Chen Institute Retreat 2023

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Poster title: Mice in Manhattan: Mastering and Memorizing Multiple Maps of a Massively Modifiable Maze in Minutes

Abstract: In the wild, mice need to constantly explore their surroundings and rapidly update their navigation solutions upon environmental changes. Here we study their learning and exploration strategies in a novel reconfigurable maze. We trained the mice (C57BL6/J) in the “Manhattan maze” – a three-dimensional grid-like structure that can be easily reconfigured to up to 2^{121} graph permutations. Over two days, a completely naïve mouse was exposed to three different configurations: to solve each requires 9 correct decisions at different turning locations. Within a few hours and fewer than 10 reward experiences, the mice developed close to optimal trajectories in all three maps. Surprisingly, new configurations were solved much faster than the first, possibly via an increased forwarding bias. This suggests that the mice can update their exploration strategies based on the common feature shared by different environments. We then compared the exploration strategies of animals with zero- and first- order Markov models of a random walk. For certain configurations that consist of bicliques with many cycles, the animals were much more efficient than the random walkers. In all cases, the mice continued routine exploration after learning the paths to reward, potentially by employing simple turning biases that favors efficient coverage of the entire maze. The Manhattan maze will provide a flexible framework that allows quantitative evaluation of many domains of learning and memory in mice, which could be more comparable to the complex cognitive processes of humans.