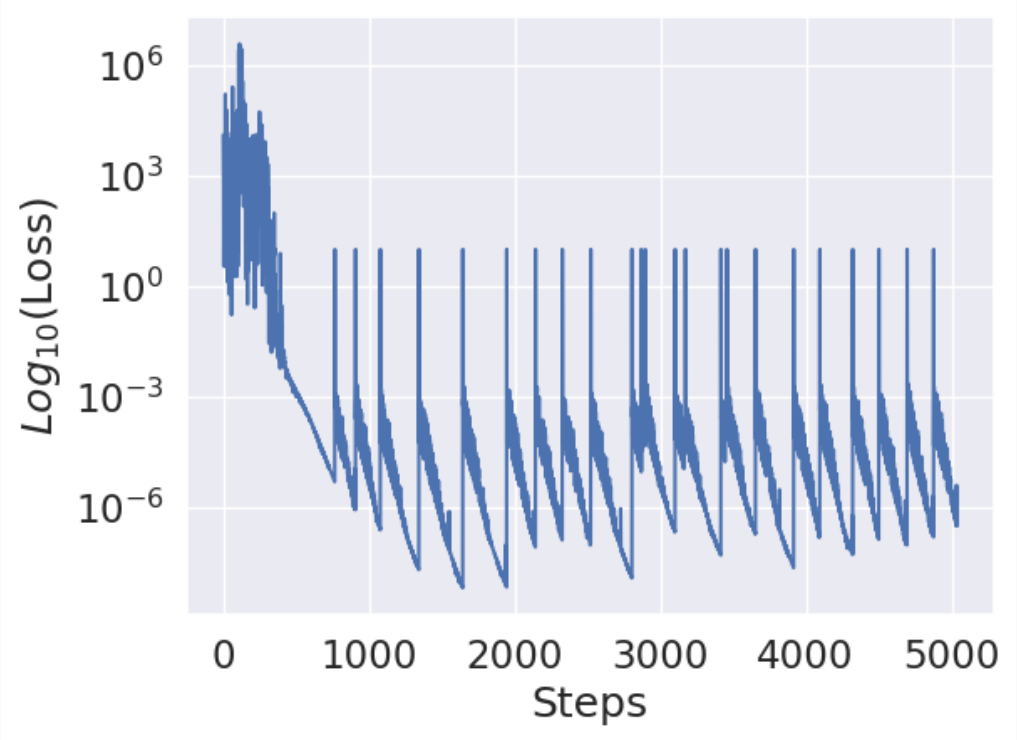
Network used



Rewards and steps



Cost function



Current algorithm

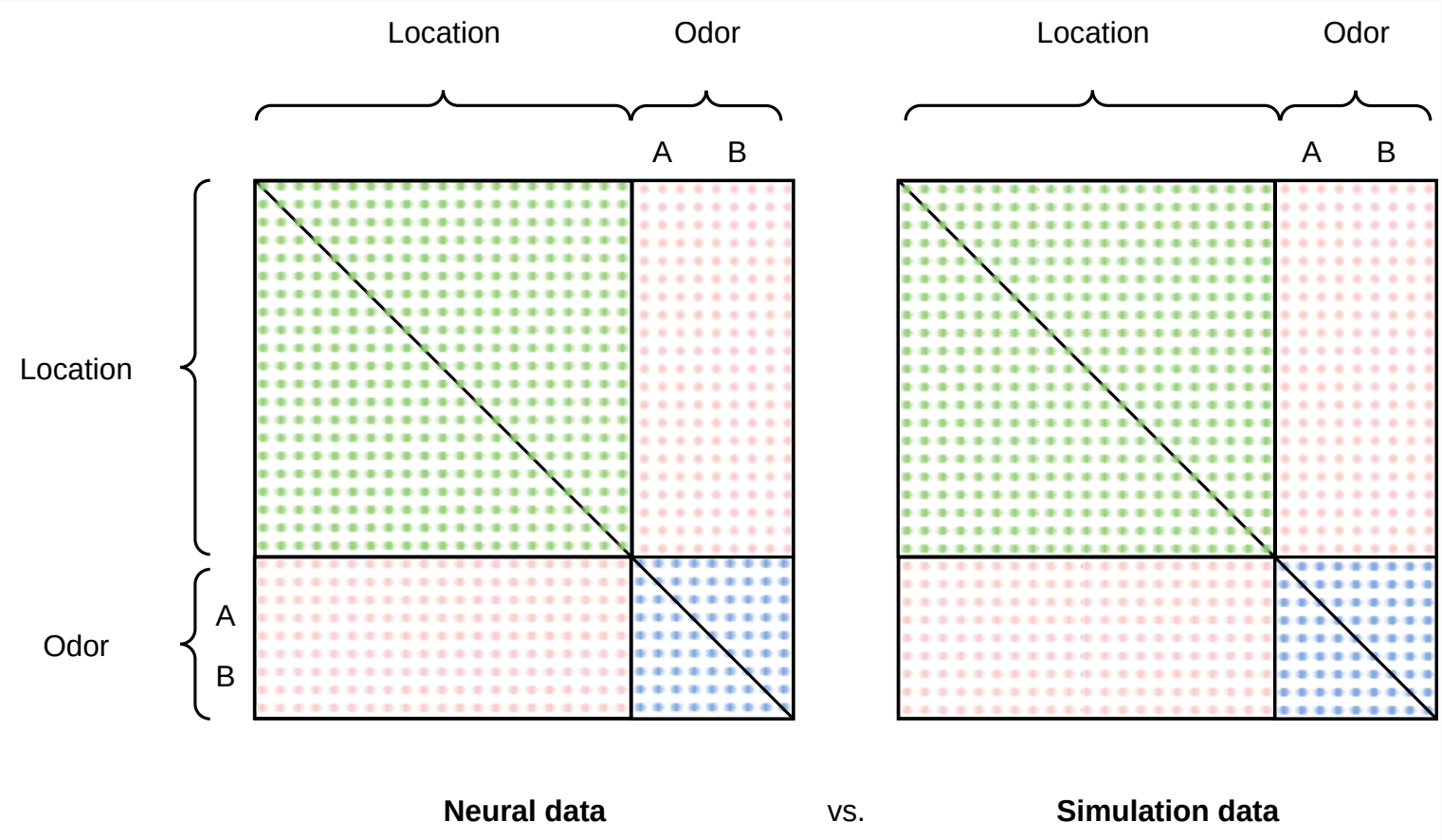
Algorithm 1: Deep RL algorithm implemented

initialize network with random weights
for $episode \leftarrow 1 \ldots T$ **do**
    $state \leftarrow reset(env)$
    $done \leftarrow False$
    while $done \neq True$ **do**
        $Q \leftarrow forward\_pass(state)$ /* 4 values vector */
        $action \leftarrow \epsilon_{greedy}(action\_space, state, q)$
        $state_{new}, reward, done \leftarrow env.step(action, state)$
        $Q \leftarrow forward\_pass(state_{new})$ /* 4 values vector */
        $Q_{new} \leftarrow reward + \gamma max(Q)$ /* scalar */
        $y \leftarrow max(Q)$ /* scalar */
        if $done = True$ **then**
            $\hat{y}_{pred} \leftarrow reward$ /* scalar */
        else
            $\hat{y}_{pred} \leftarrow Q_{new}$ /* scalar */
        end
        $Loss \leftarrow (y - \hat{y}_{pred})^2$
        update network weights to minimize Loss
    end
end

Outline

1. Context
2. Deep RL on toy task
3. Deep RL on half triangle task
4. Next steps brainstorming

Correlation matrices between neural data vs. simulation data

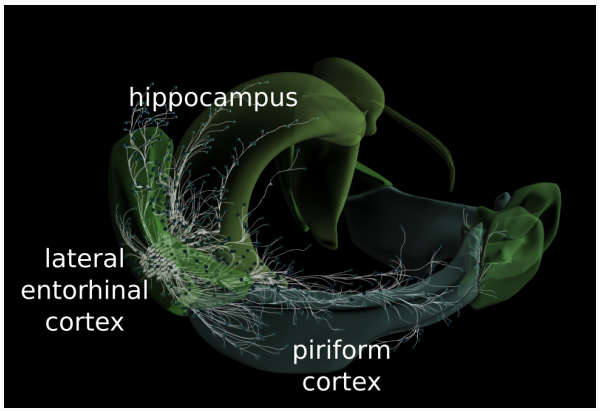


Ablation study?

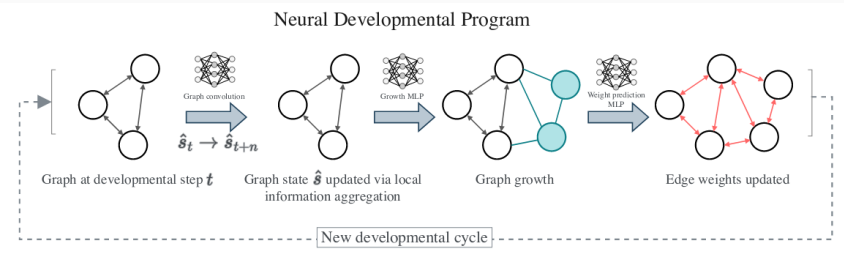
1. Train the model on the task
2. Identify the congunctive cells
3. Knock-out the congunctive cells (equivalent to KO LEC?)
4. Measure the proportion of congiuntive cells the model needs to solve the task

Network architecure

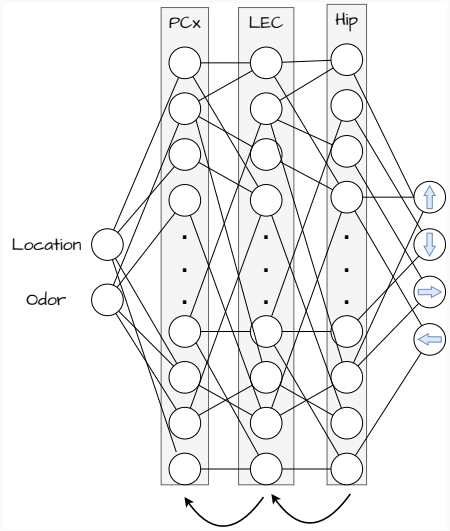
From brain connectivity...

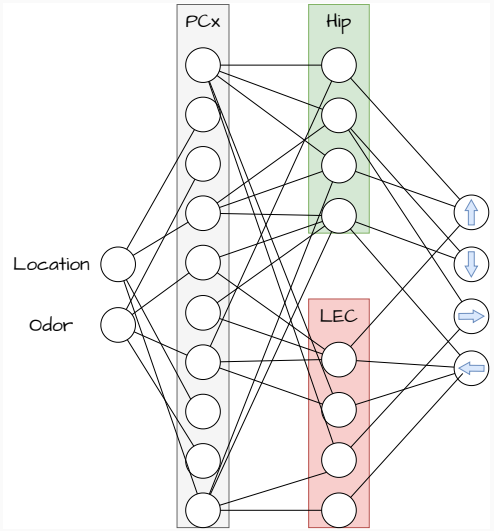


→ Let the architecture being optimized?



...To ANN architectures





Najarro, et al. (2023)

Questions ?