VirtualBrainCloud

Personalized Recommendations for Neurodegenerative Disease

Public summary

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The objective of **The VirtualBrainCloud (TVB-Cloud)** project is to develop and validate the VirtualBrainCloud, a dedicated cloud-based environment that leverages the potential of big data and high-performance computing (HPC) for personalized prevention and treatment of neurodegenerative diseases (NDD).

TVBCloud is embedded in The European Cloud Initiative. It combines already existing technologies and contributes to the development of new Information and communication technology (ICT) services while ensuring the appropriate data safety and protection.
A major focus is to ensure that the TVB-Cloud is in line with existing legislation, that personal data is protected and all ethical issues are duly considered. We deeply analysed requirements stemming from new European regulatory approaches, in particular GDPR, and we developed best practices thus we are participating in the development of industry standards and privacy-friendly technologies in the domain. In addition, we ensure appropriate ethical standards in the processing of personal data. For the planned cloud architecture, we identified issues related to data protection and implications of data mining. The data sharing contractual structure was analysed based on use case scenarios. We designed the overall architecture of TVB-Cloud, we started the setup of a cloud-based development infrastructure, which serves as the data- and compute-backend for the TVB-Cloud platform. We developed first components prototypes (Semantic and Knowledge, Simulation environments, Visualization and Interactive interfaces and Cognitive Intervention tools). We advanced the personalized modeling theory, did research on the identifiability of the generative brain network model from empirical data, and laid the groundwork for a more efficient statistical model. We have developed tooling to manage the data relevant for the consortium work in a FAIR setting. This includes primarily the ability to comprehensively track data from its origin, across all stages of processing, until its final impact on modelling and diagnostic decision-making. We set up processes for curation and processing of clinical data. We aim to model the progression of NDD such as Parkinson's and Alzheimer's disease using patient-level data. The foundation for this approach are clinical cohort studies.

However, to access and utilize these data, a systematic evaluation of the available datasets needed to be conducted. Based on the datasets gathered, the partners started to generate appropriate models which will facilitate disease risk prediction, diagnosis, subtyping and ultimately understanding the disease at question. We are in the process of validating longitudinal models based on other datasets that have been aligned for that purpose. We are further in progress of linking ontologies, terminologies and knowledge graphs with TVB-Cloud. The ultimate goal is to link disease progression models with virtual brain simulations to increase their predictive accuracy based on simulation inferred mechanistic features underlying the neuroimaging observations. TVB-Cloud's multifactorial approach takes into account individual genetic, metabolic and environmental aspects, and integrates them with our understanding of the biophysical processes underlying NDD.
We drafted scenarios for exploitation and sustainability of the TVB-Cloud. The platform is inherently sustainable and "fit for the future" as it is firmly rooted in a generic mechanism-based ontology that formalizes state-of-the-art biomedical knowledge and instantly and automatically integrates novel results. EU healthcare around NDD is clustered. Researchers, healthcare providers, patients and industry are distributed and there exists no common platform that enables coordinated flow of information. To drive integration in accordance with the European Initiatives, we foster collaboration with the European Open Science Cloud (EOSC), the Human Brain Project's EBRAINS infrastructure and we collaborate with five SME's – thus promoting exploitation of the TVB-Cloud platform. In this project, we take an approach to reach our vision of future healthcare where regular routine minimally invasive health-state profiling allows early diagnosis and patient-specific treatment, which will reduce the burden of NDD from the individual and society as a whole.