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Learning about memory from (very) large scale hippocampal networks. LEENOY MESHULAM, JEFFREY GAUTHIER, CARLOS BRODY, DAVID TANK, WILLIAM BIALEK, Princeton University — Recent technological progress has dramatically increased our access to the neural activity underlying memory-related tasks. These complex high-dimensional data call for theories that allow us to identify signatures of collective activity in the networks that are crucial for the emergence of cognitive functions. As an example, we study the neural activity in dorsal hippocampus as a mouse runs along a virtual linear track. One of the dominant features of this data is the activity of place cells, which fire when the animal visits particular locations. During the first stage of our work we used a maximum entropy framework to characterize the probability distribution of the joint activity patterns observed across ensembles of up to 100 cells. These models, which are equivalent to Ising models with competing interactions, make surprisingly accurate predictions for the activity of individual neurons given the state of the rest of the network, and this is true both for place cells and for non-place cells. Additionally, the model captures the high-order structure in the data, which cannot be explained by place-related activity alone. For the second stage of our work we study networks of ˜2000 neurons. To address this much larger system, we are exploring different methods of coarse graining, in the spirit of the renormalization group, searching for simplified models.

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