Topic:
Hippocampal Dynamics and Related Cognitive Functions: From Neurophysiological Observations to Computational Models.

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Link: http://www.dei.brain.riken.jp/~cmolter/tutorialsetc/2009_ijcnn_tutorial.html

Abstract:
The hippocampus' beautiful neuronal architecture and its importance in several cognitive functions as for spatial navigation and memory formation have made it a central topic of research during the past 40 years. The many recent exciting discoveries and development in experimental and in computational studies, are bringing keys to break the neural code of this central brain area.
This tutorial aims to provide the current state of the art of our understanding of how the hippocampus manages to perform these two functional roles; memory formation and spatial navigation. To this aim, a state of the art of current biological evidences will be given. Among others, this will focus on:

1. How the hippocampus processes information from an anatomical point of view.
2. How different rhythms are involved in the processing of hippocampal information (from slow rhythms (~1Hz) to fast ripples (~200Hz)).
3. What are the specific firing activity of hippocampal pyramidal cells (place cells, direction cells, grid cells and more recently the border cells).
4. How firing activity is modulated by the hippocampal rhythms.
5. How learning occurs and its relation to the various form of synaptic plasticity.

To decipher the hippocampal cognitive functions, biological data alone are not enough. Computational neuroscientists are playing a key role in giving insights on how to put these biological data together in an integrative view. To this aim, computational hypotheses are proposed and simulated using computational models. In turn, these models are proposing new predictions which lead to new experiments. In this tutorial, several of these models will be reviewed and compared. Since these models involve different neural architectures (e.g. feedforward and recurrent), different types of learning rules (e.g. asymmetric Hebbian learning and long term potentiation), different types of neural units (e.g. McCullogh and Pitts or oscillator units), we expect these models to be insightful for researchers in the field of artificial intelligence and neural information processing.