NEUROSCIENCE
2014

Presentation Abstract

Program#/Poster#:	463.25/TT85
Presentation Title:	Place cell response variance in an attractor network model of hippocampal ca3
Location:	WCC Hall A-C
Presentation time:	Monday, Nov 17, 2014, 1:00 PM - 5:00 PM
Presenter at Poster:	Mon, Nov. 17, 2014, 1:00 PM - 2:00 PM
Topic:	++F.02.k. Learning and memory: Cortical and hippocampal circuits

Authors: *H. N. YOUSIF[1], T. SOLSTAD[2], T. J. SEJNOWSKI[1];
[1]CNL, Salk Inst. For Biol. Studies, La Jolla, CA; [2]Ctr. for Neural Computation, Norwegian Univ. of Sci. and Technol., Trondheim, Norway

Abstract: The hippocampus is a neural structure strongly implicated in long term episodic memory. Hippocampal anatomy can be well described by implementations of recurrent neural networks (RNNs). Built on the dynamics of systems with a simple fixed point attractor structure, these models have successfully described many aspects of memory storage and recall. In addition, hippocampal place cells also have firing fields that strongly correlate with environmental location. The class of models describing this second phenomenon have hinged on the dynamics of continuous attractor neural networks (CANNs) as a computational substrate for spatial selectivity. However, current modeling efforts have shown that the fixed point attractor structure of RNNs and the spatially invariant structure of CANNs seem computationally incompatible. We propose a stochastic spiking model in a novel architecture that remedies this problem. We combine the two network types into a 2D lattice of Hopfield modules interconnected by spatially invariant weights. This model successfully replicates the spatial selectivity of hippocampal place cells without compromising the network's memory recall capabilities. This system architecture exhibits several interesting behaviors in both the spatial and

temporal domain. Individual neurons have a high degree of firing variability as has been observed experimentally. However, the long-time behavior of each cell retains reliable temporal structure. Although activation of each unit is unpredictable within single field traversals, the accumulated spike total of each unit is roughly constant. We found several distinct modes of large scale network activation. These two modes exhibit highly distinct responses at the population scale when exposed to a simulated morph sequence depending on the ratio of recurrent hippocampal drive and external entorhinal drive. We explore the wide range of transitioning behaviors at the level of single neurons and discuss some of the possible explanations with regards to different hippocampal remapping paradigms. The simulated data motivates the exploration of place cell activity across large populations at timescales of order ten milliseconds.

Disclosures:	**H.N. Yousif:** None. **T. Solstad:** None. **T.J. Sejnowski:** None.
Keyword (s):	HIPPOCAMPAL NEURONS
	MODELING
Support:	HHMI
	INC