



Human Brain Project



EBRAINS

Learning in the Brain and NeuroRobots
from Molecules to Behaviour with the EBRAINS Training on the
Brain Function, Dysfunction and Neurobotic Systems
8th BALTIC-NORDIC SUMMER SCHOOL

21–25 SEPTEMBER 2021
VIRTUAL EVENT

Registration deadline: 13 September 2021



Human Brain Project
Education Programme

CALL FOR REGISTRATIONS

The 8th Baltic-Nordic Summer School on Neuroscience and Neuroinformatics 2021 “Learning in the Brain and NeuroRobots – from Molecules to Behaviour with the EBRAINS Training on the Brain Function, Dysfunction and Neurobotic Systems” offers an interdisciplinary course and covers modelling at different levels of organization of the brain, from single neurons to microcircuits, neural networks and neurorobotics.

The course offers **lectures on the latest achievements** in understanding learning, neural and network dynamics and function in health and disease, neurobotic theory and applications, and hands-on tutorials on the EBRAINS services and tools. The summer school **targets advanced master students, doctoral students and postdoctoral researchers in biomedical and technology sciences**, ranging from medicine, biology, psychology, to mathematics, informatics, information technology, physics and chemistry, and anyone who would like to get an introduction to neuroinformatics, computational neuroscience and the EBRAINS Infrastructure.

Scientific Committee

Arvind Kumar | KTH Royal Institute of Technology, Sweden
Jeanette Hellgren Kotaleski | KTH Royal Institute of Technology, Sweden
Jörg Conradt | KTH Royal Institute of Technology, Sweden
Pawel Herman | KTH Royal Institute of Technology, Sweden
Erik Fransén | KTH Royal Institute of Technology, Sweden
Marja-Leena Linne | Tampere University, Finland
Ausra Saudargiene | Lithuanian University of Health Sciences, Lithuania

Organisers

Jeanette Hellgren Kotaleski | KTH Royal Institute of Technology, Sweden
Jörg Conradt | KTH Royal Institute of Technology, Sweden
Pawel Herman | KTH Royal Institute of Technology, Sweden
Erik Fransén | KTH Royal Institute of Technology, Sweden

Co-organisers

Human Brain Project Education Programme | Medical University Innsbruck, Austria

Further information & registration

humanbrainproject.eu/education/8th-BNNI

Contact

training-support@humanbrainproject.eu



SESSIONS

Session 1 - Synapses, neurons and networks

Session 1 will introduce the motivation behind and basic concepts of theoretical and computational modelling of the neurons, neural networks and brain functions.

Session 2 - Networks: Functions and Dynamics

Session 2 will focus on complex dynamics, both at single neuron and population level. The goal of this session is to learn about theoretical methods to study the origin of the dynamical state of biological neural networks, and then to discuss how these insights help in mechanistic understanding of essential brain functions such as working memory. The tools to numerically simulate the activity of biological neural networks will also be discussed.

Session 3 - Learning and Plasticity

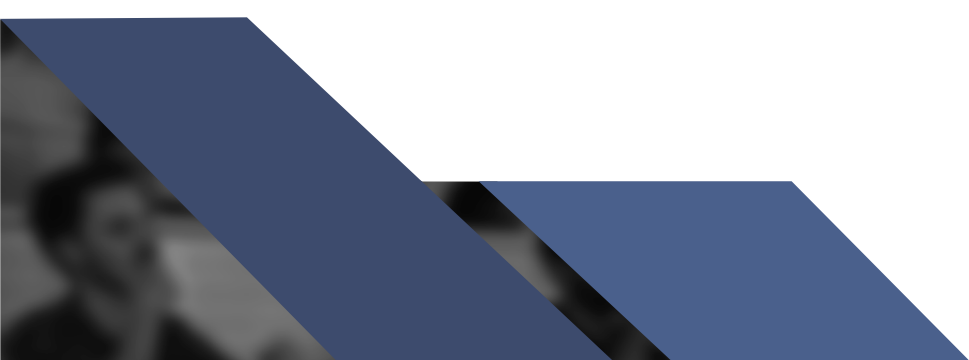
Session 3 will introduce synaptic plasticity, the biological basis of learning and memory. At the most fundamental level, perception, cognition, learning and memory ultimately depend on complex molecular processes. Modelling of these processes requires simulating phenomena that occur on a wide range of spatial and temporal scales. The goal of this session is to inform and teach students about the modelling of synaptic plasticity and learning. Also, data mining approaches relevant for better understanding of synapses will be exemplified. Some EBRAINS resources providing modelling of synaptic plasticity will be used in the tutorials.

Session 4 - Brain function and dysfunction: models and experiments

Session 4 will be devoted to the computational perspective on brain disease. It is becoming increasingly clear that the classical approach of relating behavioral deficits to the morphology, genetics or chemistry of the brain is highly simplified. The genetic, chemical, morphological changes manifest in behavioural changes via multi-scale interactions between neurons and networks. Therefore, a number of diseases can be understood as diseases of brain dynamics. In addition, psychiatric diseases are better understood in the computational framework of decision making and reinforcement learning. In this session we will provide a pedagogical lecture on how our understanding of brain dynamics provides a bottom-up view of brain dysfunction such as Parkinson's diseases, while the decision making, and reinforcement learning provides a top-down framework for understanding psychiatric disorders.

Session 5 - Artificial systems and embodied brains

Session 5 will discuss technical applications of neuronal computation. We introduce concepts of neurocognitive systems, give an overview of available neurocomputing hardware and software environments, and introduce closed-loop neuronal control systems. The second part of the day is dedicated to hands-on sessions that allow students (remote) access to simulated neurorobotics and neurocomputing environments. We will prepare a virtual environment, where participating teams can develop neuronal models to train a virtual robot in a competitive task (e.g. collecting items in an arena full of obstacles). We will organize a final competition.



DAY 1 - 21 SEPTEMBER 2021

The programme may be subject to change.
All times in the programme are CEST (UTC+2)

- 13.00 – 13.15** **Welcome & Introduction**
BNNI Organisers
- Session 1 - Synapses, neurons and circuits**
Chair: Marja-Leena Linne | Tampere University
- 13.15 – 13.45** **Why to model the brain**
Gaute Einevoll | Oslo University
- 13.45 – 14.45** **Synapses, neurons, circuits: Introduction to computational neuroscience**
Bruce Graham | University of Stirling
- 14.45 – 15.00** **Coffee break**
- Tutorials: Hands-on NEURON and Python**
- 15.00 – 15.30** **Modelling in NEURON and Python: useful tips**
Arnd Roth | University College London
- 15.30 – 16.30** **Simulating synapses, neurons and circuits**
Bruce Graham | University of Stirling
Arnd Roth | University College London
Ausra Saudargiene | Lithuanian University of Health Sciences
- 16.30 – 17.00** **Coffee break**
- Tutorials: Hands-on EBRAINS**
- 17.00 – 17.45** **From modelling single neurons to large-scale networks in EBRAINS**
Jeanette Hellgren Kotaleski | KTH Royal Institute of Technology
- 17.45 – 18.30** **Circuit building (theory and practice)**
Johannes Hjorth, Alex Kozlov | KTH Royal Institute of Technology
- 18.30 – 19.00** **Break**
- 19.00 – 20.00** **Evening Discussions**
Ask anything you ever wanted to know about neuroscience
- Marja-Leena Linne | Tampere University**
Gaute Einevoll | Oslo University
Bruce Graham | University of Stirling
Arnd Roth | University College London
Jeanette Hellgren Kotaleski, Johannes Hjorth, Alex Kozlov | KTH Royal Institute of Technology
- 20.00 – 21.00** **Virtual Tour in Stockholm, Sweden**
Hangout
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DAY 2 - 22 SEPTEMBER 2021

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- 13.00 – 13.15** **Introduction Day 2**
- Session 2 - Biological Neuronal Networks: Functions and dynamics**
Chair: Arvind Kumar | KTH Royal Institute of Technology
- 13.15 – 14.00** **Dynamics of spiking neuronal networks**
Nicolas Brunel | Duke University
- 14.00 – 14.30** **Computational models of working memory**
Pawel Herman | KTH Royal Institute of Technology
- 14.30 – 15.00** **Statistical mechanics of memory in biological neuronal networks**
Yasser Roudi | Norwegian University of Science and Technology
- 15.00 – 15.30** **Coffee break**
- Tutorial: Hands-on EBRAINS**
- 15.30 – 17.00** **Simulation of network with spiking neurons (NEST)**
Sebastian Spreizer | Forschungszentrum Jülich
- 17.00 – 17.30** **Coffee break**
- 17.30 – 18.30** **Models of mesoscopic brain activity: The Virtual Brain**
Viktor Jirsa | Aix-Marseille University
- 18.30 – 18.45** **Coffee break**
- 18.45 – 19.45** **Understanding behavior and the brain from the perspective of a dynamical theory of coordination**
Scott Kelso | Florida Atlantic University
- 19.45 – 21.00** **Understanding the Brain – an evolutionary perspective**
Sten Grillner | Karolinska Institutet



DAY 3 - 23 SEPTEMBER 2021

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- 13.00 – 13.15** **Introduction Day 3**
- Session 3 - Synaptic Plasticity and Learning**
Chair: Jeanette Hellgren-Kotaleski | KTH Royal Institute of Technology
- 13.15 – 13.45** **How we learn and forget**
Ausra Saudargiene | Lithuanian University of Health Sciences
- 13.45 – 14.15** **Astrocyte-neuron interactions**
Marja-Leena Linne | Tampere University
- 14.15 – 14.45** **Learning in large networks**
Abigail Morrison | Forschungszentrum Jülich
- 14.45 – 15.00** **Coffee break**
- Tutorials: Hands-on EBRAINS**
- 15.00 – 16.30** **STEPS simulator**
Andrii Stepaniuk | École Polytechnique Fédérale de Lausanne
- 16.30 – 17.00** **Coffee break**
- Tutorials: Hands-on EBRAINS**
- 17.00 – 18.30** **STDP in Nest**
Abigail Morrison's lab | Forschungszentrum Jülich
- 18.30 – 19.00** **Coffee break**
- 19.00 – 19.30** **Evening Lecture: The Synaptome Architecture**
Seth Grant | University of Edinburgh
- 20.00 – 21.00** **Evening Discussions**
Ask anything you ever wanted to know about learning & plasticity
- Seth Grant | University of Edinburgh**
Andrii Stepaniuk | École polytechnique fédérale de Lausanne
Abigail Morrison | Forschungszentrum Jülich
Marja-Leena Linne | Tampere University
Ausra Saudargiene | Lithuanian University of Health Sciences

DAY 4 - 24 SEPTEMBER 2021

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- 13.00 – 13.15** **Introduction Day 4**
- Session 4 - Brain dysfunction: how modelling can help**
Chair: Arvind Kumar | KTH Royal Institute of Technology
- 13.15 – 13.45** **Free energy principle and computational models of brain disorders**
Yukie Nagai | University of Tokio
- 13.45 – 14.15** **A computational framework to understand psychiatric disorders**
Tobias Hauser | University College London
- 14.15 – 14.45** **Striatal dopamine computations in learning about agency**
Michael J. Frank | Brown University
- 14.45 – 15.00** **Coffee break**
- Brain dysfunction: a clinical view, or bottom up modelling**
- 15.00 – 16.30** **Modelling of disease related brain activity with The Virtual Brain**
Jan Fousek | Aix-Marseille University
- 16.30 – 17.15** **Title: Excitatory-Inhibitory balance and changes in emergent patterns of circuit activity in brain disorders**
Vikaas Sohal | University of California, San Francisco
- 17.15 – 17.45** **Coffee break**
- Brain dysfunction: a clinical view, or bottom up modelling**
- 17.45 – 18.30** **The role of signaling molecules in synaptic plasticity and relapse to alcohol use**
Kim T 'Avrama' Blackwell | George Mason University
- 18.30 – 19.00** **Coffee break**
- 19.00 – 19.30** **Evening Lecture: Neural Oscillations in Schizophrenia: Circuit Dysfunctions, Development and Biomarker**
Peter Uhlhass | University of Glasgow
- 20.00 – 21.00** **Evening Discussions**
Ask anything you ever wanted to know about neuroscience
- Kim T 'Avrama' Blackwell | George Mason University**
Michael Frank | Brown University
Peter Uhlhass | University of Glasgow
- 21.00 – 22.00** **Brain Quiz**
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DAY 5 - 25 SEPTEMBER 2021

The programme may be subject to change.
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- 13.00 – 13.15** **Introduction Day 5**
- Session 5 - Artificial systems and embodied brains**
Chair: Pawel Herman | KTH Royal Institute of Technology
- 13.15 – 13.45** **Neuro-Cognitive Systems**
Rainer Goebel | Maastricht University
- 13.45 – 14.15** **Neurocomputing Hardware**
Yulia Sandamirskaya | Intel
- 14.15 – 14.45** **Neuromorphic Technical System**
Jörg Conradt | KTH Royal Institute of Technology
- 14.45 – 15.00** **Coffee break**
- Tutorials: Hands-on neurorobotics platform and neurocomputing**
- 15.00 – 15.30** **Hands-on EBRAINS: the Neurorobotics Platform**
KTH NCS Neuro Computing Systems Team | KTH Royal Institute of Technology
- 15.30 – 16.30** **Hands-on EBRAINS: the SpiNNaker neurocomputing platform**
KTH NCS Neuro Computing Systems Team | KTH Royal Institute of Technology
- 16.30 – 17.00** **Coffee break**
- Hands-on Competition / Neuromorphic Robotics Olympics**
- 17.00 – 18.00** **Train your neuronal network / neurorobot**
KTH NCS Neuro Computing Systems Team | KTH Royal Institute of Technology
- 18.00 – 18.30** **Competition**
KTH NCS Neuro Computing Systems Team | KTH Royal Institute of Technology
- 18.30 – 19.00** **Coffee break**
- 19.00 – 19.45** **Evening Lecture: Spaun 2.0: Cognitive Flexibility in a Large-scale Brain Model**
Chris Eliasmith | University of Waterloo
- 19.45 – 21.00** **Evening Discussions**
Closing the BNNI summer school, round table debate, feedback
- Jeanette Hellgren Kotaleski | KTH Royal Institute of Technology**
Jörg Conradt | KTH Royal Institute of Technology
Pawel Herman | KTH Royal Institute of Technology
Erik Fransén | KTH Royal Institute of Technology
- 21.00** **Farewell**



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