BMC Neuroscience

POSTER PRESENTATION Open Access

Network structure predicted by second order motifs

David J Nichols, Danielle R Sandler, Maxwell J Schlatter, Liqiong Zhao, Duane Q Nykamp*

From Nineteenth Annual Computational Neuroscience Meeting: CNS*2010
San Antonio, TX, USA. 24-30 July 2010

We present a model of directed networks that is based on the relative frequency of second order edge motifs, which are patterns of two network edges. The four second order motifs are reciprocal, convergent, divergent, and causal connections (Figure 1), and our goal is to understand the network structure that one can predict just from these motifs. To describe a network ensemble that is determined by a particular distribution of second order motifs, one must infer a probability distribution that characterizes the full network. There are many possible network probability distributions consistent with a given distribution of second order motifs, and we select the one with minimal additional structure, i.e., the maximum entropy network [1]. We determine a probability distribution on networks connecting N neurons that is parametrized by five quantities: the probability of a single edge and the relative occurrence of each of the four second order edge motifs. We refer to the resulting network models as second order networks.

We examine the extent to which the second order networks predict the distribution of edges in neuronal networks. Using the data from simultaneous whole cell recordings of three neurons published by Song et al. [2], we calculate the second order network determined from the data and demonstrate that the network predicts most of the higher order structure. The one exception is that three edge cycles were more prevalent than predicted by the second order network. We discuss the properties of the second order networks and compare them to other network models.

Figure 1 The four second order edge motifs of reciprocal, convergent, divergent, and causal connections.

* Correspondence: nykamp@math.umn.edu
School of Mathematics, University of Minnesota, Minneapolis, MN 55455, USA

Published: 20 July 2010

References

1. Jaynes ET: **Information theory and statistical mechanics.** *Phys. Rev.* 1957, **106**:62-79.
2. Song S, Sjöström PJ, Reigl M, Nelson S, Chklovskii DB: **Highly nonrandom features of synaptic connectivity in local cortical circuits.** *PLoS Biology* 2005, **3**:e68.

doi:10.1186/1471-2202-11-S1-P43
Cite this article as: Nichols *et al.*: Network structure predicted by second order motifs. *BMC Neuroscience* 2010 **11**(Suppl 1):P43.