UCLouvain

lgbio2072

2020

Mathematical models in neuroscience

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

5 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Crevecoeur Frédéric ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	The course will provide an introductory overview of how mathematical models are used to characterize the nervous system, and how these models capture the relationship between neural activity and functions such as decision-making, perception, and learning. The topics are organized from the microscopic scale of a single cells' activity to macroscopic models of movement control. The intended program will cover the following topics: - Motivation: the brain as an information processing system. Perspective from evolution, behaviour, and computational models. - Models of neurons' activity: leak integrate-and-fire, from continuous current input to spike trains of action potentials - From spike trains to rate/time encoding of information, receptive fields, homogenous Poisson model of firing rates, tuning functions. - Population activity, competing populations, drift-diffusion model and link with decision-making. - From population codes to perception: maximum likelihood/Bayesian estimation, cue-combination, multisensory integration. - Motor control: closed loop control of reaching movements, internal models, motor responses to mechanical or visual perturbations, feedback control models, neural basis of feedback control, motor learning. - (Optional) Graph-theoretic approach of brain architecture: topology, classification, and link with cognitive functions.
Aims	1 At the end of this course, students will be able to: c. Disciplinary Learning Outcomes 1. Understand how mathematical models are useful to study how neural activity supports behaviour. Critique and discuss models and their limitations, identify challenges in neuroscience. 2. Evaluate whether a model is suitable to account for experimental data. 3. Manipulate equations and simulations of the activity in neural circuits to produce behaviour in silico. 4. Understand the literature on the neural basis of motor and cognitive functions. 5. Draft up an experimental protocol intending to validate or falsify a pre-existing model. d. Transversal Learning Outcomes 1. Read and present a scientific article 2. Communication skills : prepare figures and illustration, describe results, set up presentation slides and present results to the audience - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Faculty or entity in charge	GBIO

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Biomedical Engineering	GBIO2M	5		