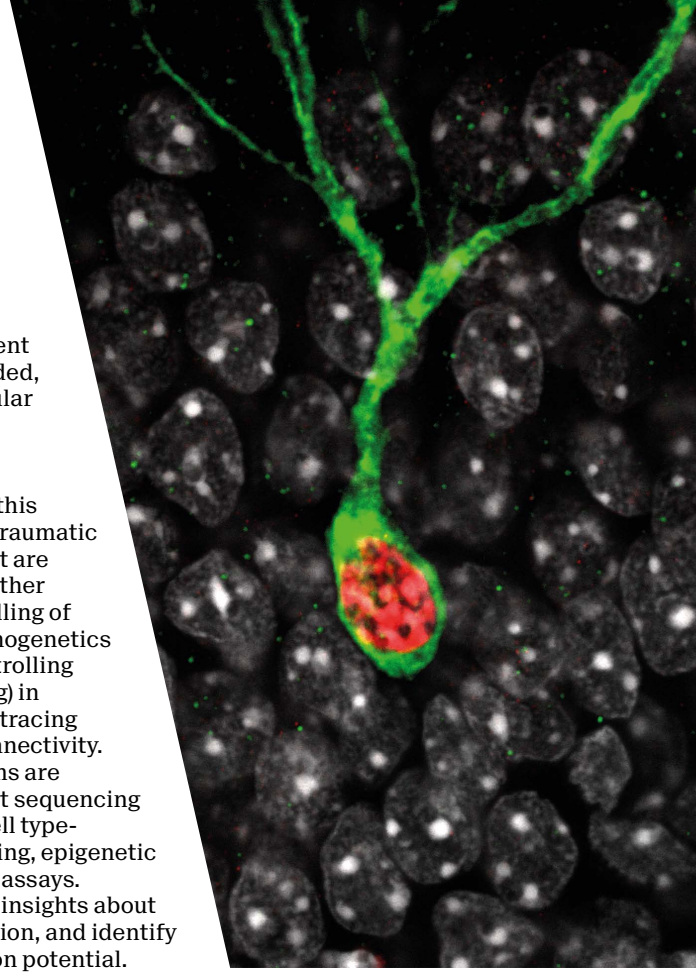
NEURO-X

MASTER

EPFL

Science, technology and computation are the foundations onto which engineers in Neuro-X build their expertise. Their multidisciplinary profile complements the fundamental skills of engineers and medical-domain specialists by a strong technological component, making them not only highly demanded and valued professionals in neurotechnology, but also preparing them for research in neuroscience-related fields.

Molecular and cellular mechanisms of remote traumatic memory formation



J. Graeff Lab

Despite the high prevalence of trauma-related disorders and the consequent need to better understand how long-lasting traumatic memories are encoded, the brain circuits supporting this process as well as the underlying molecular mechanisms therein remain largely unknown.

In this project, students employ cutting-edge neurocircuit as well as cell-type specific molecular tools to investigate this question from various angles in rodent models of traumatic memories. Specifically, brain areas of interest are artificially activated or silenced using either optogenetics (light-induced controlling of neuronal functioning) or chemogenetics (chemically induced controlling of neuronal functioning) in combination with viral tracing tools to identify their connectivity. Molecularly, key mechanisms are identified using state-of-the-art sequencing technologies which encompass cell type-specific and single cell RNA sequencing, epigenetic sequencing and chromatin accessibility assays. Together, these experiments yield valuable insights about the underpinnings of enduring memory formation, and identify preclinical candidate mechanisms with translation potential.

Camille Frayssinhes:
"The opportunity to experiment new perspectives in neurosciences thanks to the multidisciplinary scientific background offered by the Neuro-X Master's program will be a valuable asset for the students in their future professional career."

Daniel Tadros:
"Graduating from EPFL is a milestone in my career. While following high quality courses, I had the opportunity to work with distinguished faculties in cutting edge research facilities."

Animal pose estimation with a deep learning program

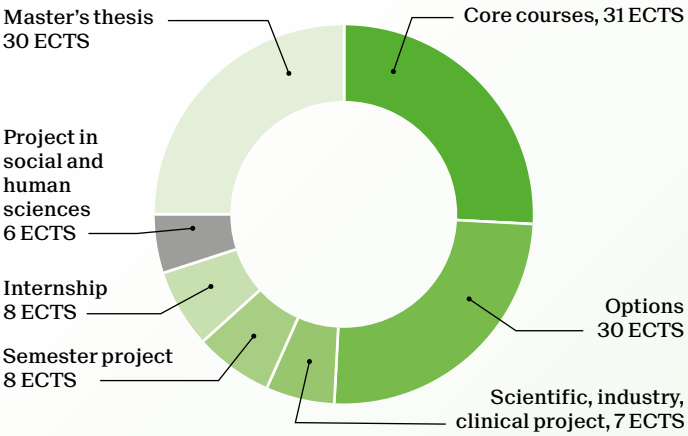
Mathis Labs

Understanding how the brain controls behavior is one of the major goals of fundamental and applied neuroscience. To make better inferences about the nature of neural computations or to better control the body via protheses, it is essential to measure behavior in a fine-grained way. Computer Vision lends itself to this challenge, and projects in this Master allow students -for instance- to perform 2D and 3D pose estimation and behavioral analysis on a variety of species, ranging from biomechanics of Cheetah's (FIG XYZ) to mice solving naturalistic tasks. This involves getting familiar with state-of-the-art deep learning architectures and then adapting them to perform inverse dynamics, which allows researchers to infer from video the biomechanical torques that are required to achieve a particular movement.

Master of Science in

NEURO-X

2-year program - 120 ECTS



Students may choose a minor (30 ECTS), e.g.:

- Biomedical technologies
- Imaging
- Photonics

Career prospects

Thanks to their interdisciplinary profile and their translational spirit, graduates will have the opportunity to become future leaders, start-up managers, or innovative health professionals in the industry (MedTech, pharmaceutical companies or health care), in hospitals and in research in general. Their ability to see the big picture in terms of systems combined with a realistic perspective of what it means to develop and manufacture a product, as well as their ability to interact with many other types of experts in this field makes them highly esteemed professionals.

	Credits
Core courses	**31**
Computational neuroscience: biophysics	5
Computational neuroscience: neuronal dynamics	5
Machine learning	8
Neural interfaces	6
Neural signals and signal processing	6
Neuroscience: behavior and cognition	5
Neuroscience: cellular and circuit mechanisms	5
Neuroscience: from molecular mechanisms to disease	5
Translational neuroengineering	6

Options	**30**
Area: Technology	
Analog IC design	3
Basics of robotics for manipulation	3
Bioelectronics and biomedical microelectronics	3
Bio-nano-chip design	3
Computational motor control	4
Controlling behavior in animals and robots	4
Design technologies for integrated systems	6
Fundamentals of biosensors and electronic chips	3
Haptic human robot interfaces	3
Nanotechnology	3
Organic and printed electronics	2
Sensors in medical instrumentation	3
Sustainability and materials	3
Virtual reality	6
Area: Data Science and Machine Learning	
Applied biostatistics	5
Applied data analysis	8
Applied machine learning	4
Applied probability and stochastic processes	4
Artificial neural networks/reinforcement learning	6
Brain-like computation and intelligence	4
Causal thinking	5
Deep learning	4
Deep learning in biomedicine	6
Dynamical system theory for engineers	6
Introduction to natural language processing	6
Machine learning for behavioral data	6
Mathematics of data: from theory to computation	6
Optimization for machine learning	8
Understanding statistics and experimental design	4
Visual intelligence: machines and minds	6
Area: Imaging and image analysis	
Advanced computer graphics	6
Biomedical optics	3
Biomicroscopy I	3
Biomicroscopy II	4
Computer vision	6
Fundamentals of biomedical imaging	4
Fundamentals of biophotonics	3
Image analysis and pattern recognition	4
Image Processing I	3
Image Processing II	3
Area: Neuro-exploration	
Advanced methods for human neuromodulation	4
Neural circuits of motivated behaviors	4
Scientific literature analysis in neuroscience	4
Scientific project design in integrative neurosciences	4
Systems neuroscience	4
Ethics and law of AI	4

Schools of Life Sciences, Engineering, Computer and Communication Sciences
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