UCLouvain

lgbio2072

2021

Mathematical models in neuroscience

5.00 crédits	30.0 h + 30.0 h	Q1

Enseignants	Crevecoeur Frédéric ;
Langue d'enseignement	Anglais
Lieu du cours	Louvain-la-Neuve
Préalables	Prerequisites are the fundamentals in mathematics and physics from bachelor level in engineering, including: basic electrical circuits, mechanical systems, system theory (sampling, time-frequency domains, and transfer functions), state-space representations, ordinary differential equations, probability theory and fundamentals of linear algebra. Basic knowledge of biology will be covered in the course.
Thèmes abordés	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.
Acquis d'apprentissage	**A la fin de cette unité d'enseignement, l'étudiant est capable de :** 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
Faculté ou entité en charge:	GBIO

Programmes / formations proposant cette unité d'enseignement (UE)

Intitulé du programme	Sigle	Crédits	Prérequis	Acquis d'apprentissage
Master [120] : ingénieur civil en informatique	INFO2M	5		
Master [120] : ingénieur civil biomédical	GBIO2M	5		
Master [120] : ingénieur civil en mathématiques appliquées	MAP2M	5		