Mathematics of Networks 10 (MoN10) Programme

10:30 – 11:00	**Welcome and coffee**	
11:00 – 11:45	Niels Hoffmann (Paxassign Consulting)	A dynamic stochastic multipath network decision process: A framework which adheres to the central limit theorem throughout a network
11:45 – 12:30	Mike Smith (York)	Proof of convergence of a natural splitting-rate adjustment algorithm in models of telecommunications and transport networks
12:30 – 13:45	**Lunch**	
13:45 – 14:30	Alexander Hartmann (Oldenburg)	Large deviation properties of random graphs
14:30 – 15:15	Ben Parker (QMUL)	Design of networked experiments
15:15 – 15:45	**Coffee break**	
15:45 – 16:30	Vasileios Giotsas (UCL)	Inferring autonomous system relationships from border gateway protocol attributes
16:30 – 17:15	Olaf Maennel (Loughborough)	10 lessons from 10 years of measuring and modelling the internet's autonomous systems
17:15	**Closing remarks**	

Niels Hoffmann (Paxassign Consulting) - A dynamic stochastic multipath network decision process: A framework which adheres to the central limit theorem throughout a network

The DV3 framework for routing pedestrians in complex networks has been used since the beginning of the nineties in modelling passenger flows and densities in railway stations, airports and at major events such as Olympic/Commonwealth games and a million plus population at the projected Mecca expansion . The method is shown to be a probit model dealing appropriately with multiple paths and their correlation, reflecting the behaviour of infinitely many travellers. This is achieved by combining E(X) and V(X) in an assignment process over the network as an integral part of the tree/vine building process towards each destination subject to no circular path being generated. In the process splitting rate/progression probabilities are calculated at each stage from E, V and C where C=capacity or quality factor. A deterministic function for calculating Path Progression Probabilities PPP=G(E,V,C) is presented and shown to give results corresponding well with the equivalent Monte Carlo simulation probabilities. C deals with the problem of the well-known IIA problem. Finally, each destination process enables travellers from everywhere to reach its destination by evaluating multiple paths at every stage of the progression either by flow or individual agents. Since the process is linear in E and V we assume that changes to journey times in the simulation/model is scalable and the process hence able to cope with the dynamics of a seamless update of simulated or observed journey times.

Mike Smith (York) - Proof of convergence of a natural splitting-rate adjustment algorithm in models of telecommunication and transportation networks

The talk proves the following convergence result.

Suppose that for each destination and each node and each pair of exit links from that node, traffic flow (to the destination) swaps from the more costly exit link to the less costly exit link at a rate which is proportional to the flow on the more costly exit link times the difference in costs between the two exit links. Then under natural conditions the link flow pattern converges to an approximate equilibrium. (For each exit link, the exit link cost here is the flow-weighted cost to the destination via that exit link.)

It will be shown that the conditions used to prove the theorem are in a sense necessary; by giving a counterexample.

Alexander Hartmann (Oldenburg) - Large deviation properties of random graphs

The large-deviation properties of different types of random graphs are studied using numerical simulations.

First, distributions of the size of the largest component, in particular the large-deviation tail, are studied numerically for two graph ensembles, for Erdős-Rényi random graphs with finite connectivity and for two-dimensional bond percolation. Probabilities as small as 10^-180 are accessed using an artificial finite-temperature (Boltzmann) ensemble and applications of the Wang-Landau algorithm. The distributions for the Erdős-Rényi ensemble agree well with previously obtained analytical results. The results for the percolation problem, where no analytical results are available, are qualitatively similar, but the shapes of the distributions are somehow different and the finite-size corrections are sometimes much larger. Furthermore, for both problems, a first-order phase transition at low temperatures T within the artificial ensemble is found in the percolating regime, respectively.

Second, the distributions of the diameter are presented. Here, partial analytic results are available from previous studies for Erdős-Rényi random graphs in the small connectivity region. The numerical results follow a Gumbel distribution and agree well with the analytics. For higher connectivities, where no analytic results are available, the simulation results show that the distributions are qualitatively different from the low connectivity region. This is also connected to a first-order phase transition within the associated finite-temperature ensemble.

Ben Parker (QMUL) - Design of Networked Experiments

We consider experiments on a number of subjects, and examine how the links between subjects in an experiment affect the optimal design. For example, in a marketing experiment, it is reasonable to believe that a product may be preferred more by a subject whose 'friend' also prefers that product, and we may wish to use this 'friendship' information to improve our design.

We present optimal designs to measure both the direct effect and the network effect. We discuss how the structure of the network has a large influence on the optimal design, but show that even if we know many properties of the network, as represented by the eigenvalues of a graph, we cannot determine an absolute design.

We present examples based on marketing experiments, and show how the results can be applied to experiments in social sciences and elsewhere.

Vasileios Giotsas (UCL) - Inferring AS relationships from BGP attributes

Business relationships between autonomous systems (AS) are crucial for Internet routing. Existing algorithms used heuristics to infer AS relationships from AS topology data. In this paper we propose a different approach to infer AS relationships from more informative data sources, namely the BGP Community and Local Preference attributes. These data contain rich information on AS routing policies and therefore closely reflect AS relationships. We accumulate the BGP data from RouteViews, RIPE RIS and route servers in August 2010 and February 2011. We infer the AS relationships for 39% of links that are visible in our BGP data. They cover the majority of links among the Tier-1 and Tier-2 ASes. The BGP data also allow us to discover special relationship types, namely hybrid relationship, partial-transit relationship, indirect peering relationship and backup links. Finally we evaluate and analyse the problems of the existing inference algorithms.

The talk is based on the papers Inferring Internet AS Relationships Based on BGP Routing Policies and Detecting and Assessing the Hybrid IPv4/IPv6 AS Relationships.

Olaf Maennel (Loughborough) - 10 Lessons from 10 Years of Measuring and Modeling the Internet's Autonomous Systems

Formally, the Internet inter-domain routing system is a collection of networks, their policies, peering relationships and organizational affiliations, and the addresses they advertize. It also includes components like Internet exchange points. By its very definition, each and every aspect of this system is impacted by BGP, the de-facto standard inter-domain routing protocol. The element of this inter-domain routing system that has attracted the single-most attention within the research community has been the "inter-domain topology". Unfortunately, almost from the get go, the vast majority of studies of this topology, from definition, to measurement, to modeling and analysis, have ignored the central role of BGP in this problem. The legacy is a set of specious findings, unsubstantiated claims, and ill-conceived ideas about the Internet as a whole. By presenting a BGP-focused state-of-the-art treatment of the aspects that are critical for a rigorous study of this inter-domain topology, we demystify in this paper many "controversial" observations reported in the existing literature. At the same time, we illustrate the benefits and richness of new scientific approaches to measuring, modeling, and analyzing the inter-domain topology that are faithful to the BGP-specific nature of this problem domain.

Organisers: Keith Briggs (BT), Richard Clegg (UCL), Iain Phillips (Loughborough)

Confirmed Attendees: Ahmed Abubakar (Loughborough), Sarah Chisholm (UCL), Boyd Duffee (Keele), Frederic Francois (Surrey), Vasileios Giotsas (UCL), Ali Hammad (Essex), Uli Harder (Imperial), Lin Guan (Loughborough), Alexander Hartmann (Oldenburg), Niels Hoffmann (Paxassign Consulting), David Hunter (Essex), Paul Jakma (Glasgow), Antonio Liotta (Eindhoven), Olaf Maennel (Loughborough), Glenford Mapp (Middlesex), Ibrahim Musa (Essex), Mirco Musolesi (Birmingham), Ben Parker (QMUL), Shuping Peng (Essex), Colin Perkins (Glasgow), Christopher Pluntke (UCL), Igor Razgon (Leicester), Martin Reed (Essex), Ana Salagean (Loughborough), Mike Smith (York), Joseph Spring (Hertfordshire), Alexander Stepanenko (Aston), Johnny Shichun Wang (Loughborough), Kun Yang (Essex), Shi Zhou (UCL)

Thanks to Loughborough Computer Science department for sponsoring this meeting.