

International School of Brain Cells & circuits “Camillo Golgi”

The Ettore Majorana Foundation and Centre for Scientific Culture opened, in 2015, the International school of brain cells & circuits dedicated to the Italian Nobel laureate “Camillo Golgi”.

The brain, with 10^{12} neurons interacting through 10^{15} synapses, is quite surely the most complex structure of the whole Universe. Neurosciences are systematically tackling brain functions at multiple complexity levels, from cells to microcircuits to the whole brain. Understanding the brain is a Grand Challenge for the Humankind with social implications in the biomedical and technological fields. Multiscale computational modelling is a new powerful approach for understanding the brain that has recently been supported by international initiatives like the *Human Brain Project* and EBRAINS.

The school of Brain Cells & Circuits will face hot topics in modern Neuroscience, providing the basics of understanding, fuelling discussion, and helping to form a critical perspective in the new generation of Neuroscientists. Our vision is that, to explain brain functions, it is fundamental to integrate molecular and cellular knowledge into microcircuits and large-scale networks through the use of multiscale computational models.

Further reading can be found in the review articles:

Modelling the brain: Elementary components to explain ensemble functions
Authors: *Egidio D’Angelo and Claudia Gandini Wheeler-Kingshott* (2017)
Il Nuovo Cimento. DOI: 10.1393/ncr/i2017-10137-5 pp. 297-333

The coming decade of digital brain research - A vision for neuroscience at the intersection of technology and computing.
Authors: *Amunts, et al.* (2022).
Zenodo. DOI: 10.5281/zenodo.6345821

The quest for multiscale brain modelling
Authors: *Egidio D’Angelo and Viktor Jirsa* (2022)

Trends Neurosci. 2022 Jul 26; S0166-2236(22)00125-4.
doi: 10.1016/j.tins.2022.06.007.

2022 course

Modeling the brain

30th November 2022 - 3rd December 2022

Ettore Majorana Foundation and Centre for Scientific Culture
Erice (Italy)



Course Directors:

Egidio D’Angelo, Claudia Gandini Wheeler-Kingshott and Viktor Jirsa

Rationale: The 2022 Course of the school of brain cells and circuits will continue the theme of modelling the brain, from local microcircuits properties to large scale network properties, essential to understand how the brain works and to foster biomedical and technological applications.

Preliminary Programme

Arrival day – 29th November 2022

9pm : Evening gathering in the Marsala Cellar St. Rocco Monastery, main cloister

Marsala wine and marzipan pastries typical of Erice.
Music and chats as people join in.

Day 1 – 30th November 2022

INTRODUCTION TO THE COURSE (chair: E. D'Angelo/ C. Gandini/ V. Jirsa)

Foreword: This section will introduce the course and provide an overview of what multiscale brain modelling is and how it is implemented into EBRAINS, a new digital research infrastructure, created by the EU-funded Human Brain Project, that gathers an extensive range of data and tools for brain-related research.

8:30 – **Current status on modeling the brain and course overview**

Egidio D'Angelo, Claudia Gandini Wheeler-Kingshott, Viktor Jirsa

9:00 – **Multi-scale brain modeling**

Egidio D'Angelo

10:00 – **The EBRAINS infrastructure for brain modelling: overview (EBRAINS hands-on session on day 4)**

France Nivelle

10:45-11:45 *Coffee break & posters display*

I – FROM NEURONS TO MICROCIRCUITS (chair: A. Destexhe /M. Migliore)

Foreword: This section provides the foundations of cellular biophysics and of neuron and microcircuit modelling. It explains how “bottom-up” models are generated at different levels of detail and how they can be applied to the investigation of physiology and pathology.

11:45 – **Didactical lecture: foundations of cell physiology and biophysics**

(45 min)

Lisa Mapelli (UNIPV)

12:30-14:00 *Lunch*

14:00 – **Multicompartment neuron models**

Michele Migliore

15:00 – **Point neuron models and spiking neural networks**

Claudia Casellato

16:00 – **Mean field models**

Alain Destexhe

17:00-17:30 *Coffee break & posters display*

17:30 - ROUND TABLE - Applications of bottom-up modelling to physiology and pathology

(Chair: Claudia Casellato, Spase Petkoski)

Day 2 – 1st December 2022

II – THE LARGE SCALE BRAIN (chair: C. Gandini Wheeler-Kingshott/R. Kooijmans)

Foreword: This section provides the foundations of large-scale brain structure, function, and dynamics, which are the essential ingredients of “top-down” brain models. It explains how this knowledge can be integrated in Bayesian brain models.

8:30 – **Didactical lecture: basics of MRI (45 min)**

Mara Cercignani

9:30 – **Brain reconstruction from histology**

Roxana Kooijmans

10:30-11:00 *Coffee break*

11:00 – **Linking brain structure, microstructure and function**
Matteo Mancini

12:00 – **In vivo in humans brain function characterisation**
Alessandra Bertoldo

13:00-15:00 Lunch

15:00 POSTER BLITZ (Chair: **Shyam Diwakar**)
(20 posters, 3 min each, 1 slide)

16:00-16:30 Coffee break

16:30 - **The predictive brain**
Giovanni Pezzulo

17:30 - **ROUND TABLE: Multiscale data, models and theories**
(Chair: *Jonathan Mapelli, Daniela Gandolfi*)

20:00 SOCIAL DINNER

Day 3 – 2nd December 2022

III – BRAIN FUNCTION FROM NETWORKS (chair: Claudia GWK/Gustavo Deco)

Foreword: This section addresses the relationship between microscopic phenomena and large-scale functions and provides the foundations of virtual brain modelling. It also considers the propagation of brain models into digital twins, neurorobots and neurocomputers.

10:00 – **Didactical lecture: building blocks of virtual brain modelling (45 min)**
Spase Petkoski

11:00-11:30 Coffee break

11:30 – **MRI, parameterisation and validation: the quest for personalised models of pathology**
Claudia Gandini Wheeler-Kingshott

12:30 – POSTER BLITZ (Chair: **Fulvia Palesi**)
(20 posters, 3 min each, 1 slide)

13:30-15:00 Lunch break

15:00 – **Brain states and consciousness**
Giulio Tononi

16:00 – **Virtual brain and neurodegeneracy**
Viktor Jirsa

17:00 – **ROUND TABLE: Modeling the brain: virtual brains, digital twins, neurorobots and neurocomputers**
(Chair: *Egidio D'Angelo, Claudia Gandini, Viktor Jirsa*)

18:00 Poster prize and adjournment

Departure day - 3rd December 2022

9:00 – 13:00 HANDS-ON SESSION: EBRAINS atlas, models, and simulation facilities

Farewell

Speakers

1. *Egidio D'Angelo (organizer)*
2. *Claudia Gandini Wheeler-Kingshott (organizer)*
3. *Viktor Jirsa (organizer)*
4. *Shyam Diwakar*
5. *Alessandra Bertoldo*
6. *Claudia Casellato*
7. *Mara Cercignani*
8. *Alain Destexhe*
9. *Roxana Kooijmans*
10. *Matteo Mancini*
11. *Jonathan Mapelli*
12. *Lisa Mapelli*
13. *Michele Migliore*
14. *France Nivelles*
15. *Spase Petkoski*
16. *Giovanni Pezzulo*
17. *Giulio Tononi*