SOUTH-EAST EUROPEAN RESEARCH CENTRE

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OPEN SEMINAR SERIES

Wednesday 4 June 2014

12:00 – 13:00

Sofou Conference Room 7th floor,
L. Sofou Bldg

"Spike-Based Reinforcement Learning in Continuous State and Action Space: Modelling the Morris Watermaze navigation task"

By
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ABSTRACT

Changes of synaptic connections between neurons are thought to be the physiological basis of learning. These changes can be gated by neuromodulators that encode the presence of reward. We study a family of reward-modulated synaptic learning rules for spiking neurons on a learning task in continuous space inspired by the Morris Water maze. The synaptic update rule modifies the release probability of synaptic transmission and depends on the timing of presynaptic spike arrival, postsynaptic action potentials, as well as the membrane potential of the postsynaptic neuron. The family of learning rules includes an optimal rule derived from policy gradient methods as well as reward modulated Hebbian learning. The synaptic update rule is implemented in a population of spiking neurons using a network architecture that combines feedforward input with lateral connections. Actions are represented by a population of hypothetical action cells with strong mexican-hat connectivity and are read out at theta frequency. We show that in this architecture, a standard policy gradient rule fails to solve the Morris watermaze task, whereas a variant with a Hebbian bias can learn the task within 20 trials, consistent with experiments. This result does not depend on implementation details such as the size of the neuronal populations. Our theoretical approach shows how learning new behaviors can be linked to reward-modulated plasticity at the level of single synapses. It is an important step towards connecting formal theories of reinforcement learning with neuronal and synaptic properties.

The seminar series is open to all members of *staff* and *students* of CITY and to any *externals* that wish to attend.

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