A.Y. 2024/2025
TEACHING OFFER

BASIC COURSES

The PhD students (together with the supervisor) have to choose minumum 2 out of 3 macro curricula or choose specific courses across the curricula (minimum 80 hours)

Course unit	Dealing with cognitive neuroscience data with R: an introduction
Teacher	Andrea Zangrossi
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course aims to provide an introduction to the R software (with practical coding sessions) focusing on the following points: - Introduction to the R environment; - Reading and importing data; - Working with data of different types; - Automating repetitive processes; - Creating functions; - Visualizing data; - Exporting data from R to other software.
Course unit learning goals	Learn how to flexibly deal with different types of data and automatize data processing.
Type of assessment	Practical coding session

Course unit	Statistic for neuroscience – Level A
Teacher	TBD
Teaching hours	15
No of ECTS credits	3
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Introduction to R. Multiple Linear models (i.e. t-test, Anova and Ancova)
Course unit learning goals	Basics of R programming. Fitting, interpreting and evaluating multiple linear models.
Type of assessment	Brief homework assigned after each class

Course unit	Statistic for neuroscience – Level B
Teacher	Livio Finos
Teaching hours	15
No of ECTS credits	3
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Mixed models and selective inference
Course unit learning goals	Defining and fitting generalized linear models with fixed and random coefficients. Understanding and performing post hoc corrections and multiple testing
Type of assessment	Brief homework assigned after each class

Course unit	Graph theory and null models: theory and applications for the study of the brain networks
Teacher	Samir Suweis, Arianna Menardi
Teaching hours	15
No of ECTS credits	3
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	This course will be divided into two modules. In the first module (5 hours, Prof. Suweis), we will cover some basic concepts of graph theory including connectivity, centralities, assortativity and clustering. Applications on some real networks are also shown. The second part of the first module introduces some more advanced topics, such as the use of random graphs (Erdos-Reny, Small-World and Barabasi) as null models, to actually infer biological information from data on brain networks. In the second module (10 hours, Dr. Menardi), we will apply the use of graph theory analysis on real neuroimaging data. Practical hands-on sessions will be carried out to familiarize with the data, the extrapolation of measures, as well as getting acquainted with several different tools to plot and visually represent brain graphs. In particular, we will make use of a start-to-finish analysis pipeline, from the raw functional magnetic resonance imaging data to the building of the brain graph.
Course unit learning goals	Upon completion of the course, students will be able to: (1) Calculate the main structural properties of graphs (2) understand the fundamental properties of some families of random graphs; (3) Use random graphs as null models to test different properties of real networks; (4) gain understanding on the strengths and limitations of this technique applied to neuroimaging data.

Type of assessment	Wooclap quiz and small data analysis project

Course unit	Basic Course on Programming in Python
Teacher	Emanuele Di Buccio
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	• What is Python? • Python Basics • Functions • Control statements and loops • Lists, Tuples, Sets, and Dictionaries • Python Libraries (for data science and data visualization)
Course unit learning goals	• Learn Python data types and data structures. • Write a Python program able to read data from a file, process the data through a function or a set of functions, and write the result in a file. • Create (data) visualizations in Python
Type of assessment	Homeworks and final programming assignment

Course unit	Analysis of EEG signal (theory and hands-on)
Teacher	Camillo Porcaro
Teaching hours	15
No of ECTS credits	3
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course will provide the basic skills to collect and analyze electroencephalographic (EEG) signals. Practical sessions will allow students to gain experience with EEG recording. If access to the laboratory is limited, the EEG recording will be addressed by showing ad hoc video tutorials. The course will also underline step-by-step EEG pre-processing for data at rest and during event-related potential (ERP) analysis. The analysis will be conducted using EEGLAB software or other open-access software based on the student's specific needs. All lessons will include theoretical and practical sessions to allow the students to familiarize themselves with the software. Direct interactions will be encouraged during the lessons.
Course unit learning goals	The skills acquired in the course will allow the students to critically choose the most appropriate way to analyse EEG data with basic and advanced methods such as Independent Component Analysis.
Type of assessment	Use the Toolbox EEGLAB on real data of the topics covered.

Course unit	Analysis of fMRI and PET signals (theory and hands-on)
Teacher	Alessandra Bertoldo, Lorenzo Pini
Teaching hours	15
No of ECTS credits	3
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	• Introduction (structural/functional sequences) • Atlases • Pre-processing of resting state fMRI data: coregistration, segmentation, regression, filtering • Despiking and censoring • Functional connectivity (FC) • Graph measures (principals) • Dynamic FC: sliding windows, coactivation patterns • Introduction to effective connectivity • Static PET: PET tracer, partial volume, reference region, early phase, late phase • Dynamic PET: experimental setup • Multimodal integration: PET versus resting state fMRI
Course unit learning goals	During the course, students will acquire fundamental skills in analyzing imaging signals derived from fMRI and PET techniques. Furthermore, the course aims to provide an overview of the critical steps in data preprocessing, including: slice timing, distortion and motion correction, non-neural signal regression, filtering, co-registration, and normalization to a standard template.

Type of assessment	TBD

Course unit	Neuroanatomy
Teacher	Manara Renzo
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Brain anatomy as investigated by MRI and CT Fissures, scissures and primary sulci, main giri of the frontal, parietal, insular, temporal and occipital lobes, basal ganglia, brainstem and cerebellum.
Course unit learning goals	Recognition of above mentioned anatomical structure on MRI and CT
Type of assessment	Practical exam

Course unit	Neurophysiology (theory and laboratory)
Teacher	Aram Megighian
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Movement and its central control: Visuomotor responses; Locomotion or navigation in the local environment; Motor Control
Course unit learning goals	1. Behaviour is the internally coordinated responses (actions or inactions) of whole living organisms (individuals or groups) to internal and/or external stimuli 2. Motor responses are produced by spatial and temporal patterns of muscular contractions orchestrated by neural circuits in the brain and spinal cord. 3. Circuits in the forebrain and cerebellum that organize the intricate patterns of neural activity responsi- ble for more complex motor acts.
Type of assessment	Homework and interactive assesment during the course

Course unit	Psychophysiology
Teacher	Chiara Spironelli, Simone Messerotti Benvenuti
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The Psychophysiology course provides a brief review of the main psychophysiological models along with the basic techniques and methods used in this field during a psychophysiological assessment. The association between body and mind is scientifically analyzed not only by introducing the characteristics of every approach, but also with a practical/supervised training session. 1. First module (5 hours) – Prof. Spironelli: (1) The key concepts of the psychophysiological approach; dependent and independent variables. (2) Electroencephalography (EEG), electromyography (EMG) and eye movement/blinks: basic information and practical/supervised training on EEG; (3) functional Transcranial Doppler sonography (fTCD): basic information and practical/supervised training on fTCD. 2. Second module (5 hours) – Prof. Messerotti Benvenuti: (1) The key concepts of psychophysiology of emotion and its clinical applications; (2) Emotion, attention and the startle reflex; (3) Autonomic psychophysiology: models and basic techniques, including examples of clinical applications and practical activities.
Course unit learning goals	• Comprehension of the subjects covered, and acquisition of the methods and topics discussed throughout the course. • Gaining knowledge of the main models and methods in clinical psychophysiology
Type of	Active participation to the classroom exercises will be considered to pass.

assessment	
Course unit	Cognitive Science and Neuropsychology
Teacher	Andrea Zangrossi
Teaching hours	10
No of ECTS credits	2
Period	1st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The Cognitive Science and Neuropsychology course will give a theoretical and practical introduction to the study of the brain-behavior link. The course will focus on a set of cognitive functions (e.g., memory, attention and visuospatial functions, executive functions) to discuss their cognitive models, related deficits, quantitative assessment (i.e., tests) and neural correlates.
Course unit learning goals	During this course the students will learn to: 1. use cognitive models to study behavior; 2. relate cognitive and brain models of a cognitive function; 3. identify cognitive deficits in clinical populations; 4. assess cognitive functions by means of tests.
Type of assessment	NA

SOFT SKILLS COURSE

Mandatory for every PhD Student

Course unit	Soft Skills
Teacher	Giorgia Cona, Judit Gervain, Antonino Vallesi
Teaching hours	15 Module 1 – Presentation skills and public outreach (Giorgia Cona): 4 hours Module 2 – Academic writing: How to write a scientific paper (Judit Gervain): 5 hours Module 3 – Grantsmanship: The art of securing funding for research (Antonino Vallesi): 6 hours
No of ECTS credits	3
Period	1st semester
Year	1st, 2nd, and 3rd year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Module 1 – Presentation skills and public outreach (4 hours) This course illustrates the basic guidelines to make an effective talk and includes practical exercises. In the first part of the course, theoretical lessons will deal with: (a) how to prepare slides; (b) communicative aspects; (c) emotional aspects; (d) content of the talk. In the second part of the course PhD students will be challenged with theatrical and public speaking exercises. Module 2 – Academic writing: How to write a scientific paper (5 hours, 2nd year) This course is a hands-on, practical course introducing students to the basic

	principles of writing academic texts in English. Students will be familiarized with basic guidelines and best practices, will carry out exercises and small assignments and will then be working on an individual writing project for which they will get personalized feedback. • 1h: How to write an efficient sentence • 1h: How to write an efficient paragraph • 2h: How to write an efficient text • 1h: Project discussion and individual feedback <u>Module 3 – Grantsmanship: The art of securing funding for research</u> (6 hours, 2nd and 3rd year) Writing a successful grant application is an ability that needs being trained to fully flourish. While the primary focus of the evaluation process is on the scientific content, feasibility, impact and methodological soundness, the way you present your proposal and your adherence to the specific requirements of the funding agency are also critical factors that can help determining the fate of your application. In this 6-hour interactive course, I will provide some guidelines and practical examples on how to manage grant applications from the generation of the idea to the submission of the final proposal and even further.
Course unit learning goals	<u>Module 1 – Presentation skills and public outreach:</u> • Presentation skills and public outreach • Undestanding what are the key points for a good presentation • Learning how to deal with a successful presentation <u>Module 2 – Academic writing: How to write a scientific paper:</u> • Writing an efficient sentence • Writing an efficient paragraph • Writing an efficient scientific/argumentative text <u>Module 3 – Grantsmanship: The art of securing funding for research:</u> • Distinguishing the different grant types and their purposes • Aligning a grant proposal with the requirements and goals of your selected funding agency • Enhancing a grant proposal to be more informative, convincing, and captivating

Type of assessment	Module 1 – Presentation skills and public outreach: Individual performance on the assigned work will be considered as criterium to pass the course. Module 2 – Academic writing: How to write a scientific paper: Written assignment Module 2 – Academic writing: How to write a scientific paper: Active participation to the classroom exercises (e.g., presentations, group work, flipped classroom) and individual performance on the assigned work will be considered as criteria to pass the course.

ADVANCED COURSES

Select miminum 20 hours – 4 CFU

Area 1: Programming and Computational Neuroscience

Course unit	Basic introduction to Bayesian reasoning
Teacher	Giovanni Zanzotto
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required to be awarded the ECTS credits for the Course unit.
Course unit contents	The probability that a woman of age 40-60 has breast cancer is about 1%. If she has breast cancer, the probability that she tests positive on a screening mammogram is 90%. If she does not have breast cancer, the probability that she nevertheless tests positive is 9%. What are the chances that a woman who tests positive actually has breast cancer? This class briefly presents some basic notions of Bayesian probability to help in the analysis of uncertainty inherent in statistical information. Techniques based on the use of natural-frequency trees will be emphasized, which give an intuitive and direct insight into risk estimation, providing tools for a more transparent risk representation and a reduction of misleading risk information. Real-world examples will be considered throughout, connected for instance with the medical, psychological, and legal practice. One focus will be the correct judgment of the predictive value of medical diagnostic tests, also in relation to the recent COVID-19 public-health emergency.

Course unit learning goals	Formal and intuitive understanding of Bayes' Theorem, and its use in real world scenarios. Use of Natural-frequency Trees to develop the intuition, and facilitate the handling, of probabilistic information when a Bayesian approach is helpful.
Type of assessment	Brief homework assigned during or after each class.

Course unit	Dimensionality reduction and controllability of neural systems
Teacher	Michele Allegra, Samir Suweis
Teaching hours	10
No of ECTS credits	2
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	An outstanding problem in contemporary neuroscience is understanding how to intervene on the brain to control its global activity – chiefly, with the aim of restoring a normal activity balance in subject affected by brain pathologies. From the microscopic scale of a few neurons to the macroscopic one of large brain areas, control requires understanding how to collectively modulate the behavior of several neural units at the same time. As these units are not independent, it is convenient to apply suitable dimensionality reduction schemes to achieve a low-dimensional representation of the system in terms of a few collective variables effectively controlling the global behavior of the system. In this course, we shall introduce the traditional paradigm for “brain controllability”, highlighting its limitations when many units are simultaneously considered. We will then provide a few dimensionality reduction techniques that can be applied to achieve a ‘collective’ view of neural activity ad differerent scales. <u>Contents:</u> • The Kalman approach to dynamical controllability • Kalman control for brain activity and its limitations • Dimensionality reduction: linear approaches (PCA, ICA) • Dimensionality reduction: non-linear approaches (Isomap,

	Autoencoders)
Course unit learning goals	The students will learn how to perform a dimensionality reduction starting from high-dimensional neural data, and to perform a linear controllability analysis of a (linear) model of brain dynamics
Type of assessment	Data analysis exercise

Course unit	Deep Learning for Biomedical Images [Course unit taken from the Department of Information Engineering]
Teacher	Marco Castellaro
Teaching hours	20
No of ECTS credits	4
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The rapid evolution of deep learning in the field of computer vision provided state-of-the-art solutions for classical tasks such as object detection, classification, segmentation, and activity recognition. Besides, medical imaging is the ideal candidate model for the application of complex deep neural network (DNN) or Convolutional neural network (CNN) and more recent introduced Transformers architectures. In this course the teacher will provide students the knowledge and the practical skills to understand the most recent networks and to use them in the field of biomedical imaging. Topics: • Introduction to biomedical images (DICOM/Nifti standards) • Introduction to Pytorch and Monai (Medical Open Network for Artificial Intelligence) • Pre-processing, transform and data augmentation • Case studies: DNN and CNN architectures for image classification, segmentation, and image reconstruction • Training procedures, algorithms, and strategies • Transfer learning and fine tuning • Transformers, attention principle and its application to biomedical images analysis tasks.

	Course requirements: Python programming and basic machine learning theoretical background.
Course unit learning goals	The learning goal of the deep learning for biomedical images course is to equip students with the knowledge and practical skills necessary to comprehend and utilize the latest deep neural network. Through topics such as data pre-processing, deep neural network and convolutional neural networks architectures, training, transfer learning and fine-tuning procedures, the course aims to empower students to address complex challenges in medical image analysis using cutting-edge deep learning methodologies.
Type of assessment	The examination will be based on a team-work to implement a deep learning based task to be applied to a real dataset of biomedical images.

Course unit	A primer on machine and deep learning
Teacher	Marco Zorzi
Teaching hours	5
No of ECTS credits	1
Period	2st semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course will provide a non-technical overview of machine learning and deep learning, with a focus on conceptual understanding of the main methods, their pros and cons, and the methodological issues for their application to neuroscience data analysis.
Course unit learning goals	The students will learn basic conceptual and methodological knowledge of machine and deep learning, as well as the ability to evaluate its applicability to neuroscientific data.
Type of assessment	Discussion of possible use cases in the student's own research work

Course unit	Analysis of EEG signal (theory and hands-on) – Advanced
Teacher	Camillo Porcaro
Teaching hours	10
No of ECTS credits	2
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course will provide advanced skills to analyze electroencephalographic (EEG) signals. Practical sessions will allow the students to gain experience with EEG recording. If access to the laboratory is limited, the EEG recording will be addressed by showing ad hoc video tutorials. The course will also underline step-by-step advance EEG data analysis such as: • Independent Components (ICs) dimensionality reduction through Principal Component Analysis (PCA) in the high-density EEG (hdEEG); • Application of methods of automatic identification of artifacts and management of the effects of down-cleaning and over-cleaning of the data; • EEGLAB Study Design implementation, pre-calculation and statistics. • TMS-EEG by TESA.
Course unit learning goals	The skills acquired in the course will allow the students to critically choose the most appropriate way to analyse EEG data and TMS-EEG data.
Type of assessment	The use of the EEGLAB Toolbox on real data of the topics covered.

Area 2: Cognitive and Behavioral Neuroscience and Psychophysiology

Course unit	Practical course for transcranial magnetic stimulation
Teacher	Giorgia Cona
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course will address theoretical, methodological and practical issues of transcranial magnetic stimulation including: 1) Basic TMS principles, 2) TMS parameters; 3) safety issues; 4) possible applications. The course includes also a practical part in which students will familiarize with coil position, selection of motor threshold, change of frequency and paradigm (single-pulse vs. repetitive TMS).
Course unit learning goals	• Learning how to design a TMS experiment • Learning how to administer the TMS stimulation
Type of assessment	Active participation of the working-class exercises will be used as a criterium to pass the course

Course unit	Systematic review meta-analysis and study quality in neuroimaging
Teacher	Claudio Gentili
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Basic knowledge for the course: • Principles of neuroimaging techniques (principal techniques, main differences among techniques) • Basic knowledge in literature search • Basic knowledge in neuroanatomy Knowledge to be acquired: • how to perform a systematic search • how to write a systematic review • how to assess quality of a neuroimaging paper • how to perform a basic ALE meta-analysis Possibly the students will be guided toward the different steps of systematic review and meta-analysis in order to perform their own meta-analysis. Basic knowl
Course unit learning goals	Understand the differences among narrative review, systematic review, meta-analysis, coordinate based meta-analysis. Understand which information are relevant for each of the above (narrative narrative review, systematic review, meta-analysis, coordinate based meta-analysis) and where to find them.P

Type of assessment	Design a coordinate based meta-analysis and perform a systematic research

Course unit	Practical course for Functional Near-Infrared Spectroscopy (fNIRS) and infant brain imaging
Teacher	Judit Gervain
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	NIRS is an increasingly popular brain-imaging technique, which, apart from its classical use in developmental cognitive neuroscience, has wide range of applications in freely behaving participants and in situations where MRI/EEG are not applicable, such as real-time brain-computer interfaces, cochlear implant users, pilots flying planes or athletes performing physical activities. The course overviews the basic principles, different uses and analysis methods of this technique, with hands-on applications. The course has two parts. Part 1 provides a theoretical overview of the basic physical (optical) and physiological principles behind NIRS. Part 2 is a hands-on, lab-based demo where students are invited to test the technique themselves and familiarize themselves with analysis methods.
Course unit learning goals	• Understanding the physiological and physical principles underlying NIRS • Developing basic practical skills for designing and conducting NIRS studies • Developing basic skills to analyze NIRS data
Type of	Practical/Written assignment (e.g. designing a NIRS experiment)

assessment	

Area 3: Cellular and Molecular Neuroscience

Course unit	Light-based methods for reconstructing brain activity at cellular resolution
Teacher	Mario Bortolozzi (Parts 1-5: 5 hours), Marco Dal Maschio (Parts 6-8: 5 hours)
Teaching hours	10
No of ECTS credits	2
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.

Course unit contents	Workload: about 8 h in classes and 5 h for the exam preparation (group activity with teachers and tutors)
	
	The course combines a set of lessons on basic concepts of light microscopy and fluorescence imaging with practical sessions dealing with optics and microscopy along with the acquisition and the analysis of a functional dataset from a living model organism.
	• Part 1 (Mario Bortolozzi)
	  ○ Lesson on optics theory: light propagation, reflection, refraction, lenses, image formation, transverse and longitudinal magnification, magnifier, angular magnification.
	  ○ Hands-on session: playing with a lens.
	• Part 2 (Mario Bortolozzi)
	  ○ Lesson on fluorescence: irradiance, absorption and transmission, fluorescence emission, Jablonsky diagram, saturation irradiance, quenching, bleaching, fluorescence spectra.
	• Part 3 (Mario Bortolozzi)
	  ○ Lesson on microscopy: upright and inverted microscopes, filters and

	beam splitters, point spread function, diffraction limit, numerical aperture. ◦ Hands-on session: working with a microscope. • Part 4 (Mario Bortolozzi) ◦ Lesson on Multiphoton microscopy: the basic principles, pulsed lasers, 2P-microscope configuration, 2P resolution, typical 2P dye spectra, examples of typical experiments. • Part 5 (Mario Bortolozzi) ◦ Lesson on Calcium Imaging: fluorescent dyes, deriving Ca2+ concentration from fluorescence, practical limitations and formula, examples, ratiometric dyes, non-equilibrium conditions, genetically encoded fluorescent activity reporters. • Part 6 (Marco Dal Maschio) ◦ Lesson on light-based methods to modulate circuit activity. • Part 7 (2h) (Marco Dal Maschio) ◦ Hands-on session on the acquisition of a functionally activity dataset using a multiphoton microscope: sample preparation, visual stimulus presentation, multiphoton microscope configuration and acquisition of the dataset. • Part 8 (2h) (Marco Dal Maschio) ◦ Hands-on session on the data analysis using Suite2P and Python: segmenting the dataset and retrieving the neuronal time series, plotting of the time series, regression analysis to highlight visual stimulus tuning.
Course unit learning goals	Acquiring (i) theoretical knowledge about optics and microscopy observation of biological samples; (ii) practical experience in the use a multiphoton microscope and data analysis of neuronal activity.
Type of assessment	30 minutes, preparation of short report on the activity (max 3 pages)

Course unit	Theoretical models of classification learning in neural systems and of the primary visual cortex
Teacher	Davide Bernardi
Teaching hours	10
No of ECTS credits	2
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	This class aims to offer an intuitive understanding of two fundamental topics in Computational Neuroscience. The first part focuses on a core computational task faced by living systems: learning categories and associations. We will show how idealized models of neurons and synaptic plasticity can create and store associations. Notably, this kind of task is one that artificial intelligence algorithms inspired by biological networks excel at. In the second part, we will explore the primary visual system, illustrating how phenomenological models can effectively describe and predict neuronal responses to stimuli. The course includes a hands-on component in which simple tasks related to the course topics will be solved using basic analytical calculations and computer programming in Python. Only a basic math and programming knowledge is assumed as a prerequisite.
Course unit learning goals	• Developing an understanding of how computational models can interpret and mimic functions in biological systems. • Learning the application of analytical and programming skills to model and analyze neurobiological systems.
Type of assessment	Two brief assignments discussed in class

Course unit	Visuomotor responses in a simple nervous system: the invertebrate nervous system (*Drosophila melanogaster*)
Teacher	Aram Megighian
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	• Visuomotor mechanisms in invertebrates and vertebrates ○ Optic flow and optomotor responses ○ Selective visual responses ○ Pursuit? • Navigation in invertebrates and vertebrates ○ Navigation as a goal directed response ○ Internal and external sensory information ○ Cognitive maps in navigation
Course unit learning goals	1. Navigation is a behavioral response involving the integration of multiple sensory informations together with previous memories and individual decision-making processes. 2. Visuomotor responses permit to analyse the neurobiological processes orchestrating navigation
Type of assessment	Homework and interactive assesment during the course

Course unit	Electrophysiological recordings in animals
Teacher	Stefano Vassanelli
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Methods to measure and characterize brain activity based on electrophysiological tools, both ‘in vitro and ‘in vivo’.
Course unit learning goals	• Knowledge of fundamental single neurons recording methods • Knowledge of fundamental neural populations and brain circuits recording methods • Knowledge of main neural stimulation methods and underlying neurophysiological mechanmisms
Type of assessment	Discussion with the teacher

Area 4: Translational and Clinical Neuroscience

Course unit	Translating neuroscience into clinical practice
Teacher	Angelo Antonini
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	The course aims to offer a holistic and integrated vision of the molecular, genetic and clinical alterations underlying neurodegenerative diseases including dementia, Parkinson's disease and rare neurological diseases
Course unit learning goals	- Understand the pathological aggregation processes of brain proteins such as amyloid, tau and synuclein. - Explain how pathological protein aggregates alter brain functioning and connectivity. - Define the contribution to cognitive and behavioral alterations and explore consequences for the patient's functioning
Type of assessment	TBD

Course unit	Motor recovery and neuroplasticity after central nervous system injury
Teacher	Alessandra Del Felice
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	Neurobiological and neurophysiological signatures of recovery after CNS injury; basic principles of neurorehabilitation.
Course unit learning goals	The course will provide students the conceptual understanding of the micro- and meso-scale events underpinning neuroplasticity after CNS injury, exploring clinical and experimental interventions to boost recovery. Learning objectives include the knowledge of timing of neurobiological events occurring after lesions and the rationale for intervention in different time windows, the experimental approaches trialed and the reasons for the lack of translatability, and a brief review of current clinical approaches according to international guidelines
Type of assessment	Critical review of a recent top-journal paper on the topic

Course unit	Brain-body interactions in psychopathology and the bio-neurofeedback
Teacher	Elisabetta Patron
Teaching hours	5
No of ECTS credits	1
Period	2nd semester
Year	1st year
Teaching method	In person
Language	English
Attendance	A minimum of 70% teaching hours is required in order to be awarded the ECTS credits for the Course unit.
Course unit contents	This course intends to provide an introduction to the psychophysiological basis of brain-body interaction, with a particular focus on brain-heart interplay in emotion and psychopathology. Bio- and neurofeedback are interventions based on brain body interaction. The course will provide theoretical framework and clinical protocols. • First module (2 hours): The psychophysiological basis of brain body interaction with a particular focus on the role of brain heart interplay. • Second module (3 hours): The scientific basis of biofeedback and neurofeedback and their main clinical applications.
Course unit learning goals	• Theoretical knowledge of the physiological basis of brain-body interaction • Basic ability to design bio- neurofeedback experimental protocols
Type of assessment	Brief homework assignment: design a bio-neurofeedback experimental protocol.