Dr Áine Byrne, University College Dublin

Title: An introduction to modelling the brain using mathematics

Abstract:

The use of mathematics has many historical successes, especially in the fields of physics and engineering, where mathematical concepts have been put to good use to address challenges far beyond the context in which they were originally developed. More recently, mathematics has been employed to further our understanding of biological systems, such as the human brain. Despite the immense complexity of the brain, mathematical modelling has allowed for major advances to be made towards understanding behaviour, consciousness and disease. Assuming no specific neuroscience knowledge, this talk introduces the general ideas behind mathematically modelling the human brain. I will briefly review seminal work in the field, such as the Hodgkin-Huxley and Wilson-Cowan models, before discussing the development of the next generation of mesoscopic models for neural activity. This new class of model provides an explicit relationship between the neural activity and the level of within population synchrony at the mesoscopic level. To highlight the usefulness of such models, I will show how they can be deployed in a number of neurobiological contexts, such as providing understanding of the changes in power-spectra observed in EEG/MEG neuroimaging studies of motor-cortex during movement, insights into patterns of functional-connectivity observed during rest and their disruption by transcranial magnetic stimulation, and to describe wave propagation across cortex.