Inferring properties of the human brain from clinical and experimental data

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The human brain is one of the most complicated systems known to humankind. With around 85 billion neurons and nearly 100,000 miles of blood vessels, it is a highly complex, self-organised, active system. However, measuring brain structure and function is surprisingly difficult. Despite major advances in imaging technologies, our understanding of both the structure and the function of the brain remains surprisingly poor. Mathematical models thus play an important role in interpreting clinical and experimental data. I will present work in my group that has led to the development of multiple scale methods to simulate cerebral blood flow, oxygen transport, and water movement. These have now been used to simulate these processes in whole-brain models for the first time within a mathematically rigorous, yet computationally inexpensive framework.

A key difficulty with these models, however, remains the issue of parameter estimation. I will present our preliminary work on parameter estimation and the use of optimisation techniques, together with data from a potential new imaging modality. However, much work remains to be done to obtain robust estimates of model parameters across different length scales from both experimental data (both human and animal) and clinical data. Potential future avenues for this will be discussed with a view to drawing on the expertise of others at the workshop.