BMC Neuroscience

BioMed Central

Poster presentation

Integration of anatomical and physiological connectivity data sets for layered cortical network models

Tobias C Potjans*[1] and Markus Diesmann[1,2]

Address: [1]Computational Neuroscience Group, RIKEN Brain Science Institute, Wako-shi, Saitama, 351-0198 Japan and [2]Bernstein Center for Computational Neuroscience, Albert-Ludwigs-University, 79104 Freiburg, Germany

Email: Tobias C Potjans* - tobias_potjans@brain.riken.jp

* Corresponding author

from Seventeenth Annual Computational Neuroscience Meeting: CNS*2008
Portland, OR, USA. 19–24 July 2008

Published: 11 July 2008

BMC Neuroscience 2008, **9**(Suppl 1):P60 doi:10.1186/1471-2202-9-S1-P60

This abstract is available from: http://www.biomedcentral.com/1471-2202/9/S1/P60

Introduction

The specific connectivity of the local cortical network provides the structural basis for the function of the information-processing unit usually referred to as cortical column, cortical module or canonical microcircuit. We investigate in large-scale simulations the dynamical implications of layer-specific connectivity compatible with experimental data. However, the existing data sets are still diverse in their results as in their methodology ranging from electrophysiology to purely anatomical methods. The integration of the different data sets into a consistent model again advances the interpretation of the data.

Layer-specific connectivity structure

Restricting ourselves to pairwise connectivity we use the two most comprehensive and quantitative data sets from the literature [1,2]. Despite their apparent inconsistency we identify invariant measures that may reflect canonicity in the relationship of intra-layer recurrence and inter-layer projections. The assumption of a gaussian connectivity profile explains the connectivity data [1,2] while predicting a lateral spread of connections consistent with other studies [3,4]. This reduces the discrepancies to the specificity in target type selection as typically found for functional connections (for instance [1,5]). Hence, the data sets represent diversity in methodology rather than connectivity. Surmounting this obstacle, we can extract the information required to construct a multi-layered neocortical network model and propose a data set that best summarizes present knowledge.

Neural network dynamics

The dynamical properties induced by layer-specific connectivity are investigated by means of numerical simulations of a local cortical module consisting of 80,000 neurons. We elaborate on the existence and stability of asynchronous irregular activity for stationary and transient thalamo-cortical inputs, respectively. The cortical connectivity alone predicts a distribution of firing rates across layers. Quantification of target type specificity allows us to ascertain its dynamical implications.

Conclusion

We integrate various data sets and find that local connectivity is best described by layers of balanced random networks interconnected with partly target specific projections providing feed-forward and feedback signaling. Our quantitative analysis supplies researchers with the information required for simulations and renders the consistent usage of electrophysiological and anatomical data possible. Simulations of the multi-layered model can now be compared to the observed network activity, linking structure to dynamics.

Acknowledgements

Partially funded by DIP F1.2, BMBF Grant 01GQ0420 to the Bernstein Center for Computational Neuroscience Freiburg, and EU Grant 15879 (FACETS).

References

1. Thomson AM, West DC, Wang Y, Bannister AP: **Synaptic connections and small circuits involving excitatory and inhibitory neurons in layers 2–5 of adult rat and cat neocortex: Triple**

intracellular recordings and biocytin labelling *in vitro*. *Cereb Cortex* 2002, **12:**936-953.
2. Binzegger T, Douglas RJ, Martin KAC: **A quantitative map of the circuit of cat primary visual cortex.** *J Neurosci* 2004, **24(39):**8441-8453.
3. Hellwig B: **A quantitative analysis of the local connectivity between pyramidal neurons in layers 2/3 of the rat visual cortex.** *Biol Cybern* 2000, **82:**111-121.
4. Stepanyants A, Hirsch JA, Martinez LM, Kisvarday ZF, Ferecsko AS, Chklovskii DB: **Local potential connectivity in cat primary visual cortex.** *Cereb Cortex* 2008, **18:**13-28.
5. Zarrinpar A, Callaway EM: **Local connections to specific types of layer 6 neurons in the rat visual cortex.** *J Neurophysiol* 2006, **95:**1751-1761.