Online Summer School
The Virtual Brain in Clinical Research

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Official website: https://www.brainsimulation.org/bsw/zwei/events/single/9651-online-summer-school-the-virtual-brain-in-clinical-research
BCCN website: https://www.bccn-berlin.de/courses-and-modules.html
Training type: Webinar
Language: English
Location: Online
Costs: Free
Commercial interests: None
Registration: Online form
https://docs.google.com/forms/d/e/1FAIpQLSdUb69L16sVn3elyruuK2-VoXV9Zg2eu6Nt3QTKVDNcAyy87g/viewform
Credits: 2 ECTS for Master students at the Bernstein Center Computational Neuroscience Berlin (BCCN), and 3 ECTS for PhD students at the Charité (Promotionsumgebung)

Learning Outcomes
After completing this module, participants will know the basic concepts and methods for personalized brain network modeling and simulation. Students will gain knowledge about how to construct models, process multimodal imaging data for creating individualized models, run simulations and use supporting neuroinformatics tool such as the Charité/BIH Virtual Research Environment, workflows and build interfaces to related tools via APIs. Students will understand how to run brain simulations to address medical problems and have a good understanding of the open-source neuroinformatics platform The Virtual Brain (TVB; thevirtualbrain.org).

Content
This module provides basic knowledge on personalized brain network modeling for state-of-the-art in clinical research. Required interdisciplinary methods will be introduced. A focus will be set on the open-source simulation platform TVB.
Course overview:
- Theoretical background of large-scale brain network modeling
- Personalization pipelines: processing of brain images for individualization of brain network modeling
- Concepts of nonlinear dynamics
- Running workflows on high-performance computers
- Parameter optimization and model inference
- Application of brain network modeling for clinical questions
- Introduction to the medical condition targeted through brain simulation: dementias, psychosis and epilepsy
- Visualizations of multimodal brain dynamics, ontologies, machine learning, graph theory
- Making use of digital Research Infrastructures used for data integration and simulation in compliance with the EU general Data Protection Regulations (GDPR)

Module Components

<table>
<thead>
<tr>
<th>Course name</th>
<th>Type</th>
<th>Number</th>
<th>Cycle</th>
<th>SWS</th>
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<tbody>
<tr>
<td>The Virtual Brain in Clinical Research: An Introduction</td>
<td>VL (lecture)</td>
<td>1</td>
<td>WS &amp; SS</td>
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Workload and Credit Points

<table>
<thead>
<tr>
<th>The Virtual Brain in Clinical Research: An Introduction</th>
<th>Multiplier</th>
<th>Units</th>
<th>Total Units</th>
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<tr>
<td>Attendance</td>
<td>12</td>
<td>2.5</td>
<td>30</td>
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<tr>
<td>Lecture rehearsals / individual studies</td>
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<td>2.5</td>
<td>30</td>
</tr>
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1 unit = 45 min
One ECTS/Credit Point equals 30 units (for Master students at the Bernstein Center Computational Neuroscience Berlin, BCCN)/ 20 units (for PhD students at the Charité Promotionsumgebung).

2 ECTS for Master students at the Bernstein Center Computational Neuroscience Berlin (BCCN), and 3 ECTS for PhD students at the Charité (Promotionsumgebung)

Description of Teaching and Learning Methods
The lecture part consists of weekly virtual teaching using the free conference platform GoToMeeting. In addition to the presentation of theoretical concepts, it comprises several demonstrations of how to operate workflows, simulation engines, high-performance computers and collaborative platforms. Participants are expected to rehearse content after class, using their class notes, digital jupyter notebooks, video tutorials and recommended literature.

Requirements for Participation and Examination
Mandatory requirements:
- Good English language skills
- Basic programming expertise

Successful module completion will require participation in a written exam. Exam tasks will be provided during the last course week and results need to be submitted by until one week after.

**Module Completion**
Type of exam: written exam
Grading: none

**Duration of the Module**
This module can be completed in 1 semester.

**Maximum Number of Participants**
50

**Registration Procedure**
Registration via online form is required:
https://docs.google.com/forms/d/e/1FAIpQLSdUb69L16sVn3elyruuK2-VoXV9Zg2eu6Nt3OTKVNdAyy87g/viewform

**Recommended Reading**
- Meier, Perdikis, Blickensdörfer, Stefanovski, Liu, Maith, Dinkelbach, Baladron, Hamker, Ritter (2022) Virtual deep brain stimulation: Multiscale co-simulation of spiking basal ganglia model and whole-brain mean-field model with The Virtual Brain. *Experimental Neurology*
- Schirner, Kong, Yeo, Deco, Ritter (2022) Dynamic primitives of brain network interaction. *Neuroimage*
- Stefanovski, Triebkorn, Spiegler, Diaz-Cortes, Solodkin, Jirsa, McIntosh, Ritter; for the Alzheimer's Disease Neuroimaging Initiative (2019). Linking molecular pathways and
large-scale computational modeling to assess candidate disease mechanisms and pharmacodynamics in Alzheimer’s disease. [Frontiers Computational Neuroscience]

- Schirner, McIntosh, Jirsa, Deco, Ritter (2018) Inferring multi-scale neural mechanisms with brain network modelling. [eLife]

Lecture Notes
Lecture notes will be made available for all classes. Presentations will be published here:

YouTube: [https://www.youtube.com/channel/UCZxHt1mmrCafBwS4iPoUSrQ/playlists](https://www.youtube.com/channel/UCZxHt1mmrCafBwS4iPoUSrQ/playlists)

Assigned Degree Programs
Students of other courses can take this module if capacity allows.

Miscellaneous
Open-source software The Virtual Brain ([thevirtualbrain.org](http://thevirtualbrain.org)) can be installed on own notebook/computer (runs on MacOS, Linux, Windows) or used via the research infrastructure EBRAINS (requires free registration at [https://ebrains.eu/register/](https://ebrains.eu/register/)).

Course Structure
The courses take place in the summer and winter semester and consists of the following parts:
Lectures and self-study: 2 ECTS for Master students at the Bernstein Center Computational Neuroscience Berlin (BCCN), and 3 ECTS for PhD students at the Charité (Promotionsumgebung)

Dates SS 2022:
June 28, 2022 – September 12, 2022

Tuesday
1. June 28  16:30-18:30 = 2.5 units á 45 min
2. July 5th  16:30-18:30 = 2.5 units á 45 min
3. July 12th 16:30-18:30 = 2.5 units á 45 min
4. July 19  16:30-18:30 = 2.5 units á 45 min
5. July 26st 18:30-20:30 = 2.5 units á 45 min (Starts 2h later than usually!)
6. August 2nd 16:30-18:30 = 2.5 units á 45 min
7. August 9th 16:30-18:30 = 2.5 units á 45 min
8. August 16th 16:30-18:30 = 2.5 units á 45 min
9. August 23rd 16:30-18:30 = 2.5 units á 45 min
10. August 30th 16:30-18:30 = 2.5 units á 45 min
11. September 6st 16:30-18:30 = 2.5 units á 45 min
12. September 12th 16:30-18:30 = 2.5 units á 45 min

Total: 30 units á 45 min
Each session has a short bio break of 7 minutes.

**Target Group**
Master and PhD students with interest in the topic of computational neuroscience and its applications in clinical research.

**Course Certificate**
Students have to pass a written exam that can be completed at home. The exam tasks are given in the last week of the course and must be solved until one week later. Students who successfully pass the written exam are awarded 2 or 3 ECTS depending on their program enrollment.

**Program**
The order of lectures may change.

**Week 1** “The Virtual Brain - Overview” Prof. Dr. Petra Ritter

Recommendation for self-study:

**Week 2** “Inferring mechanisms through brain network modeling” Dr. Michael Schirner

Recommendation for self-study:
- Schirner, Kong, Yeo, Deco, Ritter (2022) Dynamic primitives of brain network interaction. *Neuroimage*

**Week 3** “Modeling neurodegeneration” Dr. Leon Stefanovski

Recommendation for self-study:
- Stefanovski, Triebkorn, Spiegler, Diaz-Cortes, Solodkin, Jirsa, McIntosh, Ritter; for the Alzheimer’s Disease Neuroimaging Initiative (2019). Linking molecular
pathways and large-scale computational modeling to assess candidate disease mechanisms and pharmacodynamics in Alzheimer’s disease. Frontiers Computational Neuroscience


**Week 4 “Integrating biological knowledge in brain network models”** Leon Martin

Recommendation for self-study:

- [https://www.youtube.com/watch?v=QzEyD-9HOw8&t=5s](https://www.youtube.com/watch?v=QzEyD-9HOw8&t=5s)

**Week 5 “Modeling mechanisms of psychosis”** Dr. Konstantin Büllau

Recommendation for self-study:


**Week 6 “Machine learning basics”** Dr. Kiret Dhindsa

Recommendation for self-study:


**Week 7 “The Virtual Brain and multiscale co-simulation”** Dr. Dionysios Perdikis

Recommendation for self-study:

- TVB advanced tutorials [https://training.incf.org/course/virtual-brain-node-6-workshop](https://training.incf.org/course/virtual-brain-node-6-workshop)


**Week 8** “In silico optimization of deep brain stimulation” Dr. Jil Meier

Recommendation for self-study:
• Meier, Perdikis, Blickensdörfer, Stefanovski, Liu, Maith, Dinkelbach, Baladron, Hamker, Ritter (2022) Virtual deep brain stimulation: Multiscale co-simulation of spiking basal ganglia model and whole-brain mean-field model with The Virtual Brain. Experimental Neurology

**Week 9** “TVB-Ontology” Dr. Julie Courtiol

Recommendation for self-study:
• [https://www.youtube.com/watch?v=UyS7Tt3oVuE](https://www.youtube.com/watch?v=UyS7Tt3oVuE)

**Week 10** “Workflows on GDPR compliant platforms: VRE and EBRAINS” Dr. Michael Schirner

Recommendation for self-study:


**Week 11** “Generating stroke virtual brains using docker images” Patrik Bey

Recommendation for self-study:
• [https://www.youtube.com/watch?v=vFsi7L9zPdk&t=8s](https://www.youtube.com/watch?v=vFsi7L9zPdk&t=8s)

**Week 12** “Understanding principles of traveling waves” Dominik Koller
Recommendation for self-study:

- Muller, Piantoni, Koller, Cash, Halgren, Sejnowski (2016) Rotating waves during human sleep spindles organize global patterns of activity that repeat precisely through the night. Elife