

Progetto IR00011– EBRAINS-Italy - Missione 4, “Istruzione e Ricerca” - Componente 2, “Dalla ricerca all’impresa” - Linea di investimento 3.1 del PNRR, Azione 3.1.1 “Creazione di nuove IR o potenziamento di quelle esistenti che concorrono agli obiettivi di Eccellenza Scientifica di Horizon Europe e costituzione di reti” - Area ESFRI H&F. Finanziato dall’Unione europea – NextGeneration EU (CUP B51E22000150006)

Computational Neuroscience (24 hours)

Prof. Michele Migliore

The main goal of this course is to develop in the students the capacity to use the specific language of Computational Neuroscience, in order to study and understand the physiological and pathological processes and the mechanisms for generating, encoding, and transmitting signals in the central nervous system.

Course content

The membrane equation. Passive characteristics and propagation of signals in dendrites. The input resistance of a neuron; the membrane time constant. Download and use of 3D reconstructions of neurons; Introduction to the NEURON simulation environment. NEURON GUI, creation of a neuron and manipulation of the passive properties. Kinetics of activation and inactivation of ion channels. The action potential dynamics. Types of synapses and expressions for their conductance in the various cases. The main types of ionic conductance (Na, KA, KDR), and their role for the generation of action potentials. The distribution of ion channels in the dendrites of the main types of pyramidal neurons, and their role in the modulation of the propagation of an action potential in the dendrites. Implementation of a realistic neuronal network. Electroencephalographic rhythms, synchronization processes: the role of reciprocal connections and subthreshold oscillations. Implementation of synaptic plasticity rules. Hopfield - Brody model for pattern recognition; associative memory. Computational models to investigate brain diseases, drug effects, biochemical pathways, and external factor such as Electrical Fields at power lines frequency. The Retina and the Olfactory Bulb: structure, neuron types, and principal circuits.

Course material

- Christof Koch (1999). Biophysics of Computation. Oxford: Oxford University Press.
- Lytton W.W. (2002). From Computer to Brain: Foundations of Computational Neuroscience. Berlin: Springer.
- Johnston D., Wu S.M. (1995). Foundations of Cellular Neurophysiology. Cambridge, MA: The MIT Press.
- Course slides

Class schedules

From 2 March to 24 March. Thursday: 2-5pm and Friday: 9-12am

The course will be held in room **Aula Professori I livello** of the Dipartimento di Matematica e Applicazioni “R. Caccioppoli” (ed. 5A), Complesso Universitario di Monte S. Angelo, Via Cintia Napoli

Teams code: zy1zkv9

https://teams.microsoft.com/l/team/19%3asV5TT9zHOiPYBcJk8TJqfkJTO3BGZKDHR_im4inCWYo1%40thread.tacv2/conversations?groupId=2b315049-54c6-4184-9aa4-5df274f27bb8&tenantId=2fcfe26a-bb62-46b0-b1e3-28f9da0c45fd