

Network Neuroscience: Concepts, Methods and Applications

Full Day Course / 8:00-16:30

Organizers:

Alex Fornito

Monash University, Australia

Andrew Zalesky

University of Melbourne, Australia

Recent large-scale efforts to map neuronal connectivity in diverse species, including the nematode worm, fruit fly, mouse, macaque and human, have led to an explosion of data acquired using a diverse array of measurements techniques, and at scales ranging from the level of single cells to large brain areas. In parallel, rapid advances in the physics of complex networks have led to a new understanding of the organization and dynamics of systems of interacting elements, with nervous systems being but one example. The confluence of these approaches lies at the heart of network neuroscience, which is concerned with understanding how nervous systems function as integrated systems. Critically, network neuroscience offers one of the few unified frameworks for representing different kinds of brain imaging data, acquired in different species at different scales and with different measurement techniques, by modelling all nervous systems in their most abstract form: as collections of nodes connected by edges.

This approach has already generated many novel insights into brain organization, showing for example that nervous systems across scales and species show a hierarchical, modular and small-world organization, that they contain highly connected hubs, and that they are economically wired. As the field matures, tools and techniques developed in other areas of network science are being increasingly refined and adapted to the neuroscience context.

As large-scale and high-quality data on brain connectivity become increasingly available, familiarity with the tools and techniques of network neuroscience is rapidly becoming an essential component of a neuroscientist's training. This workshop will provide a comprehensive introduction to both historical applications and cutting-edge techniques, covering topics that span both basic and advanced concepts in the area. It will address issues associated with measurement and modelling, statistical analysis and applications to key questions in neuroscience.

Course Schedule:

8:00-8:35

An introduction to network neuroscience

Alex Fornito, Monash University, Australia

8:35-9:10

Network statistics and thresholding

Andrew Zalesky, University of Melbourne, Australia

9:10-9:45

Null models for networks

James Roberts, QIMR Berghofer Medical Research Institute, Australia

9:45-10:20

Models of communication in brain networks

Bratislav Misic, McGill University, Canada

10:20-10:50

Break

10:50-11:25

Network infrastructure for integration: hubs and rich club

Martijn van den Heuvel, PhD, Center for Neurogenomics and Cognitive Research, Netherlands

11:25-12:00

Questions and Answers

12:00-13:00

Lunch

13:00-13:35

Modules in structural and functional brain networks

Rick Betzel, University of Pennsylvania, United States

13:35-14:10

Introduction to network control: Concepts, methods, and applications to neuroscience

Emma Towilson, Northeastern University, United States

14:10-14:50

Generalised Stochastic Blockmodels of Network Topology

Dragana Pavlovic, National University Singapore, Singapore

14:50-15:00

Break

15:00-15:35

Introduction to applied algebraic topology for the analysis of brain networks

Ann Sizemore, University of Pennsylvania, United States

15:35-16:10

Models of network dynamics

Joana Cabral, University of Oxford, United Kingdom

16:10-16:30

Questions and Answers