



eBRAIN-Health

Public report

D7.1 - Multiscale model visualizer

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1. eBRAIN-Health

The Project eBRAIN-Health will deliver a distributed research platform for modeling and simulating complex neurobiological phenomena of human brain function and dysfunction in a data protection compliant environment. It will provide thousands of multilevel virtual brains from patients and healthy human controls for research and innovation. Brain data from multiple sources will be pre-processed. Solving the societal grand challenge of dementia is a big task. Yet it appears feasible in a collective approach. Therefore, we will build an interdisciplinary digital twin for dementia for modeling and simulating complex phenomena at the service of research infrastructure communities. eBRAIN-Health-Cloud will offer end-to-end services for personalized complex brain modeling and simulations in distributed e-infrastructures with data protection by design and by default and simulation-ready human multiscale brain data that range from molecular (genomics, proteomics, metabolomics) and cellular to electrophysiology and imaging to behavioural, clinical, life-style and environmental data as well as data from wearables. Brain data are pre-processed and annotated such that they all relate to a common reference 3D brain space.

eBRAIN-Health-Cloud constitutes a blend of three large-scale research programs: the FET Flagship Human Brain Project with its EBRAINS Research Infrastructure, the EOSC project Virtual Brain Cloud with its Virtual Research Environment for sensitive data and the H2020 project AI-MIND with intelligent tools for dementia risk estimation. The project will have synergies to topics of the Digital Europe Program, such as artificial intelligence, cybersecurity and supercomputing and the Health Data Space. eBRAIN-Health-Cloud offers a next generation clinical research infrastructure and creates an open yet protected space for groundbreaking digital health innovation by the research infrastructure communities comprising academia and the private sector.

2. eBRAIN-Health consortium

- CHARITE – Universitaetsmedizin Berlin, Germany
- EBRAINS, Belgium
- Forschungszentrum Juelich GmbH, Germany
- Stichting Radboud Universiteit, Netherlands
- Universidad Pompeu Fabra, Spain
- OSLO Universitetssykehus, Norway
- tp21 GMBH, Germany
- Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung eV, Germany
- INDOC RESEARCH EUROPE gGmbH, Germany
- Universitaet Wien, Austria
- Universidad Complutense de Madrid, Spain
- EODYNE Systems SL, Spain
- ATHENA – Research and Innovation Center, Greece
- University of Oslo, Norway
- Universita degli Studi di Roma la Sapienza, Italy
- Alzheimer Europe, Luxembourg
- Institute National de Recherche en Informatique et Automatique, France
- Centre Hospitalier Universitaire Vaudois, Switzerland
- The University of Edinburgh, United Kingdom

[Find the partners on our website](#)

3. Introduction

T7.1 Multi-scale brain model visualizer / frontend (Mo 24-Mo 48)

To provide a neuroinformatic tool for the visualization of the multiscale digital twin brain and integrate with data, services, and models to create advanced pipelines to perform data analysis, diagnostics, and prognostics. Grounded on the existing BrainX3 software, an open-source software based on libraries commonly used by the bioinformatics community (python, VTK, QT), we will focus on extending this software to the needs of the eBRAIN-Health on data visualization, interaction, data and analytical services. BrainX3 will provide methods to visualize multiple data modalities such as MRI, DTI, EEG, SEEG exploring the use of different representations in 2D and 3D. It will add new features to query knowledge services (provided by WP4) and map results back to the visualizations. This task will also focus on the re-design of the user interface to adapt it to the data analysis workflows considering standard interactions of bioinformatics tools.

4. Partners involved

SRU (lead), EODYNE

5. Description of work performed.

In this section, we outline the development and enhancements made to BrainX3, focusing on its evolution into a multi-scale brain model visualiser and frontend tool. Grounded in the existing BrainX3 software architecture, we expanded its capabilities to meet the requirements of eBRAIN-Health, with a specific focus on data visualisation, interaction, and analysis.

5.1. BrainX3

BrainX3, a neuroinformatic tool built upon commonly used libraries such as Python, VTK, and QT, has undergone significant advancements in line with the objectives outlined in the task. Through the integration of new features and enhancements, BrainX3 now offers enhanced capabilities for multi-scale visualisation and performing advanced data analysis. The recent updates in BrainX3 boast a layered architecture with a focus on improving user interaction, data visualisation, and integration with knowledge services. Notable enhancements include the integration of the Desikan-Killiany and Destrieux atlases, enabling researchers to explore brain connectivity patterns and functional networks with greater detail. Additionally, the introduction of the 'MRI to Atlas' feature streamlines the process of anatomical referencing and spatial context establishment, facilitating precise localisation of brain structures. The signal processing module, powered by the MNE library, empowers researchers to preprocess raw EEG or MEG data, enhancing the quality and reliability of neural signal analysis.

6. Results

The integration of new features and enhancements into BrainX3 enhances its capabilities and utility across various domains of neuroinformatics. Here's a detailed overview of the results achieved:

6.1. Brain Atlases Integration

With the integration of the Desikan-Killiany and Destrieux atlases, BrainX3 now offers a comprehensive suite of cortical atlases. This expansion enables users to delineate structurally consistent brain regions with greater detail and precision, facilitating in-depth investigations into brain connectivity patterns and functional networks. The incorporation of these atlases aligns BrainX3 with prevailing usage in Electroencephalogram (EEG) / Magnetoencephalogram (MEG) data reconstruction, empowering researchers to explore and understand the complexities of the brain.

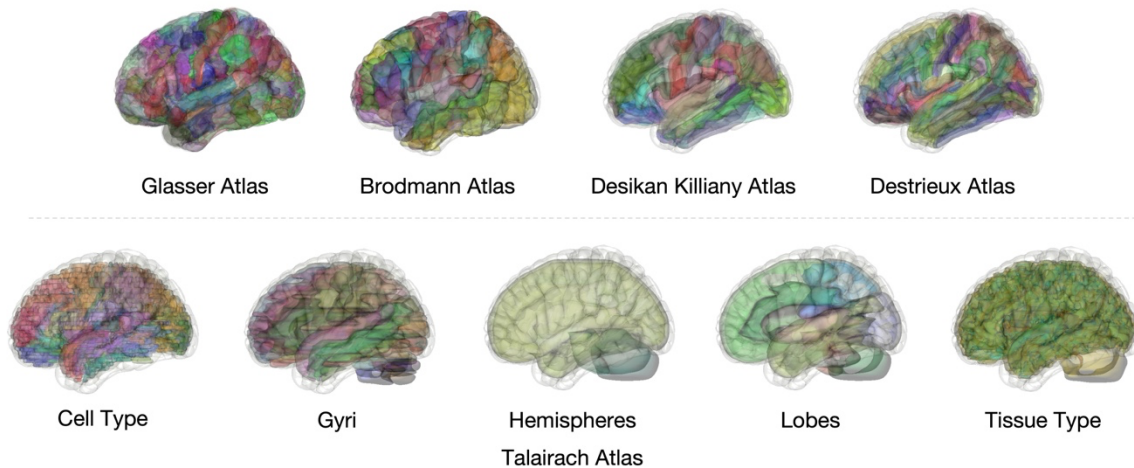


Figure 1: BrainX3 visualises 3D structures from a wide array of atlases, including recent additions like Desikan-Killiany and Destrieux, along with others such as Brodmann, Glasser, and Talairach.

6.2. MRI Coordinates Mapping to 3D Atlases

The introduction of the 'MRI to Atlas' feature marks a significant advancement in BrainX3's functionality. By mapping MRI coordinates to 3D atlases, researchers can now visualise and localise brain structures with accuracy and efficiency. This feature streamlines the process of anatomical referencing and spatial context establishment, accelerating the study of brain anatomy and facilitating precise identification of regions of interest. The dynamic interaction between MRI data and 3D atlases provides researchers with a powerful tool for investigating brain anatomy.

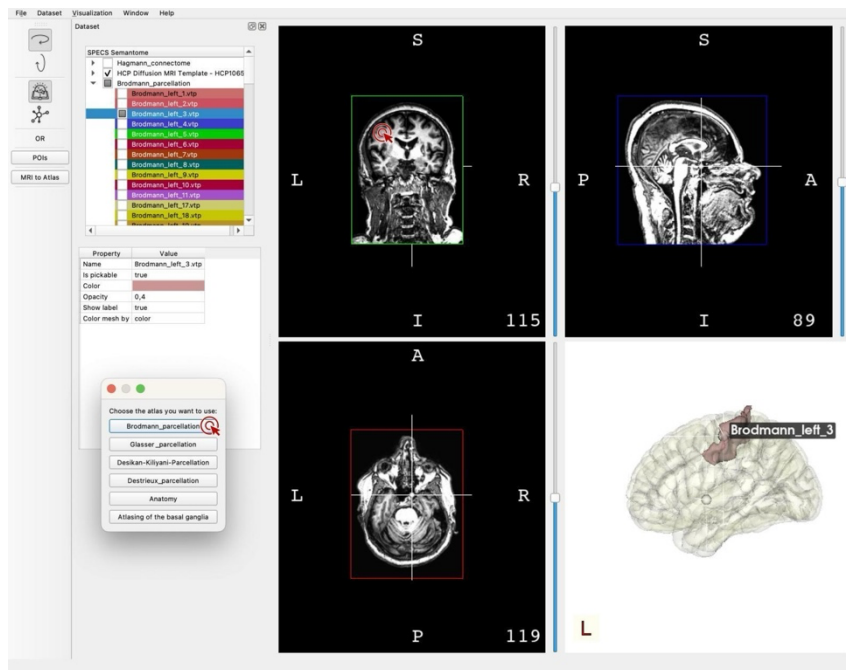


Figure 2: Demonstration of the MRI to Atlas function: Mapping the identified region from MRI scans onto the 3D brain atlas by selecting the desired atlas and region of interest, exemplified by the selection of Brodmann area 3 on the left hemisphere.

6.3. Signal Processing Module

The incorporation of the signal processing module represents a major milestone in BrainX3's evolution. Leveraging the MNE library, this module enables researchers to preprocess raw EEG or MEG data efficiently. Advanced preprocessing capabilities, including noise reduction and artifact removal, enhance the quality and reliability of EEG and MEG data, enabling researchers to extract meaningful insights from complex neural signals. The three-dimensional visualisation feature further enhances data exploration, allowing researchers to visualise brain activity in spatial and temporal dimensions and identify aberrant patterns with ease.

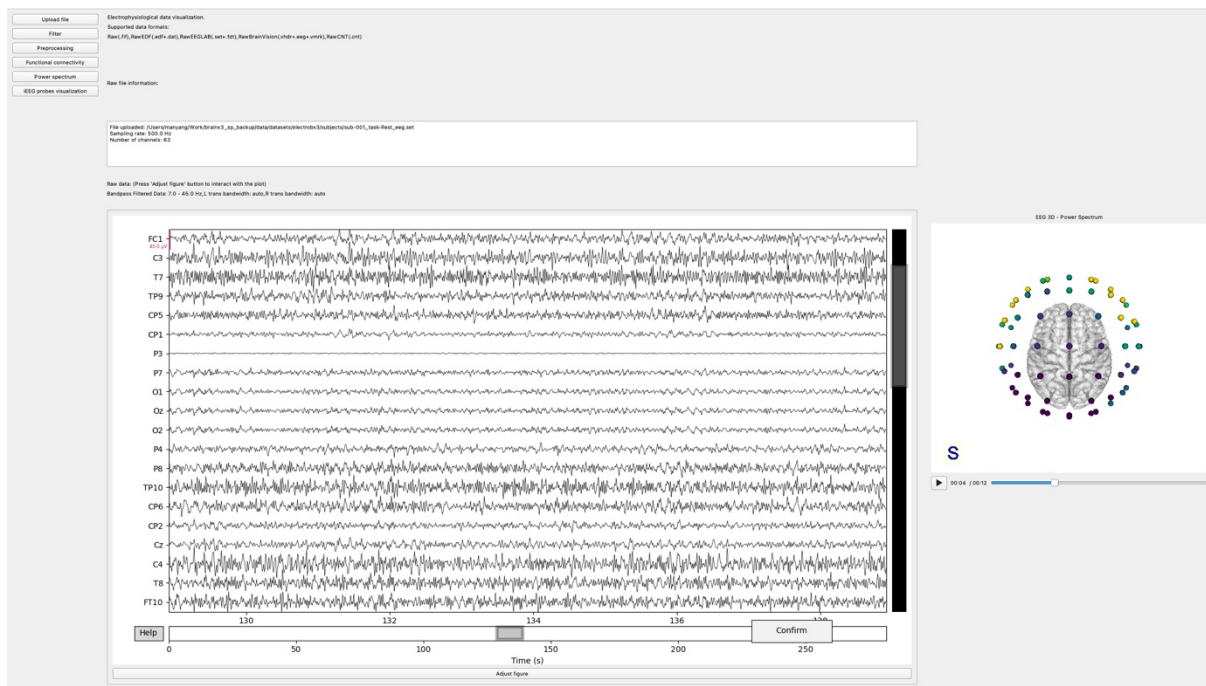


Figure 3: BrainX3's Signal Processing Module: Upon raw data upload, this window showcases brain activity alongside essential details like file name, sampling rate, and channel count. The accompanying 3D model visualises Power Spectral Density (PSD) across diverse locations.

7. Conclusion, next steps

In conclusion, the advancements made to BrainX3 significantly augment its capabilities, positioning it as a versatile tool for neuroscientists, researchers, and developers in the field of artificial brains. Moving forward, continued refinement and integration of knowledge services will further elevate BrainX3's impact on neuroscience research and applications.

8. Bibliography

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