Mathematical Neuroscience 2011

Apr 11, 2011 - Apr 13, 2011

ICMS, 15 South College Street, Edinburgh, EH8 9AA

Organisers

Name	Institution
Coombes, Stephen	University of Nottingham
Timofeeva, Yulia	University of Warwick

Training Workshop Organiser:
Dr Mark van Rossum, University of ...

Reseach Results of the BCF presented at:

This thre...
Ch...
...ill allow
...rimental facts
...and techniques that
...d to date. Importantly, it will
...help develop, those pieces of
...heory which are likely to be relevant to
...tudies of the brain.

The meeting will consist of invited speakers and registered participants, though will be limited to 100 people. The schedule will allow for a number of poster presentations.

This event is sponsored by the EPSRC via the UK Mathematical Neuroscience Network

Arrangements
Programme
Presentations
Participants

Arrangements

Please note that the workshop will begin with registration from 09.00-10.30 on Monday 11 April (first talk at 10.45) and will close at 16.00 on Wednesday 13 April. Please take these timings into account when booking your travel.

Participation
THIS WORKSHOP IS NOW FULL AND THE APPLICATION PERIOD IS CLOSED.

Training Workshop - Informatics Forum, Edinburgh (please note that this training workshop has a different venue from the main conference)
Click here for full details and the Programme for the Training Course. Map showing Informatics Forum.
This one-day training workshop for PhD students and post-docs entitled "An introduction to Mathematical Neuroscience" will take place prior to the meeting (on Sunday 10 April). This will be organised by Mark van Rossum and will comprise a series of 'primer' lectures

Effect of Network Structure on Spike Train Correlations in Networks of Integrate-and-Fire Neurons

Volker Pernice, Benjamin Staude, Stefano Cardanobile and Stefan Rotter

Balanced networks of excitatory and inhibitory neurons can assume a state of asynchronous activity with low pairwise correlations. Nevertheless, in finite networks recurrent connectivity unevitably induces correlations between spike trains. We use a model of linearly interacting point processes to describe the effects of direct and indirect interactions between neurons on correlations. Specific characteristics of the neuron model are formally taken into account as self-interactions.

We show that reset effects, described as self-inhibition, lower overall correlations in the network. Rates and correlations in simulated networks of integrate and fire neurons can be described quantitatively, provided that spiketrain correlations are not too high and the impulse response of single neurons can be measured.

The framework allows to understand correlations in terms of indirect paths between neurons. Under certain conditions, for example in ring networks with distance dependent connectivity, analytical expressions for the distance dependence of correlations or the population fluctuations can be derived.

Supported by: BMBF 01GQ0420 to BCCN Freiburg

Inferring higher-order correlations from filtered spike activity

Imke C. G. Reimer, Benjamin Staude, Stefan Rotter

Nonlinear response properties turn neurons into highly sensitive detectors for higher-order features of their input (see e.g. Kuhn et al, Neural Comput 2003). Whether or not higher-order correlations are important for cortical information processing, however, can only be decided by the analysis of experimental data.

Common data analysis methods (e.g. Martignon et al, Biol Cybern 1995; Amari et al, Neural Comput 2003) to investigate the potential role of higher-order correlations (HOCs) are devised for the application to spike recordings from multiple single neurons. Recent particularly promising approaches (Ehm et al, Electronic Journal of Statistics 2007; Staude et al, J Comput Neurosci 2009, Front Comput Neurosci 2010) infer higher-order correlations from the population spike count, i.e. the population spike activity “filtered” with a rectangular kernel. As compared to other methods, these approaches can detect even weak HOCs in the activity of large neuronal populations based on realistic sample sizes.

However, describing HOCs in a neuronal population does not reveal its influence on the activity of a neuron e.g. at the next processing stage. In this aspect, estimating cooperative dynamics in the presynaptic spike activity from an intracellular recording of a single neuron would be advantageous (cf. Rudolph & Destexhe, The European Physical Journal B 2006, for an approach based on pairwise correlations). As, in principle, the above mentioned methods can be adapted to any kind of linearly filtered spike activity, approximating the membrane potential as a filtered version of the presynaptic activity should be a promising approach. Here, we investigate the potential and the constraints of the corresponding adaptations.

Supported by: BMBF 01GQ0420 to BCCN Freiburg

The impact of correlated input to neurons: conclusions from in vivo intracellular recordings

Man Yi Yim & Stefan Rotter

In vivo recordings in the rat somato-sensory cortex showed that excitatory and inhibitory inputs are correlated during spontaneous and sensory-evoked activity (Okun and Lampl, 2008). We study in numerical simulations howcorrelated excitatory and inhibitory inputs (E-I) control the spike probability of a single neuron. Several factors thatmodulate the output firing rate are identified, including the strength of E-I coupling, the relative timing between Eand I, and the jittering of input spikes (Kremkow et al., 2010), all of which can effectively switch on and off thereceiving neuron. Besides, we investigate the correlation transfer in a neuron pair both on the level of spike trainsand of membrane potentials. We also propose biologically plausible mechanisms to explain the in vivo findingsthat membrane potentials are correlated, but not the spikes: neighboring neurons are constantly bombarded bycorrelated background inputs, and also occasionally by uncorrelated spike-triggering inputs (Poulet and Petersen, 2008). The spike-level correlation of neuronal spike trains due to temporal integration of background inputs is found to be small, consistent with previous findings for correlated noise inputs (Kriener et al., 2008), and such correlation can be further de-correlated by neuronal heterogeneities (Padmanabhan and Urban, 2010). Our work shows how the temporal structure of inputs significantly determines the activity level and correlation of neurons.

- Okun M, Lampl I (2008) Instantaneous correlation of excitation and inhibition during ongoing and sensory-evoked activities. Nature Neuroscience 11(5): 535–537
- Kremkow J, Aertsen A, Kumar A (2010) Gating of signal propagation in spiking neural networks by balanced and correlated excitation and inhibition. J Neurosci 30(47): 15760–15768
- Poulet JFA, Petersen CCH (2008) Internal brain state regulates membrane potential synchrony in barrel cortex of behaving mice. Nature 454(7206): 881–885
- Kriener B, Tetzlaff T, Aertsen A, Diesmann M, Rotter S (2008) Correlations and population dynamics in cortical networks. Neural Computation 20(9): 2185–2226
- Padmanabhan K, Urban NN (2010) Intrinsic biophysical diversity decorrelates neuronal firing while increasing information content. Nature Neuroscience 13(10): 1276–1282

Supported by: BMBF 01GQ0420 to BCCN Freiburg

Non-equilibrium point process dynamics as a model for transient neural activity

Moritz Deger, Moritz Helias, Stefano Cardanobile, Fatican Atay, Clemens Boucsein, Stefan Rotter

Spike trains of single neurons and neural populations can be modeled as stochastic point processes. The Poisson process with dead time (PPD) is a particularly simple point process, which admits the mathematical analysis of its stationary and dynamic properties. In particular we match the stationary PPD to in vivo single neuron spike data. As we find, the statistics of superpositions of these spike trains agrees with analytical predictions for independent and identically distributed superpositions of the matched PPD. Further we present analytical means to compute the time-dependent spike rate of an ensemble of PPDs that encode a transient input rate. Solutions of the dynamics are presented for the case of a step of the input rate, which induces a stochastic transient of the output rate, and for sine modulated input. Finally we generalize the dynamics of the output rate of the PPD to the case of a stochastic dead time.

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