
*Thursday, December 11th, 2014
13h30, Room AAC 132*

Computational Neuroscience Seminar

Rainer ENGELKEN
Theoretical Neuroscience,
Max Planck Institute for
Dynamics and Network Dynamics Group

Chaos and Entropy Production in Spiking Networks

The prevailing explanation for the irregularity of spike sequences in the cerebral cortex is a dynamic balance of excitatory and inhibitory synaptic inputs - the so-called balanced state. Recently it was found that the stability of the balanced state dynamics depends strongly on the detailed underlying dynamics of individual neurons.

Previous studies of the dynamics of the balanced state used random (Erdős-Rényi) networks. We extended this to arbitrary topologies. An analytical expression for the Jacobian enables us to calculate the full Lyapunov spectrum. Using a neuron model in which action potential onset rapidness is adjustable, we simulated the network dynamics in numerically exact event-based simulations and calculated Lyapunov spectrum, Kolmogorov-Sinai entropy production rate and attractor dimension for a variety of network topologies.

We found that the importance of the internal single neuron dynamics for the network stability persists in different topologies. While the entropy production and attractor dimension in clustered and ring networks was very similar to random networks, these dynamical properties were changed substantially when introducing second order network motifs or a small world topology.

We also extended the model from constant to stochastic spiking external input and studied its transition. We found that input spike trains suppress chaos in balanced neural circuits.

Our study shows the importance of single neuron dynamics for network chaos and provides a novel avenue to study the role of sensory streams in shaping the dynamics of large networks.