

Partager

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Vous devez renseigner un email valide

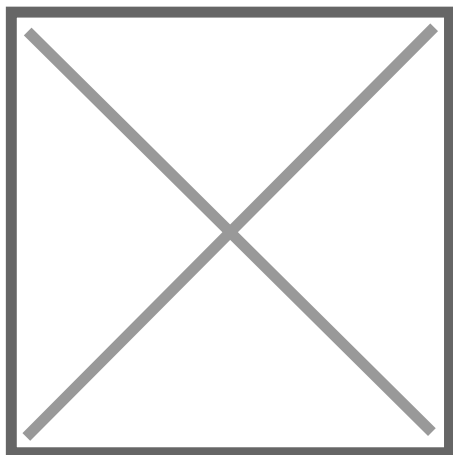
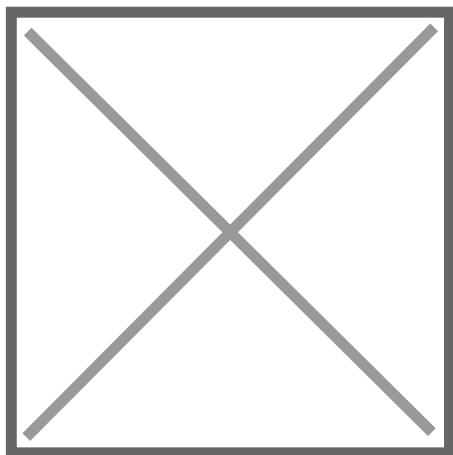
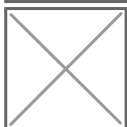
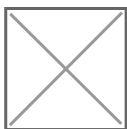
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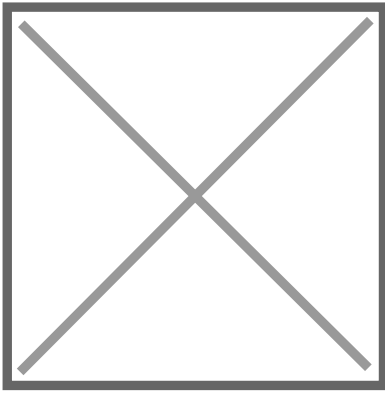
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Le mail de partage a bien été envoyé.

Ajouter au comparateur

M2 Computational Neuroscience and Neuroengineering





Master

Mention Neurosciences

Régime(s) d'inscription

Formation initiale Formation continue

Langue(s) d'enseignement

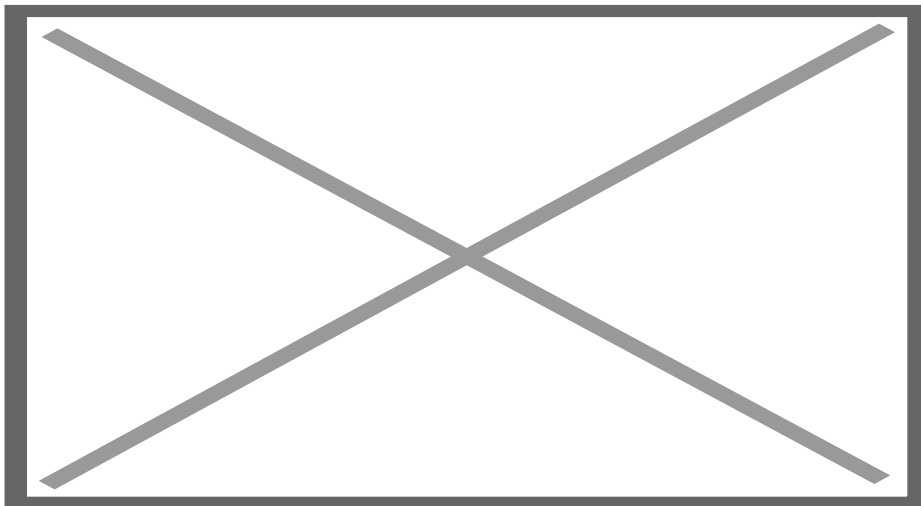
Anglais

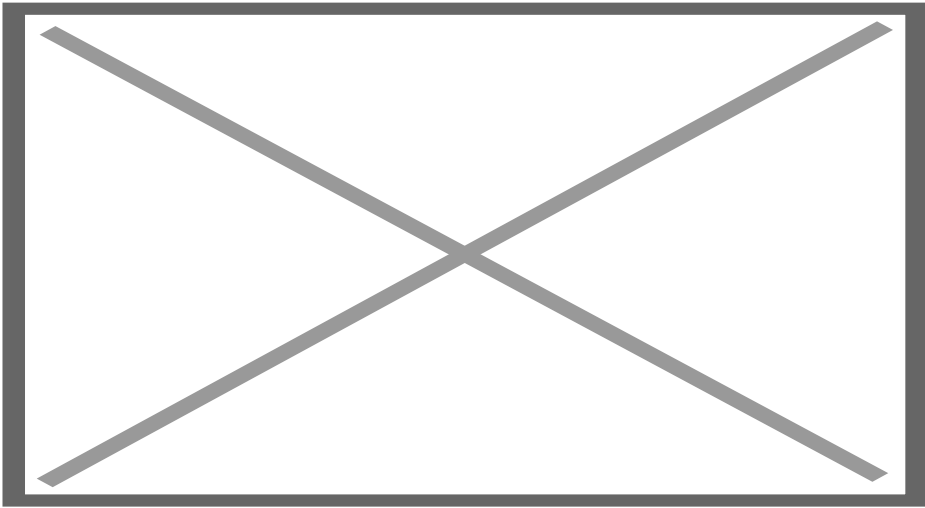
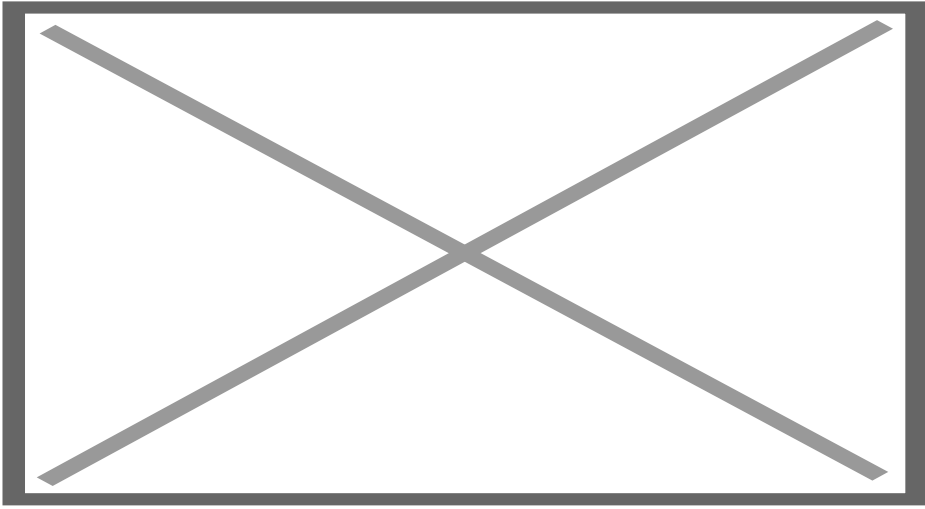
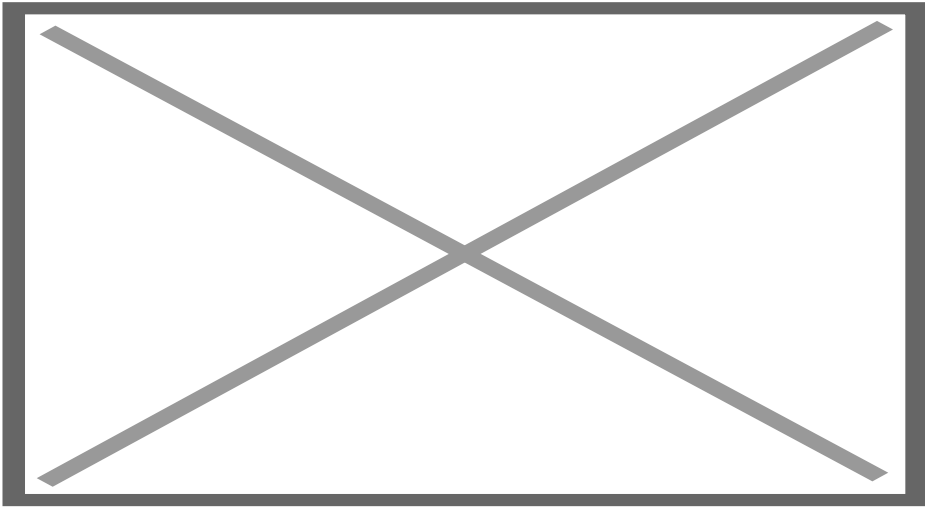
One of the greatest challenges of modern science is to understand how the brain processes information — both to replicate its computing and learning capabilities (as in Artificial Intelligence, neuromorphic circuits, and machine learning) and to compensate for its dysfunctions using computational and technological tools (such as Closed-Loop Neuroscience and Brain-Computer Interfaces). These goals are at the core of the M2 Computational Neuroscience and Neuroengineering track.

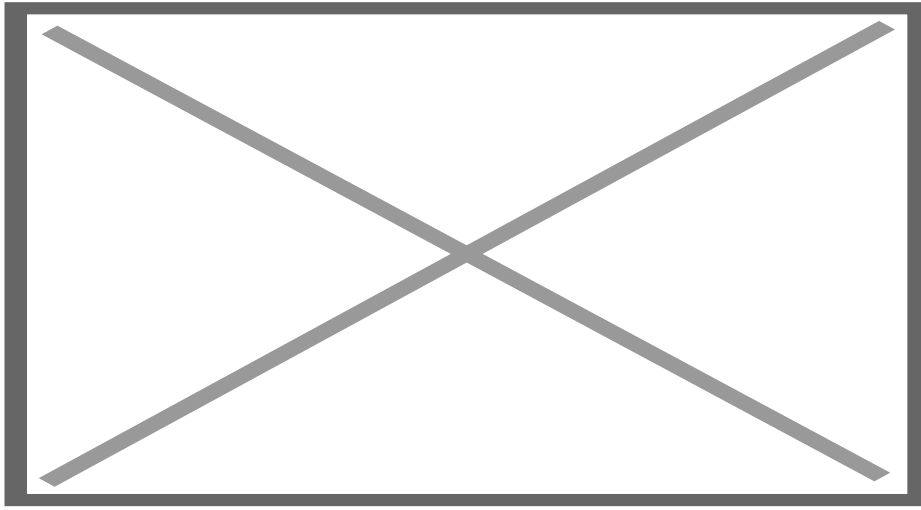
Le Master est organisé en deux semestres, le 1er semestre est composé de six unités d'enseignement et un projet supervisé. Le second semestre est consacré à un stage de 5 à 6 mois.

[Télécharger la fiche détaillée](#)

[Je candidate](#)







■ ■

Informations

- [Présentation](#)
- [Admission](#)
- [Programme](#)

Présentation

Compétences

To use adequate models, methods, experiments and technological tools. Students have access to a unique interdisciplinary training, enhancing their skills in research, analysis and scientific presentation and developing their ability to work as part of a multidisciplinary team.

Objectifs pédagogiques de la formation

The Computational Neuroscience and Neuro-engineering Master aims to train students to face problems raised by brain perception, processing and transmission of information. The training program is based on experimental, computational and theoretical approaches, combining neurosciences, physics, applied mathematics and computer sciences at different scales (cell, network, behaviour) and different organizational levels (micro, meso and macroscopic scales). Thanks to the reputation of the laboratories and research teams involved, the Master degree offers a very high level courses programme with a high international visibility. The target of this Master program is to present the concepts, technological achievements, methodological approaches and research challenges in computational neurosciences and neuroengineering. It also aims to raise students' awareness of the theoretical, experimental, applicative, entrepreneurial and ethical themes of Neurosciences using the concepts of Physics and Engineering Sciences. The CNN Master's degree trains future engineers, researchers and lecturers specialized in Computational Neurosciences and Neuroengineering with an interdisciplinary culture and approaches ranging from theory to experimentation by combining computational methodologies. Engineer jobs and Phd projects in academic, industrial laboratories, integration in R-D departments in France or abroad, represent the main opportunities. The CNN

Master courses programme targets students with a range of backgrounds, including Life Sciences, Computing Science, Mathematics, Physics and Engineering. One part of the courses is focused on the theoretical approaches and the remainder is focused on a research project. Student will achieve the CNN Master with his own skills and interests. During the first semester, lectures such as the physiological bases of neurosciences, the neural bases of perception, the techniques for measuring and stimulating neural activity, the processing and analysis of neural signals, the dynamic systems in neuroscience, will provide the necessary tools to understand the complex phenomena involved in processing and transmitting information in the brain. A supervised scientific project will complete the students' training during the semester one. Semester two begins with a research internship of three to six months. This internship gives students real research experiences in computational neurosciences and neuroengineering. They will have the opportunity to work closely with a leading research team in the academic laboratories and opportunities will be created to work on industry lead projects. They will benefit from the supervision of experienced researchers. The project can be carried out with a research group at University Paris-Saclay, with an industrial partner or with a research institute in France or worldwide.

Débouchés

Professionnels

Après Master + Doctorat : chercheur ou enseignant-chercheur

Chargé.e de recherche et innovation

Ingénieur d'études industrie / recherche publique

**Ingénieur d'études dans les domaines de la recherche
enseignant.e-chercheur.se (après un doctorat)**

Enseignants-chercheurs

Ingénieur de recherche ou d'études

Ingénieur.e recherche et développement

Poursuite d'études

**Chercheur/chercheuse en R&D ou expert·e en modélisation et
analyse de données dans des entreprises ou laboratoires de pointe.**

**Data Scientist, Data Analyst, Ingénieur·e en Machine Learning dans
des secteurs innovants (tech, finance, santé, énergie, etc.) ;**

Doctorat

**domaines de l'apprentissage statistique, de l'intelligence artificielle
ou de l'analyse de données avancée**

former des spécialistes de niveau international, produisant des travaux compétitifs au sein d'équipes reconnues des établissements publics à caractères scientifique et technologique (EPST), INSERM et CNRS en particulier

Ingénierie études, recherche et développement

Master Neurosciences

Mémoire de recherche

Thèse de doctorat

Admission

Voie d'accès

Informatique

Mathématiques

Physique

Sciences de la vie

Sciences pour la santé

Sciences et technologies

Sciences pour l'ingénieur

Double Licence Mathématique - Physique

Capacité d'accueil

Places

16

Public visé et prérequis

The Computational Neuroscience and Neuroengineering (CNN) Master's program is designed for students from diverse academic backgrounds, including life sciences, computer science, mathematics, physics, and engineering.

- Student with level equivalent to Master 1 or Master 2
- Student with level equivalent to engineer degree
- English level equivalent to B2 certification

Période(s) de candidature

Plateforme Inception

Du 15/02/2026 au 30/06/2026



Internship

ECTS : 30
 Semestre calendaire : Semestre 2
 Langue d'enseignement
 Anglais
 Enseignement à distance
 non
 Prérequis

No prerequisites

Nature de l'évaluation
 Evaluation Continue non Intégrale

Tronc commun Computational Neuroscience and Neuro-engineering

Matières	ECTS	Semestre	Cours	TD	TP	Cours-TD	Cours-TP	TD-TP	A distance	Projet	Tutorat
Sensory systems and perception	3	Semestre 1	25								

Sensory systems and perception

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

no prerequisites

Programme / plan / contenus

Anatomy and Physiology of the mammalian auditory system, Perception of artificial and natural stimuli such as communication sounds in mammals.

Acoustic communication in songbirds, Sensorimotor learning in juvenile and adult birds.

Anatomy and physiology of the mammalian visual system: from retinal light capture to complex representation of visual scenes

Active vision: Non-canonical modulation of visual cortex

Interactions between somatosensory and motor systems: bases of neuroprosthetic devices

Multisensory processing study with large scale two-photon imaging

Olfaction in vertebrates and insects

Objectifs d'apprentissage

This teaching unit aims at providing detailed knowledge on the anatomical organization and the functional properties of neurons in all sensory modalities. Students will learn the foundations of sensory physiology underlying stable perception despite the flow of fluctuating information coming from the peripheral receptors. Results from electrophysiological recordings and calcium imaging will be used to visualize and quantify the responses of individual neurons, or of large cell assemblies, to artificial and to natural stimuli. We will then determine how behaving animals use these stimuli to master new tasks and reach optimal behavioral performance. Multimodal processing will also be presented with large scale neuronal recordings, and examples of the role of corticofugal feedbacks will

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Machine learning	3	Semestre 1	17		8						

Machine learning

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 17

Travaux pratiques : 8

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

background in signal processing

programming skills

Programme / plan / contenus

Regression and classification (Ridge Regression, Generalized Linear Model -including logistic regression, Support Vector Machines). Extensions to core methods.

Generalized Linear Model and Selection of Variables (Sparsity Constraints).

Aggregation methods (Boosting, Random Forrest)

Statistical tools for the analysis of large data.

Model of mixtures

Dimension reduction (Analysis in Principal Components).

K-means / Hierarchical clustering.

Objectifs d'apprentissage

Neuroscience is a field where very large data are generated ("Big Data", several tens of GB per session in fMRI, EEG, high temporal and spatial resolution optical recordings, or multi-electrode electrophysiology). The analysis of these data requires very specific analytical methods, which are themselves the subject of advanced research. This course presents an overview of machine learning methods as well as examples of the application of the different approaches developed.

Organisation générale et modalités pédagogiques

CM et TP, challenge

Compétences

At the end of this course, students will be able to define,

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
<u>Physiological bases of neuroscience</u>	3	Semestre 1	25								

Physiological bases of neuroscience

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

no prerequisites

Programme / plan / contenus

Issues and questions in neuroscience

Development of the nervous system

Nervous system organization: from neuron to network,
transmission of the nervous signal

Synaptic transmission

Synaptic plasticity, functional plasticity

Objectifs d'apprentissage

This course will focus on the study of the brain, its functions and its adaptability (brain plasticity) to the environment. The latest knowledge on the molecular and physiological basis of synapse and neuron function will be presented. At a more macroscopic level, the anatomy and structure of the brain will be addressed. The neural processes responsible for processing sensory information and perception, as well as their short- and long-term regulation through interaction with the environment, will be described.

Organisation générale et modalités pédagogiques

CM

Compétences

At the end of this course, the student will be able to:

- Understand neural communication processes at the physiological level.

- Have a global vision of the complexity of the nervous system and the interactions between the different components of the brain.

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Supervised project	12	Semestre 1		50							
■											

Supervised project

ECTS : 12

Semestre calendaire : Semestre 1

Détail du volume horaire

Travaux dirigés : 50

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

no prerequisites

Objectifs d'apprentissage

A supervised scientific project will complete the students' training during the semester one. This project is focused on a scientific issue including a bibliographic and/or experimental and/or simulation works.

Organisation générale et modalités pédagogiques

A scientific project is proposed to student with supervision of a project leader

Nature de l'évaluation

Evaluation Continue non Intégrale

Closed loop neuroscience	3	Semestre 1	25
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Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
■											

Closed loop neuroscience

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

no prerequisites

Programme / plan / contenus

The course is divided into lectures given by research experts. Each researcher will introduce some of the different approaches used in closed-loop neuroscience including experimental, computational, theoretical approaches. One (possibly two) practical classes will be organized in order to practice some algorithmic and analysis skills. Each teacher will provide their course slides after the class.

Objectifs d'apprentissage

This UE addresses the recent interest in closed-loop experiments in neuroscience. Closed loops arise from the bidirectional interaction between a biological system and a technological device. In the case of brain-machine interfaces, for example, it is an interaction between a brain structure and a computer or robot. To this end, this UE presents various techniques for recording and influencing neural activity in real time. It discusses sensory neuroprostheses and brain-machine interface techniques based on interpreting user intentions from EEG signals or invasive recordings, as well as more recent techniques exploiting or studying brain plasticity. Finally, the UE presents neuro-robotics techniques, focusing in particular on neuroinspired learning algorithms (in which the robot is programmed based on knowledge of brain function) and on robotic prostheses or orthoses.

Organisation générale et modalités pédagogiques

The course takes place mostly during one week in December (second or third week, to be confirmed).

Compétences

On successful completion of this course, students should be able to:

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Manipulating and recording neuronal activity	3	Semestre 1	13		12						

Manipulating and recording neuronal activity

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 13

Travaux pratiques : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

No prerequisites

Programme / plan / contenus

Chapter 1: Introduction to the different scales of neural activity recording and stimulation, what are the main issues and challenges to be addressed? Chapter 2: Targeted neural stimulation/inhibition methods Chapter 3: Biophysical models of brain signals

Chapter 4: Good practices for data acquisition and analysis, statistical tools for the analysis of large data sets

Chapter 5: Non-invasive neural recording methods used in humans.

Chapter 6: Electrophysiology

Chapter 7: Optical recording of neuronal network dynamics

Chapter 8: Functional Ultrasound Imaging

Objectifs d'apprentissage

The aim of this UE is to present methods for recording and stimulating neuronal activity as a means to access the organization and functioning of the brain. It will present methods to record or stimulate neural activity at different spatial and temporal scales. The principles and main applications of cellular (unit or multiple activity) and network (EEG, ECoG, LFP) electrophysiological approaches as well as invasive (calcium or voltage-sensitive imaging in conventional or multi-photon microscopy) and non-invasive (fMRI) brain imaging approaches will be described. Data analysis methods specific to each modality will be detailed, in particular through practical sessions where actual data sets will be analyzed.

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
<u>Dynamical systems and computational neuroscience</u>	3	Semestre 1	19		6						

Dynamical systems and computational neuroscience

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 19

Travaux pratiques : 6

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

linear algebra tools

programming skills

Programme / plan / contenus

Chapter 1: Mathematical models of neurons

This chapter presents well-known neuron models. It introduces conductance-based models through the famous Hodgkin-Huxley model and underlines its electronic analogy. It then presents simplified models, such as integrate & fire or FitzHugh-Nagumo models, as well as simple models of synapses and neuronal plasticity. Numerical simulation of these models is also introduced.

Chapter 2: Analysis of neuron models

This chapter presents mathematical tools to study neuronal behavior. It introduces the notion of phase diagram and bifurcation. These notions are first given for one-dimensional systems, and then for planar systems. The chapter establishes a link between these bifurcations and the qualitative behavior of the neuron. It also shows how to simplify a neuron model based on singular perturbation theory. It finally introduces the notion of “phase response curve”, which helps simplifying complex oscillatory behaviors to the mere time evolution of its phase, and shows how to use this technique in practice for the prediction of neuronal synchronization.

Chapter 3: Biophysical neuron model

This chapter presents a realistic neuron model based on dendritic modeling.

Chapter 4: Neuronal populations “Mean field model”

This chapter addresses the dynamics of a whole population of neurons or a cerebral structure. It presents

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Methods in cognition	3	Semestre 1	2	9	9						
■											

Methods in cognition

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 2

Travaux pratiques : 9

Travaux dirigés : 9

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

The objectives of the module is to show students how to assess cognitive functions in humans and animal models. Students will visit imaging centers for animal and human research in order to learn how to measure brain activity using various cutting edge technics. They will also learn how to test animal and human brain functions and their neural and physiological correlates during practical trainings.

Objectifs d'apprentissage

Learning outcomes (OAVs):

By the end of this unit, students will be able to:

1: understand how to investigate, measure and analyse human and animal brain functions

2: understand the principle of brain imaging in humans and rodent models

3: understand how to study physiological correlates of brain functions

Organisation générale et modalités pédagogiques

The course consists of practical assessments of cognitive functions in humans and rodents and of their neurophysiological correlates, and of visits of brain imaging centers dedicated to human and animals to learn the cutting edge current methods

Nature de l'évaluation

Evaluation Continue non Intégrale

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Human developmental cognitive neurosciences	3	Semestre 1	16	4							

Human developmental cognitive neurosciences

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 16

Travaux dirigés : 4

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

This course explores the neural underpinnings of human cognitive development. It draws parallels between typical and atypical developmental trajectories and integrates insights from adult cognitive neuroscience to better understand developmental mechanisms. Students will be introduced to the main cognitive functions, core neuroscientific methods, and major developmental disorders.

Objectifs d'apprentissage

By the end of this unit, students will be able to:

- OAV 1: understand the main concepts of developmental cognitive neuroscience.
- OAV 2: develop critic lecture of the experimental approach deployed to test typical and atypical developments of cognitive functions.
- OAV 3: Extract and comment relevant information from the literature

Organisation générale et modalités pédagogiques

This teaching unit includes 16 hours of lectures delivered by research experts, illustrating the foundations of developmental cognitive neuroscience, the typical development of cognitive functions and educational aspects in healthy and pathological conditions in children. In addition 4 hours of supervised sessions, during which students will work and discuss together with researchers to design some specific studies.

Nature de l'évaluation

Evaluation Terminale

Elective courses in CNN

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Methods in cognition	3	Semestre 1	2	9	9						
■											

Methods in cognition

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 2

Travaux pratiques : 9

Travaux dirigés : 9

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

The objectives of the module is to show students how to assess cognitive functions in humans and animal models. Students will visit imaging centers for animal and human research in order to learn how to measure brain activity using various cutting edge technics. They will also learn how to test animal and human brain functions and their neural and physiological correlates during practical trainings.

Objectifs d'apprentissage

Learning outcomes (OAVs):

By the end of this unit, students will be able to:

1: understand how to investigate, measure and analyse human and animal brain functions

2: understand the principle of brain imaging in humans and rodent models

3: understand how to study physiological correlates of brain functions

Organisation générale et modalités pédagogiques

The course consists of practical assessments of cognitive functions in humans and rodents and of their neurophysiological correlates, and of visits of brain imaging centers dedicated to human and animals to learn the cutting edge current methods

Nature de l'évaluation

Evaluation Continue non Intégrale

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Human developmental cognitive neurosciences	3	Semestre 1	16	4							

Human developmental cognitive neurosciences

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 16

Travaux dirigés : 4

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

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Nature de l'évaluation

Evaluation Terminale

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Medical Image Processing	3	Semestre 1	25								
■											

Medical Image Processing

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Français

Enseignement à distance

non

Prérequis

Réservé aux étudiants de la mention HSB de CentraleSupélec

Objectifs d'apprentissage

Acquérir des notions de traitement des images médicales et en particulier des images IRM

Nature de l'évaluation

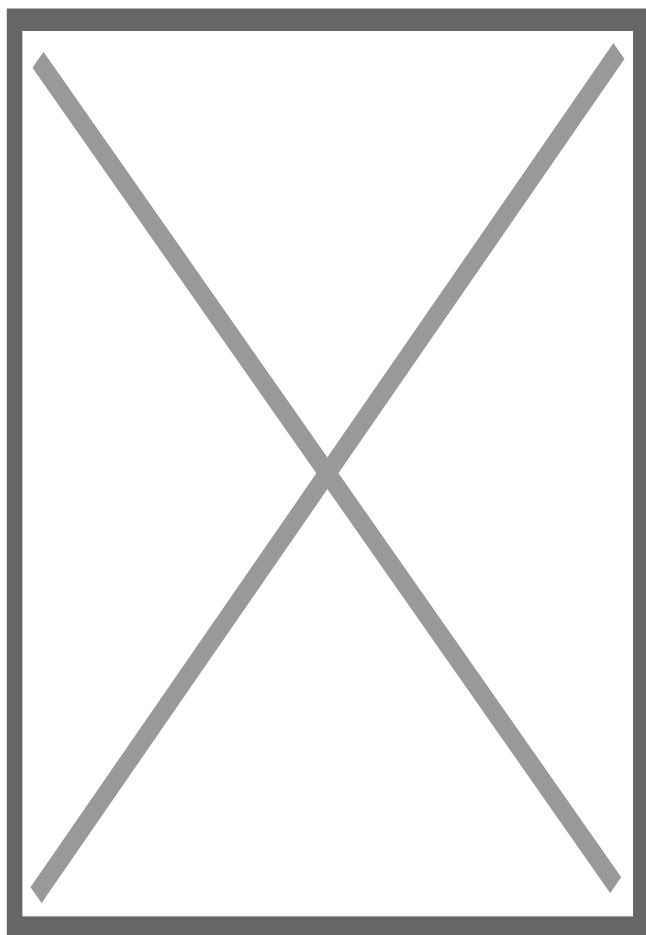
Evaluation Continue non Intégrale

Lieu(x) d'enseignement

SACLAY

Campus de la formation

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Orsay Bures

Orsay / Bures-sur-Yvette

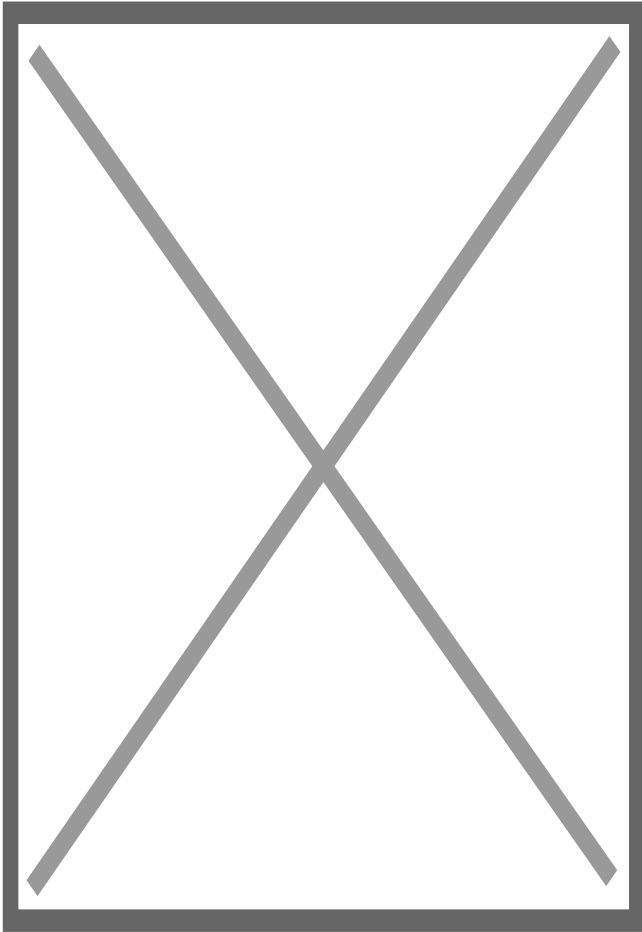
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Maison des associations



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Restaurant CROUS

Bibliothèque

Equipements sportifs

Résidence étudiante

Contact(s)

- **Sabir Jacquir**

PR

<http://www.universite-paris-saclay.fr/formation/master/neurosciences/m2-computational-neurosciences-and-neuroengineering>