Human Brain Project

Institut de Neurosciences des Systèmes

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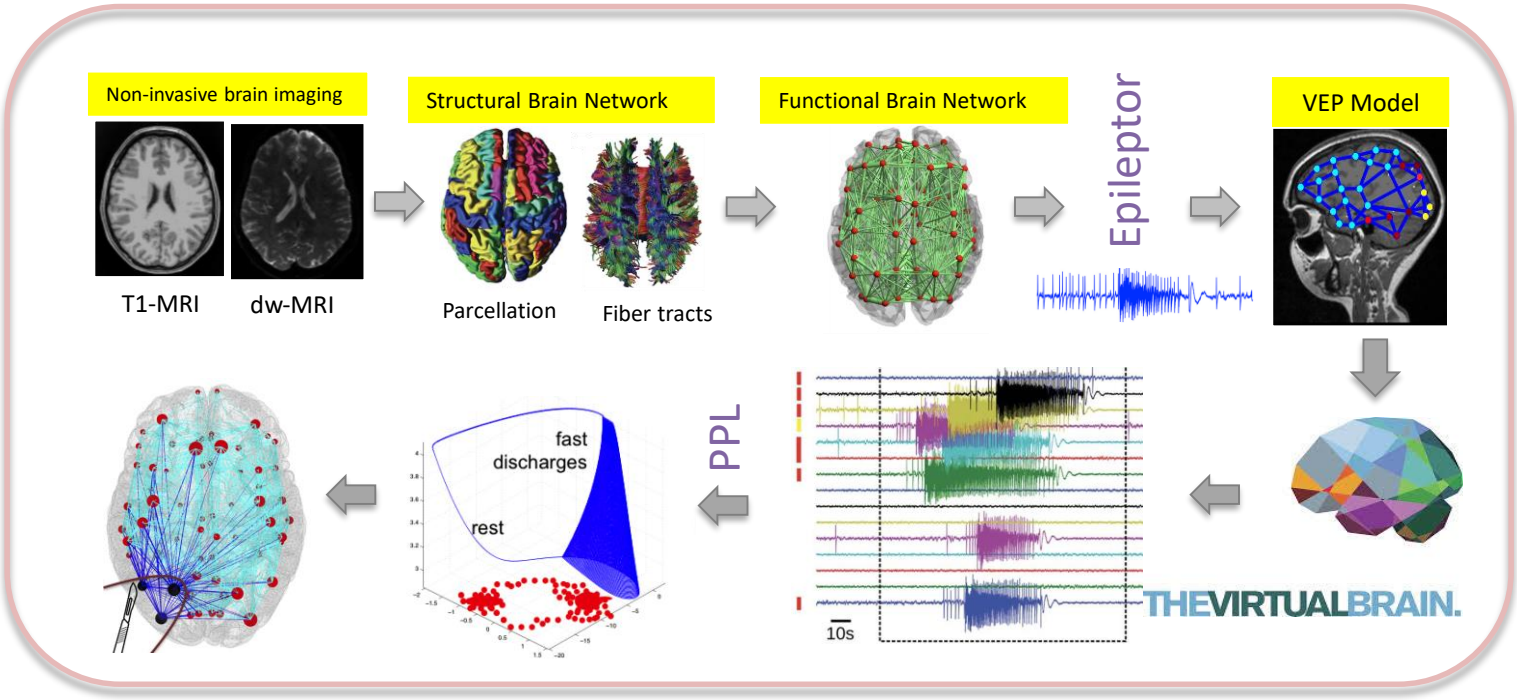
Personalized in-silico Brain Networks



Institut de Neurosciences des Systèmes (INS)
Aix-Marseille University (AMU)

Method for creating patient-specific brain models for in-silico clinical hypothesis testing

TECHNOLOGY DESCRIPTION

We have developed a probabilistic framework to systematically estimate parameters in brain models and thus render these patient-specific. In Epilepsy patients, our approach systematically predicts the location of seizure initiation and its organization. A generic mathematical model of seizure evolution (Epileptor) is integrated with patient's non-invasive structural brain imaging data, and the most advanced algorithms in probabilistic programming languages (PPLs) are used to infer the spatial map of epileptogenicity across different brain regions. The technology provides a novel patient-specific strategy for clinical hypothesis testing to improve outcome after epilepsy surgery.

A novel approach to clinical hypothesis testing is proposed based on personalized large-scale brain network models.

The approach relies on the fusion of structural data of individual patients and the advanced machine learning algorithms for whole-brain network model inversion.

AREAS

Brain network modeling | Machine learning | Individualized medicine

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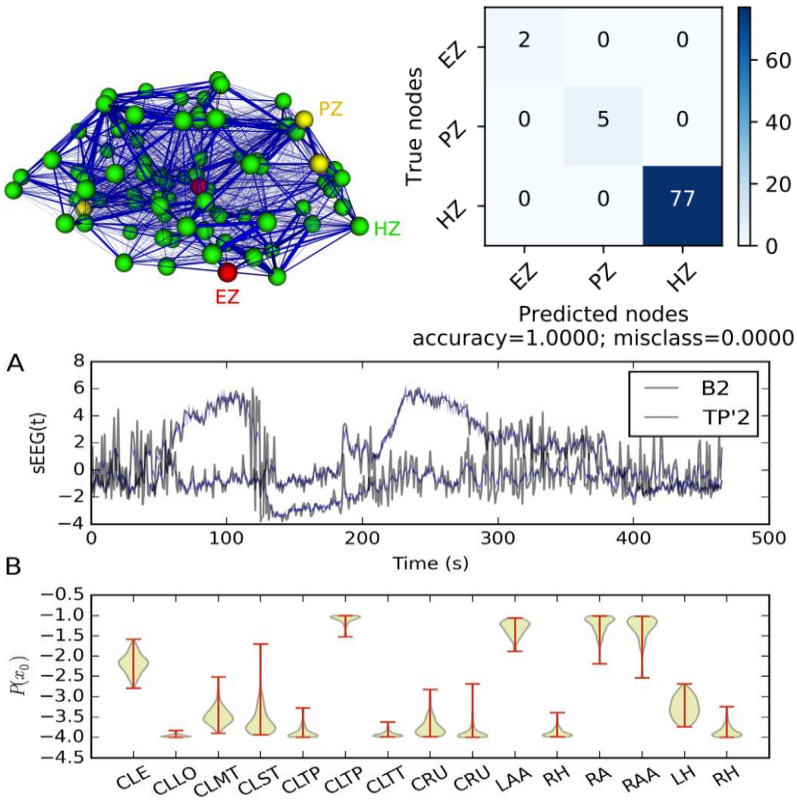
COMPETITIVE ADVANTAGES

- A novel approach to link probabilistic programming languages and personalized whole-brain network modeling
- Personalization by integrating patient specific anatomical information , and MRI lesions
- High-performance computing for systematic parameter estimation and fitting against the patient's data.
- Efficient sampling algorithms and extensive algorithmic diagnostics
- Predicting the dynamic of brain regions and seizure evolution and recruitment
- Demonstrating high accuracy in synthetic data and small-scale clinical trial with retrospective patients
- Indicating the capability of individualized large-scale brain network modeling in development of personalized strategies towards therapy and intervention

The Bayesian Virtual Epileptic Patient (BVEP) approach is opening up new avenues for patient-specific brain modeling and personalized treatment and decision making.

APPLICATION & MARKET POTENTIAL

- BVEP software prototype is used in a European clinical trial with 400 prospective patients (2019 - 2022), assessing the impact on the neurosurgery strategies for drug-resistant epilepsy patients as part of the EPINOV projet (www.epinov.com)
- Evaluation of potentially commercial prototype is ongoing
- Analysis ranked clinically-validated BVEP software highly for market potential in neurosurgery.



TECHNOLOGY READINESS LEVEL

1 2 3 4 5 **6** 7 8 9

REFERENCES

- Jirsa, V. K., Stacey, W. C., Quilichini, P. P., Ivanov, A. I. & Bernard, C. On the nature of seizure dynamics. Brain 137, 2210–2230 (2014).
- Proix, T., Bartolomei, F., Guye, M. & Jirsa, V. K. Individual brain structure and modelling predict seizure propagation. Brain (2017).
- collaboration for technology development with Codebox (www.codebox.de/codebox)
- collaboration with Charité University Medicine Berlin, Brain Simulation Section
- collaboration with University of Toronto Rotman Research Institute – Baycrest

CONTACT

Viktor Jirsa
INS, AMU | Marseille | France
viktor.jirsa@univ-amu.fr

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