First Cambridge Networks Day
18 May 2012
Programme

9:00 - 9:50	Registration/Coffee
9:50 - 10:00	**Ed Bullmore** Welcome
10:00 - 10:40	**Mason Porter** “Community Structure in Networks”
10:40 - 11:20	**Vito Latora** “Time-Varying Networks”
11:20-11:40	Coffee
11:40 - 12:20	**Greg Jefferis** “Neural Networks of the Fly Brain”
12:20 - 13:00	**Nick Jones** “Fungal networks”
13:00 - 14:30	**Buffet lunch and poster session**
14:30 - 14:40	**Ottoline Leyser** “Research in the Sainsbury Lab”
14:40 - 15:20	**Yong Yeol Ahn** “LinkClustering Reveals Multi-Scale Structural Complexity in Networks”
15:20 - 16:00	**Simone Severini** “Networks Through a Quantum Lens”
16:00 - 16:20	Coffee
16:20 - 16:40	**Jon Crowcroft** “Through a Graph, Darkly”
16:40 - 16:50	**Poster prize**
16:50 - 17:20	**Open discussion on emerging themes**
17:20 - 17:30	**Concluding remarks**
17:30 - 18:00	**Visit to the Botanic Gardens** Take a chance to wonder through the beautiful gardens that surround the Sainsbury Lab (see map on the back)

Invited speakers abstracts

Community Structure in Networks

Mason Porter
Mathematical Institute, University of Oxford

Networks arise pervasively in biology, physics, technology, social science, and myriad other areas. They consist of a collection of entities (called nodes) connected via ties, and they typically exhibit a complicated mixture of random and structured features. One of the most important areas of network science is the study of cohesive groups of nodes called "communities", which consist of groups of nodes that are tightly connected to each other in some fashion. In this talk, I will give an introduction to community structure, and I will present several applications of it from subjects such as international relations, neuroscience, and granular materials.

Time-Varying Networks

Vito Latora
School of Mathematical Sciences, Queen Mary University of London

Interacting agents moving over geographic space, functional relationships between the cortical areas of a brain during the performance of a task, messages and contacts over online social systems, are all examples of networks in which the links are frequently changing over time. All such systems have to be described in terms of time-varying networks, i.e. time-ordered sequences of graphs defined over a fixed set of nodes. Concepts, metrics and models for static networks do not straightforwardly apply to time-varying networks. In this talk we will discuss new metrics and models, which allow capturing crucial information on the time ordering and eventual concurrency of links in real time-varying complex networks. We will also investigate how the additional dimension of time influences collective processes. Finally, as an application, we will show how to exploit temporal centrality measures to contain mobile phone viruses that spread via Bluetooth contacts.

Neural Networks of the Fly Brain

Gregory Jefferis
MRC Laboratory of Molecular Biology, University of Cambridge

One of the major challenges in neuroscience at the moment is to understand how groups of connected neurons interact to generate specific behaviours. In my group, we are approaching this general problem by trying to understand how food and sex pheromone odours are processed in the fruit fly brain to generate appropriate behavioural responses.

There are about 100,000 neurons in the fly brain. The evidence so far is that they are arranged in highly stereotyped circuits of reproducible developmental origin i.e. they are essentially the same from one fly to the next. Large scale mapping efforts are now underway to map the projections of all 100,000 neurons. Such data can be used to make simple predictions about network connectivity based on 3D proximity. We have pioneered some of the underlying methodology including genetic labelling, microscopy and image analysis, and applied it in a focussed way first to the olfactory system and then to identify sex differences in brain wiring. These later studies have identified differences in olfactory networks connectivity that are likely to explain how the same sex pheromone can produce different responses across the sexes.

My talk will introduce this general area, describe some of our own work and also point out data and research questions that seem to me ripe for future analysis by scientists with an interest in networks.

Fungal Networks

Nick Jones
Department of Mathematics, Imperial College London

While transport in animals and plants is well understood, how large-scale nutrient distribution occurs in fungi (nature's 3rd major multicellular kingdom) has remained unclear. I'll first discuss ways to generate automatic taxonomies of (fungal) networks. I'll then outline a simple current based model of fungal transport networks, show that it can successfully predict measured nutrient distribution, and note that effective fluid incompressibility imparts a computational advantage.

LinkClustering Reveals Multi-Scale Structural Complexity in Networks

Yong-Yeol Ahn
School of Informatics and Computing, Indiana University Bloomington, USA

Many networks possess strong community overlap, where nodes simultaneously belong to multiple groups, preventing us from dividing them into meaningful disjoint subunits and obscuring innate hierarchical organization. We propose a natural solution to unravel this structural complexity: classify the links, rather than the nodes, into groups. Linkclustering automatically incorporates overlapping communities, reveals hierarchical organization, and is viable on a wide variety of networks. We find biologically meaningful overlapping communities in protein-protein interaction and metabolic networks and show that a large mobile phone network contains hierarchically-organized, multi-scale communitystructures while maintaining significant overlap.

Networks Through a Quantum Lens

Simone Severini
Department of Physics and Department of Computer Science, University College London

In a recent, provocative Nature Physics commentary, Albert-Lázló Barabási writes "as the field [network theory] enters the spotlight, physics must assert its engagement if it wants to continue to be present at the table". And "[Our children] dont talk quanta they dream bits. They dont see entanglement but recognize with ease nodes and links". Quantum Information Science has contributed to a deeper understanding of the Wheeler-Deutsch's motto "It from (qu)bit". Often, today, when we talk quanta, we do talk bits. Additionally, we know that the interface between subareas of Quantum Information Science and Graph Theory is vast - there are workshops on the topic. In the light of these facts, we would like to ask the following question: can the toolbox of Quantum Information Science be concretely useful in the context of Network Theory (and viz.)? This talk is not a single novel. It is a collection of short stories trying to identify potential directions for addressing the question. There are many characters in the stories: spin systems, generalizations of graphs, non-local games, reversible dynamics, and our universe as a huge network.

Through a Graph, Darkly

Jon Crowcroft
Computer Laboratory, University of Cambridge

There is now an overwhelming wealth of data sources (e.g. smart phones) about human social and mobile activities. These resources allow many useful applications: (1) Self-referential uses include: network planning for cellular; offloading and opportunistic network routing; mobile and opportunistic content distribution. (2) Applications include: planning transportation; crowd management; activity-based energy monitoring, and disease epidemic tracking. (3) Commercial use includes: location based advertising; social and mobile based recommendation; social network analysis; urban planning.

Much goodness potentially flows from this work. However, all of this comes at a massive cost to personal privacy. To make matters worse, there are trends towards data sharing and publication which (quite rightly) are placing pressure on researchers to share the evidence for their work for reasons of validation, but also (as with medical epidemic (and other) data) to allow as yet unforeseen applications to be run on the real-world datasets.

Yet historical data about human movements and encounters is intensively personal. More so even than mere browsing data, which has already caused major furores when inadequately anonymized historical data was released (by AOL). Anonymiszing (hyper)graph data is nigh on impossible according to current understanding. In this talk, I will attempt to lead a discussion about these tensions, and what we might do about this practically. There are several challenges including: culture and conventions for ethical collection of data, and the evolution of the public understanding and informed consent; the technical use of differential privacy, and private preserving queries on such data; alternative ways of building applications that do not require recording such data more than momentarily and locally; and more.