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Precision Imaging Beacon of Excellence
Studentship Form

Supervisors	**Stam Sotiropoulos** Sir Peter Mansfield Imaging Centre, School of Medicine **Theo Kypraios** School of Mathematical Sciences		
Start date	September 2018	**Duration**	3 years
Project	**Cross-modal integration for modelling the brain connectome**		
Abstract	Mapping the human brain connectome, the set of connections that support information transfer between remote areas, is not only important for understanding normal brain function and cognition, but will also help tackle the even more complex pathological brain. Magnetic Resonance Imaging (MRI) uniquely offers the possibility to perform this mapping. In particular, diffusion and functional MRI have been shown to have huge potential in estimating brain connectivity [1]. However, these approaches are indirect. Connections are inferred through complex computational modelling frameworks rather than measured. As a result, the accuracy and precision of connectivity estimates can be limited due to inherent limitations in the measurements and the modelling [2,3]. Since multiple imaging modalities aim for the same target quantity, developing frameworks that perform the estimation using all data simultaneously is expected to improve significantly the current state of the art, which considers independently diffusion and functional MRI. In this PhD project, we aim to develop such a multi-modal connectivity framework. By integrating multiple modalities, their independent sources of error will cancel out, and the complementarity in the measurements will allow better estimation. Such estimation improvement is key in our ability to characterise individual variability and improve the quality of subject-specific predictions. The student will develop novel generative models of diffusion and functional MRI data given brain connections (extending previous proof of concept attempts [4]) and will devise computational inversion frameworks for these models to estimate connectivity given the data using a Bayesian approach. The development of such multi-modal integration frameworks is very relevant to the Beacon, given the aim to map and decode the Clinical Connectome. It is also very timely, given the large number of initiatives on both sides of the Atlantic (the NIH Human Connectome Project, its Lifespan expansion and various Connectomes for Disease, the ERC Developing Human Connectome Project and the UK Biobank) that collect diffusion and functional MRI to map the connectome. Given the strong links of the supervisors with all these initiatives, the developed technology can have immediate applicability and impact. **References** 1. S. Jbabdi, S.N. Sotiropoulos et al, “Measuring macroscopic brain connections in vivo”, Nature Neuroscience 18:1546-5, 2015 2. S.N. Sotiropoulos & A. Zalesky, “Building connectomes using diffusion MRI: why, how and but”, NMR in Biomedicine, doi: 10.1002/nbm.3752, 2017 3. S. M. Smith, D. Vidaurre, “Functional connectomics using resting-state fMRI”, Trends Cogn Sci 17: 666-682, 2013 4. S. Jbabdi, M. W. Woolrich, et al, “A Bayesian framework for global tractography”, Neuroimage 37:116-29, 2007		
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