

# EBRAINS-ITALY DIGITAL ACADEMY FOR NEUROSCIENCE AND AI

## UNLOCK YOUR POTENTIAL WITH: E-DIANA – EBRAINS-ITALY DIGITAL ACADEMY FOR NEUROSCIENCE AND AI

Are you a researcher or professional eager to advance in **computational neuroscience, brain modeling, AI, or neurorobotics**?

The **EBRAINS-Italy Digital Academy for Neuroscience and AI (e-DiANA)** is a **postgraduate training program** offering **state-of-the-art digital training modules** to boost your skills and keep you at the forefront of research and innovation. e-DiANA is organised as a service which is part of the Research Infrastructure "[EBRAINS-Italy](#)"

### Why Choose the e-DiANA?

- **Learn from the best:** top experts and researchers from the EBRAINS-Italy consortium.
- **Hands-on experience:** explore the latest breakthroughs in brain science and intelligent systems.
- **Flexible and engaging:** study at your own pace, with optional live sessions for deeper interaction.

### What You Gain

✓ **Certified training credits:** each module equals **0.5 ECTS – European Credit Transfer and Accumulation System** (4h of digital learning + 8.5h of individual study), certified by EBRAINS-Italy and ISTC-CNR (*while not issued by accredited institutions, you can request recognition from your PhD program or training body*).

✓ **World-class content:** in the future, new Modules may be offered either free or fee-based — but the choice of which ones to follow will always be **entirely up to you**.

✓ **A vibrant community:** join a network of scientists and innovators shaping the future of neuroscience, AI, and robotics, which is essential to foster your future research or professional career.

# TRAINING THE NEXT GENERATION OF BRAIN SCIENCE & AI INNOVATORS



## What is EBRAINS-Italy?

The EBRAINS-Italy Digital Academy for Neuroscience and AI is a service which is part of EBRAINS-Italy and is organised by ISTC- CNR and ETICo. EBRAINS-Italy is the Italian Research Infrastructure for neuroscience, dedicated to:

- **Neuroscience & Brain Modeling**
- **Artificial Intelligence & Neuro-inspired Technologies**
- **High-performance computing & data sharing**
- **Experimental and clinic research**

It connects **universities, research institutes, and industry** to accelerate projects ranging from fundamental neuroscience to **AI-driven robotics**. By integrating data, models, and simulations, EBRAINS-Italy helps researchers **unravel the brain's complexity** and develop **next-generation technologies**.

## ETICo – EBRAINS-Italy Training and Innovation Committee

**ETICo** is a Committee linked with **ETHICS**. It guides and monitors the e-Diana's activities. Composed of representatives from most EBRAINS-Italy partners, **ETICo** ensures:

- **High-quality, innovative training**
- **Alignment with EBRAINS-Italy's mission**
- **Interdisciplinary excellence**
- Responsiveness to **emerging scientific and technological challenges**

## ETHICS – EBRAINS-Italy Training, Human-AI Research, Innovation: Commons & Smartspace

**ETHICS** is a physical and virtual Centre hosting a subset of services of EBRIANS-Italy, of which e-DiANA is part. **ETHICS** is the beating heart of training and innovation in EBRAINS-Italy.

**ETHICS**, based in Rome (Via Tiburtina 605), offers:

- Cutting-edge **educational programs**
- Support for **technology transfer** in neuroscience, AI & neurorobotics

Together, **EBRAINS-Italy, ETHICS and ETICo** create a robust ecosystem where **education, research, and innovation meet** to shape the future of neuroscience, AI, and neurotechnology.

## YOUR DIGITAL GATEWAY TO ADVANCED LEARNING IN NEUROSCIENCE, AI & NEUROTECHNOLOGY

The EBRAINS-Italy Digital Academy for Neuroscience and AI is designed as a flexible and accessible **digital environment**, where structured learning meets personal choice.

Its educational offer is built around digital **Modules**, which can be followed individually or combined into **Learning Paths**. These pathways offer thematic guidance, enabling participants to navigate the vast and rapidly evolving fields of brain science, artificial intelligence, and neuro-inspired technologies.

# LEARNING PATHS OVERVIEW

Two learning paths constitute the e-DiANA:

- The **“Emulate and Understand the Brain”** learning path provides participants with a comprehensive understanding of how to model and analyse brain function using data-driven and biologically realistic approaches. It guides learners through the key steps of computational neuroscience — from extracting electrophysiological features, to building single-cell models, and reconstructing brain microcircuits. Through a combination of theoretical lessons and hands-on exercises, participants gain practical experience with advanced EBRAINS tools and workflows for feature extraction, cellular modeling, and circuit-level simulations, fostering the ability to emulate and interpret neural activity in silico.
- The **“Modelling cognition, memory and learning in biological and robotics systems”** learning path explores how computational and neuro-inspired models can be used to understand and replicate cognitive processes in both humans and artificial agents. It bridges neuroscience and robotics by addressing mechanisms of higher-order cognition, memory, and continual learning. Participants will learn to model cognitive flexibility and executive functions in healthy and clinical populations, and to develop adaptive algorithms that enable robots to continuously learn from dynamic environments without forgetting past knowledge. Through theoretical insights and hands-on activities, the path provides an integrated perspective on cognition and learning across biological and artificial systems.

Unlike traditional training formats, the e-DiANA gives you the freedom to **shape your own path**. Focus deeply on a specific topic by following a **Learning Path**, or mix and match **Modules across different areas** to explore new possibilities. Your learning journey is entirely **customizable to your interests, needs, and career goals**.

## EBRAINS-ITALY DIGITAL ACADEMY FOR NEUROSCIENCE AND AI TRAINING MODULES

Discover our Learning Pathways and Modules, designed to build your expertise in neuroscience, AI, and neurorobotics.

**Each Module includes:**

1. **Theory and hands-on learning:** up to 3 hours of digital video lessons, divided into sub-sections, accessible offline at any time.
2. **Insight learning:** an optional 1-hour online session, to deepen the studied materials; occasionally, in-person sessions can also be organised, in coincidence with events and initiatives promoted by ETHICS.
3. **Attendance test:** an assessment based on an oral test organised by the Module Instructor, which students can choose to take to earn an official Certificate. Each Certificate provides them with the opportunity to prove their attendance and involvement in one education Module. Each Module is equivalent to 0.5 ECTS (4h of digital learning + 8.5h of individual study).

**EBRAINS-Italy Digital Academy for Neuroscience and AI** currently offers *six training modules*. The e-DiANA is constantly expanding with **new Modules**, offering students fresh opportunities to learn and grow. It embraces an **open and lifelong learning approach**, fostering a vibrant community of researchers and professionals connected through the **EBRAINS-Italy infrastructure**.

Module Title	Module Contents
<p><b>Electrophysiological feature extraction</b></p> <p>Learning path: <b>Emulate and understand the brain</b></p> <p>Principal Investigator: Rosanna Migliore  Instructor: Luca Leonardo Bologna  Affiliation: CNR- Institute of Biophysics- IBFC</p>	<p>The Module focuses on understanding the meaning of the most common features of electrophysiological signals and learning the NeuroFeatureExtract feature extraction process. It is composed of four videos:</p> <ul style="list-style-type: none"> <li>• Explanation and role of electrophysiological features and feature extraction in neuroscience</li> <li>• The Electrophys Feature Extraction Library (eFEL) for feature extraction in Python</li> <li>• How to use the EBRAINS NeuroFeatureExtract (NFE) web application for online feature extraction</li> <li>• Exercises on feature extraction through the EBRAINS NFE</li> </ul>
<p><b>Single cell data-driven model building</b></p> <p>Learning path: <b>Emulate and understand the brain</b></p> <p>Principal Investigator: Michele Migliore  Instructor: Carmen Alina Lupascu (theory)  Instructor: Paola Vitale (hands-on)  Affiliation: CNR- Institute of Biophysics- IBFC</p>	<p>This Module focuses on the construction and optimisation of biologically realistic single-cell models, utilising state-of-the-art online resources, tools, and services. Participants will learn how to access and integrate these resources through EBRAINS interactive workflows for cellular-level modeling and the Hippocampus Hub.</p> <p>Through theoretical lessons and hands-on exercises, the Module will guide participants in building, refining, and optimising single-cell models, ensuring accuracy and biological relevance in neural simulations.</p>
<p><b>Realistic modelling of brain microcircuits</b></p> <p>Learning path: <b>Emulate and understand the brain</b></p> <p>Principal Investigators: Egidio D'Angelo and Claudia Casellato  Instructor: Dimitri Rodarie  Affiliation: Dept. of Brain and Behavioral Sciences - University of Pavia</p>	<p>This Module provides a comprehensive introduction to the reconstruction, simulation, and validation of brain microcircuit models. Participants will learn key concepts, tools, and workflows essential for building biologically realistic neural circuits. The course will cover:</p> <ul style="list-style-type: none"> <li>• The Brain Scaffold Builder (BSB): Theory and workflow</li> <li>• Data Integration: Importing data from brain atlases</li> <li>• Microcircuit Construction: Cell placement and connectivity</li> <li>• Simulation Techniques: Running simulations with NEURON and NEST</li> <li>• Practical Application: A case study using the cerebellar cortex microcircuit</li> <li>• Model Validation: Principles and methodologies for assessing model accuracy</li> </ul>
<p><b>Spiking Neural Network 101</b></p> <p>Learning path: <b>Emulate and understand the brain and Modelling cognition, memory and learning in biological and robotics systems</b></p> <p>Principal Investigator: Alessandra Pedrocchi  Instructor: Alberto Antonietti  Affiliation: POLIMI-Politecnico Milano</p>	<p>The Module introduces participants to spiking neural networks (SNNs) as a tool for developing bioinspired models of brain circuits. Students will explore different single-neuron models, ranging in complexity from:</p> <ul style="list-style-type: none"> <li>• Integrate-and-fire models</li> <li>• Current-based and conductance-based models</li> <li>• Hodgkin-Huxley models</li> <li>• (Extended) Generalized integrate-and-fire models</li> </ul> <p>Then, students will learn how to choose between different</p>

	<p>synapse models, explaining how short-term plasticity and long-term plasticity can be included.</p>
<p><b>Computational Neuropsychology of higher-order conscious cognition: neuro-inspired computational models of healthy, neurological, and psychiatric conditions</b></p> <p>Learning path: <b>Modelling cognition, memory and learning in biological and robotics systems</b></p> <p>Principal Investigator: Gianluca Baldassarre  Instructor: Giovanni Granato  Affiliation: CNR-Institute of Cognitive Science and Technologies- ISTC</p>	<p>The Module will provide a brief introduction to the computational neuropsychology of higher-order conscious cognition, with a specific focus on executive functions and the Wisconsin Card Sorting Test (WCST), a gold standard test for measuring cognitive flexibility.</p> <p>Then, it will introduce a neuro-inspired computational model, in particular, its architecture and submodules (e.g., discriminative and generative processes of visual cortical hierarchies, attention and selection processes supported by higher-order cortices and basal ganglia, and working memory supported by prefrontal cortices).</p> <p>Subsequently, the Module will introduce the model code and a graphical user interface (GUI), which supports the simulation/fitting of different groups of healthy human participants and patients (brain lesions, neurodegenerative disorders, etc.).</p> <p>The Module will finally introduce hands-on activities (data fitting, virtual lesion/virtual therapy approaches), at the end of which the student will produce a short scientific report (in case of promising results, a paper draft could follow the completion of the module).</p> <p>Overall, the theoretical content and practical activities will illustrate model-based methods for assessing higher-order cognitive differences in human health and clinical conditions.</p>
<p><b>Advancing continual learning for robotic applications</b></p> <p>Learning path: <b>Modelling cognition, memory and learning in biological and robotics systems</b></p> <p>Principal Investigator: Egidio Falotico  Instructor: Nilay Kushawaha  Affiliation: SSSA - Sant'Anna school of advanced studies</p>	<p>Humans excel at lifelong learning, adapting to ever-changing environments. However, for deep learning algorithms, learning sequentially or from a non-stationary data stream without forgetting previously acquired knowledge (catastrophic forgetting) remains a significant challenge.</p> <p>In this Module, we will explore the concept of continual learning, which is essential for developing autonomous agents capable of learning in an open-ended and progressive manner. We will cover strategies for exploring the environment, acquiring new knowledge, and retaining previously learned information. Additionally, we will introduce and analyse some of the most advanced state-of-the-art algorithms for continual learning.</p>
<p><b>Neuron Cultures Model</b></p> <p>Learning path: <b>Emulate and understand the brain</b></p> <p>Principal Investigator and Instructor: Mattia Stefano  Affiliation: CNR – Department of Physical Sciences and Technologies of Matter – DSFTM</p>	<p>The module will teach the theoretical fundamentals and computational implementation of a neuronal culture model. In the first part of the course, the fundamentals of theoretical neuroscience are treated, providing the students with the essential knowledge on single compartment and single channel models, and synaptic mechanisms. In the second part of the course, we will deepen how to use the previously gained knowledge to</p>

develop a neuron culture model considering a case study and how compare the computational model results with experimental data on neuronal cells culture in-vitro.

# ENROLLMENT PROCEDURE – HOW TO JOIN EBRAINS-ITALY DIGITAL ACADEMY FOR NEUROSCIENCE AND AI

Joining the EBRAINS-Italy Digital Academy for Neuroscience and AI is a straightforward and structured process designed to ensure a smooth entry while providing the best learning experience. Follow these steps to enrol and start your training journey.

## 1. Choose Your Modules

- The e-DiANA is a postgraduate program: candidates must hold a **Bachelor's degree** or be **close to completing** one.
- Decide which **Modules** you want to attend, based on your interests and previous knowledge.
- You can choose multiple Modules **simultaneously** or start with a **single** Module and expand later.
- This flexibility allows you to **tailor your learning path** to your interests and career objectives.

## 2. Submit Your Application

- Complete the **online enrollment form** <https://forms.gle/4PBYNHzfFnBG83Ve9>
- The form collects **basic background information**, including your academic and professional experience, to assess eligibility for different Modules.
- Specify the **Module(s) you wish to attend**.
- Indicate your current knowledge and skills to ensure the Instructors check that you possess the **prerequisites** for successful attendance of the chosen Modules.



## 3. Application Review and Approval

- The Instructors **review** your application to ensure that participants have the **necessary knowledge** and background for the e-Diana and chosen Modules.
- The Instructors **review** the possession of a Bachelor's degree or the completion of sufficient exams (nearly degree level).
- Once reviewed, you will receive an **email notification**:
  - **If accepted:** you receive login credentials for the academic office, granting access to the selected and approved Module(s).
  - **If not accepted:** you are informed via email.

## 4. Course Participation

Once enrolled, you can fully engage with the **digital learning platform**, based on **Moodle**:

- Access **all course materials asynchronously**, including **video lessons, slides, and supplementary resources**.
- Study at your **own pace**, revisit content as needed, and complete exercises to reinforce learning.
- Establish connections with **Instructors and the EBRAINS community**, fostering relationships with peers and experts in neuroscience, AI, and neurotechnology.

# FINAL CERTIFICATES

The **EBRAINS-Italy Digital Academy for Neuroscience and AI** allows you to obtain an **official Certificate of Attendance** for each Module you complete. Certification is optional but highly recommended for formal recognition of your training. The official Certificate allows students to demonstrate their attendance and involvement in educational activities promoted by EBRAINS-Italy, with each module equivalent to 0.5 ECTS.

## Assessment and Certification

- To receive a Certificate, students must complete an **assessment** at the end of the Module.
- Assessments focus on the **knowledge and skills** gained during the course.

## How the Assessment Works

- The evaluation is based on a **remote oral test** conducted by the Module instructor via online streaming tools. This live contact is introduced to mitigate the impact of AI-generated responses in other forms of assessment.
- In some cases, students may also be asked to submit a **short written essay** or another form of delivery related to the Module's topic, which will be considered alongside the oral discussion.

## Certificate Issuance

- If the assessment is successfully passed, the student receives a **Module Certificate** (one per Module completed).
- The **Certificate is digital** but can be printed on paper.

## Additional Attempts

- If a student does not pass the test, the instructor provides **detailed feedback** to help improve performance. Students are then allowed to **retake the assessment**, ensuring that motivated learners can achieve certification.

# OBJECTIVES OF THE EBRAINS-ITALY DIGITAL ACADEMY FOR NEUROSCIENCE AND AI

## Our Mission

The **EBRAINS-Italy Digital Academy for Neuroscience and AI** is dedicated to advancing **training, innovation, and community building** in brain science, artificial intelligence, and neurorobotics.

Our goal is to equip researchers and professionals with **cutting-edge knowledge and skills** through high-quality, interdisciplinary training.

## Innovation

The **e-DiANA ecosystem** is more than a place for learning — it is also a **hub for innovation**.

We bridge the gap between **research and industry**, promoting the transfer of scientific breakthroughs into real-world solutions

## Lifelong Learning

EBRAINS-Italy Digital Academy for Neuroscience and AI promotes an **open, inclusive, and lifelong learning philosophy**.

Through **events, workshops, and interactive sessions**, we ensure continuous growth and adaptability to emerging technologies, building a strong and evolving community.

## Knowledge and Skills

- Learn through digital, interactive Modules that provide both theory and practice.
- Gain **hands-on experience** in computational modeling, AI-driven neuroscience, and robotics applications.

## Networking and Community

- Connect with experts from **academia, research, and industry**.
- Benefit from a **collaborative learning environment** that fosters exchange and interdisciplinary dialogue.
- Access **opportunities** for international partnerships to expand the global impact of your work.

## Impact

Ultimately, the e-DiANA empowers individuals and organisations to **push the boundaries** of science and technology, shaping the **future of brain research, AI, and intelligent systems**.