


3.00 crédits	20.0 h + 10.0 h	Q2
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Enseignants	Lee John ;Missal Marcus (coordinateur(trice)) ;
Langue d'enseignement	Anglais > Facilités pour suivre le cours en français
Lieu du cours	Bruxelles Woluwe
Préalables	Master in Biomedical Sciences, Neurosciences or equivalent background (Exact Sciences, Psychology, Applied Sciences). <i>Le(s) prérequis de cette Unité d'enseignement (UE) sont précisés à la fin de cette fiche, en regard des programmes/formations qui proposent cette UE.</i>
Thèmes abordés	- Theoretical Neurosciences. - Bayesian Approach. - AI and Neurosciences. - Synchrony and Oscillations
Acquis d'apprentissage	<b>A la fin de cette unité d'enseignement, l'étudiant est capable de :</b> 1 Read papers about neurocomputational models in neuroscience  Explain different types of models in computational neurosciences.
Modes d'évaluation des acquis des étudiants	Oral or written examination (questions with written development or multiple choices).
Méthodes d'enseignement	Ex-cathedra lessons, remotely if necessary. Group discussions. Article presentations by students.
Contenu	<p><b>I. Introduction to Theoretical Neuroscience</b></p> <ul style="list-style-type: none"> <li>• <b>Goal:</b> What is theoretical neuroscience? Its relationship to experimental neuroscience, mathematics, physics, and computer science.</li> <li>• <b>Key Topics:</b> The role of theory (prediction, interpretation, synthesis). Levels of analysis (Marr's three levels: computational, algorithmic, implementation). Causality in Neurosciences.</li> </ul> <p><b>II. The Neuron as a Computational Unit</b></p> <ul style="list-style-type: none"> <li>• Introduce the fundamental building block and its electrical properties.</li> <li>• <b>The Hodgkin-Huxley Model</b> (ionic currents, action potential generation).</li> <li>• <b>Integrate-and-Fire</b> models and their variants (e.g., leaky I&amp;F).</li> </ul> <p><b>III. Neural Encoding and Decoding</b></p> <ul style="list-style-type: none"> <li>• How does the brain represent information? How can we read it out?</li> <li>• Rate coding vs. Temporal coding.</li> </ul> <p><b>IV. The Bayesian brain hypothesis</b></p> <ul style="list-style-type: none"> <li>• <b>Predictive Coding</b> (prediction error).</li> <li>• Free energy principle.</li> </ul> <p><b>V. Theoretical Approaches to Deep Learning</b></p> <ul style="list-style-type: none"> <li>• Bridging the gap between biological neural networks and Artificial Neural Networks (ANNs).</li> <li>• Comparing ANNs and the brain (e.g., backpropagation vs. local learning rules).</li> <li>• Convolutional Neural Networks (CNNs) as models for the visual cortex.</li> <li>• Recurrent Neural Networks (RNNs) and sequence processing.</li> </ul> <p><b>VI. Oscillations and Neural Synchronization</b></p> <ul style="list-style-type: none"> <li>• Network rhythms and their functional role.</li> </ul>

	<ul style="list-style-type: none"><li>• Synchronization, binding problem.</li><li>• Coupled Oscillator Models (Kuramoto model).</li><li>• Different frequency bands (#,#,#) and their hypothesized functions (e.g., # oscillations in attention).</li></ul>
Ressources en ligne	<a href="https://moodleucl.uclouvain.be/course/view.php?id=9189">https://moodleucl.uclouvain.be/course/view.php?id=9189</a>
Faculté ou entité en charge:	SBIM

<b>Programmes / formations proposant cette unité d'enseignement (UE)</b>				
Intitulé du programme	Sigle	Crédits	Prérequis	Acquis d'apprentissage
Master [120] en sciences biomédicales	SBIM2M	3	WSBIM2280 ET (WSBIM2112 OU WSBIM2151) ET WSBIM2154 ET WSBIM2155 ET WSBIM2156	
Master [60] en sciences biomédicales	SBIM2M1	3		