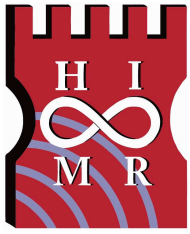

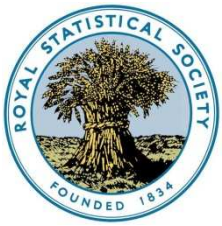

Heilbronn Institute for Mathematical Research/

Royal Statistical Society/

University of Bristol

Large Evolving Networks

19th March 2013

Abstracts

LARGE EVOLVING NETWORKS

ABSTRACTS

Predator-prey dynamics on infinite trees

Charles Bordenave
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We will consider the spreading dynamics of two nested invasion clusters on an infinite tree. This model was defined as the chase-escape model by Kordzakhia and it admits a limit process, the birth-and-assassination process, previously introduced by Aldous and Krebs. For both models, we prove an asymptotic equivalence for the extinction probability near criticality. In the subcritical regime, we give a tail bound on the total progeny of the prey before extinction.

Component structure of the vacant set induced by a random walk on a random graph

Colin Cooper
Department of Computer Science
King's College London

We consider random walks on two classes of random graphs and explore the likely structure of the the set of unvisited vertices or vacant set. In both cases, the size of the vacant set $N(t)$ can be obtained explicitly as a function of t.

Let $\Gamma(t)$ be the subgraph induced by the vacant set. We show that for random graphs $G_{n,p}$ above the connectivity threshold, and for random regular graphs G_r, for constant $r \geq 3$, there is a phase transition in the sense of the well-known Erdős–Rényi phase transition. Thus for $t \leq (1-\epsilon)t^*$ we have a unique giant plus components of size $O(\log n)$ and for $t \geq (1+\epsilon)t^*$ we have only components of size $O(\log n)$.

In the case of G_r we describe the likely degree sequence, size of the giant component and structure of the small ($O(\log n)$ size) components.

Majority Consensus: Algorithms and Spectral Optimisation

Moez Draief
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Given a network where each node initially observes one of two states, how to construct a robust distributed mechanism which ensures that the nodes reach the right consensus, i.e. the majority observation at the start of the procedure? In this talk, I will review a number of local computation procedures, and examine their properties as functions of the underlying network statistics. The algorithms considered are relevant in a number of applications including leader election and resource allocation in distributed systems, and opinion formation in online social networks. In the second part of the talk, I will present a framework for optimising the running time of such algorithms that relies on optimising some spectral properties of the graph.

Bayesian methods for monitoring a device within a large dynamic graph

Nick Heard
Department of Mathematics
Imperial College, London

Anomalous connectivity levels in a communication graph can be indicative of prohibited or malicious behaviour. Detecting anomalies in large graphs, such as corporate computer networks, requires techniques which are computationally fast and ideally parallelisable, and this puts a limit on the level of sophistication which can be used in modelling the entire graph. Here, methods are presented for detecting locally anomalous substructures based on simple node and edge-based statistical models. This can be viewed as an initial screening stage for identifying candidate anomalies, and only very basic substructures are considered. The focus of this talk will be on monitoring diverse features of the same data stream emanating from a single communicating device within the network, using conditionally independent probability models. Whilst all of the models considered are purposefully very simple, their practical implementation touches on a diverse range of topics, including conjugate Bayesian inference, reversible jump Markov chain Monte Carlo, sequential Monte Carlo, Markov jump processes, Markov chains, density estimation, change-point analysis, discrete p-values and control charts.

Twitter's big hitters

Des Higham
Department of Mathematics and Statistics
University of Strathclyde

The digital revolution is generating novel large scale examples of connectivity patterns that change over time. This scenario may be formalized as a graph with a fixed set of nodes whose edges switch on and off. For example, we may have networks of interacting mobile phone users, e-mailers, Facebookers or Tweeters. To understand and quantify the key properties of such evolving networks, we can extend classical graph theoretical notions like degree, path-length and centrality. In this talk I will focus on linear algebra-based algorithms and show that appropriate matrix products can capture various aspects of information flow around an evolving network. I will show how these algorithms performed in a recent case study on Twitter data, where independent influence rankings were available from social media experts. I will also show how classical random graph models can be extended to the time-dependent setting. In particular, a model for triadic closure (friends-of-friends tend to become friends) will be seen to produce a bistability effect.

Gossip processes and small-world networks

Gesine Reinert
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University of Oxford

Both small world models of random networks with occasional long range connections and gossip processes with occasional long range transmission of information have similar characteristic behaviour. The long range elements appreciably reduce the effective distances, measured in space or in time, between pairs of typical points. In this talk, we shall see that their common behaviour can be interpreted as a product of the locally branching nature of the models. In particular, both typical distances between points and the proportion of space that can be reached within a given distance or time can be approximated by formulae involving the limit random variable of an approximating branching process.

This is joint work with Andrew Barbour, Melbourne.