Generative modelling of brain dynamics: From principles to applications

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Educational Course

The use of modelling to infer brain connectivity has become one of the most important themes in human brain mapping. Recently, very large and concerted efforts to build in silico models of brain structure, function and its dynamics – in unprecedented details – have emerged (e.g., Human Brain Project, The Virtual Brain). Concurrently, a huge variety of high quality and data extensive repositories have been established both in healthy (e.g., HCP and UK Biobank) and clinical populations (e.g., ADNI, ENIGMA, ABIDE, ABCD). These modelling platforms and databases are largely open-access providing a highly rich combination and exciting new opportunities – all ready to be exploited – to extend, enrich and enhance our understanding of network organization of the brain. This means that in silico generative modelling techniques can now be tested with: i) increasingly high spatio-temporal resolution data coming from multiple modalities; ii) less noisy measurements due to advances in artefact removal techniques; and iii) large sample sizes allowing to probe for individual differences paving the way, to move beyond group analysis, towards normative models and precision medicine.

This educational workshop will provide the critically needed overview of the basic principles, assumptions, strengths, limitations, and applications of a few of the representative suite of generative modelling techniques. It will provide attendees an access to the much required, and highly sought after training and resources that will enable them to independently conceptualize, implement, validate and interpret these modelling techniques and their outcomes.

Learning Objectives

The main learning objective of this educational workshop is to teach attendees the basic principle, guidelines, practices, implementation and applications of some of the representative generative modelling techniques in order to extend our mechanistic understanding of the brain's structural and functional network organization. As learning outcomes of this workshop, attendees will learn:

1. How to specify and estimate models of brain structure and function using dynamical systems theory
2. How to apply these generative modelling techniques to clinical populations to estimate, compare, validate and interpret their outcomes
3. Thoroughly understand strengths, assumptions and limitations of existing generative modelling techniques

Target Audience

The target audience will be trainees (Masters, PhD and Postdocs), faculty members, and industry practitioners, with a background in psychology, neuroscience, radiology, medicine, engineering, computer science and physics, hence catering to the requirements of basic, applied, and clinical scientists with a spectrum of previous experience.