VirtualBrainCloud

Personalized Recommendations for Neurodegenerative Disease

Public summary

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The central goal of the **TVB-Cloud project** is the development of a Cloud-based platform, termed TVB-Cloud, for medical research that helps to improve early patient-specific diagnosis and treatment of neurodegenerative diseases like Alzheimer's disease and Parkinson's disease. Our long-term vision for TVB-Cloud is to pave the way for a clinical product for personalized medicine that improves the quality of life of EU citizens by enabling targeted prevention, early diagnosis, disease progression prognosis, individual treatment plans and development of novel therapies for neurodegenerative diseases with focus on Alzheimer's and Parkinson's disease. We believe that this vision will be reached by implementing a European cloud-based platform that not only connects two critical streams of biomedical research, systems biology and computational neuroscience, but that also connects clinics, researchers, patients and students. The platform is inherently designed to integrate and unify multi-modal multi-scale multi-source data and turning it into knowledge.

Major achievements have been made in the development of software for information fusion in 3D brain models, multi-scale brain simulation – and visualization, reproducible digital workflows with version control and provenance tracking, and extensive data harmonization across ca. 20 large clinical cohorts. TVB-Cloud is deployed within the GDPR-ready Virtual Research Environment (VRE) platform, providing researchers with a seamless web interface to data and tools for multi-scale brain simulation and analytics. The VRE provides the following functionality: A web portal to access the cloud environment (http://vre.charite.de), secure data ingestion and pre-processing pipelines, metadata enrichment using the openMINDS and other standards, integration of knowledge graphs, automated workflows for removal of identifying information and adoption of FAIR data processes, integration of the TheVirtualBrain (TVB) simulation and other software, integration of a graphical user interface for data visualisation based on the BrainX3 software, integration of services for semantic searches, and integration with high performance computing (HPC) resources as well as direct ingestion gateways to hospital data sources such as radiologic imaging systems. TVB-Cloud has generated a wealth of scientific publications demonstrating the new technology as well and scientific insights made with these innovations. The scope ranges from in-silico deep brain stimulation to virtual drug therapy and significant advances in disease progression modelling and prediction.

We have intensified our **dialogue** with patients, society, and policy makers, for instance, by holding an EU parliament lunch debate on data sharing and by engaging with patients directly in the development of TVB-Cloud intervention systems. A close monitoring of the regulatory and ethical framework for research and innovation with sensitive health data using novel technologies such as complex brain simulation and AI ensures that TVB-Cloud technology complies to law, best practices and ethics standards. The key exploitation route of the project is the implementation of an EU-wide cloud-based platform for personalized research, diagnostics and therapies. First achieved milestones are the acceptance of TVB-Cloud as a facility hub for the EU Flagship's Human Brain Project e-infrastructure EBRAINS, the selection of TVB-Cloud technology to provide the Service for Sensitive Data for EBRAINS, and initial commercialization activities - including a successful European Innovation Council (EIC) grant. Crucially, the platform integrates machine intelligence for diagnosis and disease prediction with a biophysically grounded brain modeling that systematizes and automatizes therapy development, drug discovery and basic research. Furthermore, the platform integrates the pathology-relevant information from millions of patients by extracting the data from heterogeneous data sets and integrating them into a standardized annotation model. We anticipate that the introduction of this system constitutes a disruptive, market-creating innovation that revolutionizes future healthcare.