NEUROSCIENCE 2014

Presentation Abstract

	This presenter will not attend
Program#/Poster#:	176.21/PP3
Presentation Title:	Statistical framework for encoding and decoding grid cell population activity
Location:	WCC Hall A-C
Presentation time:	Sunday, Nov 16, 2014, 8:00 AM - 9:00 AM
Presenter at Poster:	Sun, Nov. 16, 2014, 8:00 AM - 9:00 AM
Topic:	++F.02.k. Learning and memory: Cortical and hippocampal circuits
Authors:	***K. YOON**, I. FIETE; Ctr. for Learning and Memory, The Univ. of Texas At Austin, Austin, TX
Abstract:	In familiar 2D environments, the activity of grid cells is well described by a spatially periodic modulation of spike frequency, so that the firing pattern as a function of location forms a triangular lattice. However, the major determinants of grid cell firing are less clear during other behaviors, for instance when the animal is navigating in novel 2D environments, moving along 1D tracks of various shapes, running on treadmills, sitting quietly, or sleeping. Under such conditions, the activity profiles of grid cells are not always spatially periodic, and are generally much more difficult to interpret as being based on some regular underlying response, even if this were the case. We present a statistical model of grid cell population encoding and decoding that can contribute to a better understanding of the computational function of the grid cell system during a variety of behaviors that go beyond exploration in familiar 2D environments. We apply the generalized linear model (GLM) framework as an encoding model, and adapt recursive approximate (but asymptotically exact) Bayesian methods for decoding grid cell ensemble activity. Specifically, spiking activity in the GLM is modeled as an inhomogeneous Poisson process, with the firing rate a function of

various covariates including animal location, velocity, spike history, and lateral coupling between neurons. To decode, we alternate prediction and update steps recursively, to obtain a posterior probability on the current animal position based on the full temporal record of spike train data up to the current time. We apply the statistical decoding method to simulated data from a continuous attractor network model of grid cells and pilot the method on data recorded from grid cells in the medial entorhinal cortex of rats. We show that in principle it is possible to reconstruct an animal's path within a 1m environment with high fidelity using fewer than 10 cells, if the cells have sufficiently distinct spatial tuning phases. We show how the model can be used to infer trajectories during exploration in spatially restricted environments or during sleep, if grid cells display sleep replay events. With a large number of cells, if the accuracy of trajectory estimation is not limited by the statistical decoding algorithm, we argue that it should be possible to read out internal misestimates of location in the animal's own mental state, and to trace out when encounters with the wall or other landmarks, for instance, serve to correct the internal mental state.

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Keyword (s): ENTORHINAL CORTEX

GRID CELLS

SPATIAL MEMORY

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