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Project Water Maze

General Description

The goal of this project is for the agent to find a landing platform in a water maze. The agent is going to mimic the classic neuroscience Morris water maze experiments testing spatial learning done in the hippocampus (Morris, 1984). The agent "rats" are trying to find a platform with a reward as fast as possible. In order to investigate spatial memory abstraction using reinforcement learning the problem being tested here will have two separate conditions of training environments. One group of agents will experience "blocked" practice where they will start in the same location of the water maze for each and every trial. The other group of agents will experience "random" (sometimes referred to as interlevened) practice where the agents will start in random locations in each and every trial (Magill & Hall, 1990; Shea & Morgan 1979). The two groups will be tested on a test of retention and a test of transfer. The retention test will mimic the 2-D training environment, but the starting location will be in randomly chosen locations. The transfer test will change the environment space from 2-D to 3-D with the goal being the same for the rats. The retention test will examine if the agents can recall what they have "learned" from training, whereas the transfer test will examine if the agents can adapt and abstract what they have "learned" to a new environmental context (2-D to 3-D).

Algorithm: Actor-Critic

State-Space: Continuous but finite in size (2D: circle-shaped and 3D: cylinder-shaped)
Action-Space: Continuous
Platform: Specified shape and size within the state-space
Note: steadily decreasing negative reward for the rats swimming

Novelty

The change in location of the target objective from a 2-Dimensional space to a 3-Dimensional space is novel from what we have read in reinforcement learning literature. The transfer of learning from the "rats" (agents) using the actor-critic algorithm in spatial learning context will be tested in 3-D environment with only being trained in a 2-D environment. We are testing to see if the agents can abstract their spatial representation in a 2-D context to adapt to a 3-D test.

Evaluation

We evaluate the agent's ability to learn in terms of time. The length of time it takes the agent to reach the objective is the primary evaluation we will use in this project (Tessereau, et al., 2021).

Citations.

Magill, R.A. and Hall, K.G., 1990. A review of the contextual interference effect in motor skill acquisition. *Human movement science*, *9*(3-5), pp.241-289.

Morris, R., 1984. Developments of a water-maze procedure for studying spatial learning in the rat. *Journal of neuroscience methods*, *11*(1), pp.47-60.

Shea, J.B. and Morgan, R.L., 1979. Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *Journal of Experimental psychology: Human Learning and memory*, *5*(2), p.179.

Tessereau, C., O'Dea, R., Coombes, S. and Bast, T., 2021. Reinforcement Learning approaches to hippocampus-dependent flexible spatial navigation. *Brain and neuroscience advances*, *5*, p.2398212820975634