Abstract of Presentation

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Research interest:

1) Plasticity and Learning in behaving systems (animals and robots) and
2) Visual processing

Title: Learning and Stability during Network Development

Abstract : How developing networks can gain stability in their final activity as well as in their synaptic configuration remains a big, largely unresolved puzzle. Many times such networks, for example in the cortex, attain a final state characterized by self-organized criticality. In this state, activity is similar across temporal scales and this is beneficial with respect to information flow. If subcritical, activity can die out, if supercritical epileptiform patterns may occur. We have monitored the development between 13 and 95 days in vitro of real cortical cell cultures and find four different phases, related to their morphological maturation: An initial low-activity state is followed by a supercritical and then a subcritical one until the network finally reaches stable criticality. Using network modeling we describe the dynamics of the emergent connectivity in such developing systems. Based on physiological observations, the synaptic development in the model is determined by the drive of the neurons to adjust their connectivity for reaching firing rate homeostasis. We show that this homeostasis mechanism seems to guide the developing networks through the different observed stages into final stability. Mathematical analysis of synaptic homeostasis reveals globally stable fixed points for Hebbian learning. This result may prove to some degree important as it allows arbitrarily wired networks to become stable and to store input patterns as synaptic traces.