PhD student conference on

Complex Systems

27th June 2014 – Brunel University

Background:

"A complex system is a system composed of many interacting parts, often called agents, which displays collective behavior that does not follow trivially from the behaviors of the individual parts." (Mark Newman).

Emergent complexity can be witnessed almost everywhere, whether it is in a swarm of **insects**, in a **business** enterprise, in a group of **people**, in a **market** place, or in a collection of **atoms**.

Many problems that are posed nowadays in science are problems of complexity. Solutions for these problems require multidisciplinary approaches.

Goals:

create a community of young researchers in Brunel to…

- exchange ideas on how to tackle the challenges that arise from complexity
- learn about interesting applications and techniques in this field and
- initiate future research collaborations.

Invited speakers:

Keynote: Prof. Geoff Rodgers (VP Research)
Georgia Melaki (Economics)
Amy Monroe (Psychology)
Stanley Okom (Environmental Science)
Ovidiu Pârvu (Information Systems and Computing)

Organiser: Konrad Hoppe (Mathematics)

Abstract submission deadline 30th May, 2014

http://sites.brunel.ac.uk/complexity2014

Brunel UNIVERSITY LONDON

PhD Student Conference on Complex Systems

Brunel University, 27th June 2014

Program

9.00 – 9.15	Arrival	
9.15 – 9.30	Welcome and Introduction, *Konrad Hoppe*	
9.30 –10.00	A power law distribution in patients' lengths of stay in hospital, *Geoff Rodgers*	1
10.10 – 10.40	Cumulative advantage in the evolution of a network, *Ewan Colman*	1
10.50 – 11.05	**Break**	
11.05 – 11.35	Moral Elevation and the Up-Regulation of Prosocial Motivation, *Amy Monroe*	1
11.45 – 12.15	The Impacts of Electronic Word of Mouth on Social Media on Consumers' Purchase Intentions, *Ismail Erkan*	2
12.25 – 13.25	**Lunch**	
13.25 –13.55	Event-Clustering for Real-Time Data Modelling in Complex Systems, *Morad Danishvar*	2
14.05 – 14.35	Towards an improved approach for Banking Crisis Prediction, *Georgia Melaki*	3
14.45 – 15.15	The amalgamation of weaving and electronic circuits for woven e-textile materials via design led processes, *Priti Veja*	3
15.25 – 16.00	**Coffee**	
16.00 – 16.30	Applying Complex Systems to Climate Change and Agriculture, *Stanley Okom*	3
16.40 – 17.10	A Spatio-Temporal Bayesian Network Approach for Revealing Functional Ecological Networks in Fisheries, *Neda Trifonova*	4
17.20 – 17.50	Spatio-temporal modelling and analysis of biological systems, *Ovidiu Pârvu*	4
18.00 – . . .	**Drinks and Nibbles**	

*All talks will be held in room **LC 067** in the Lecture Centre.*

A power law distribution in patients' lengths of stay in hospital

Geoff Rodgers

Mathematics, VP Research, *g.j.rodgers@brunel.ac.uk*

The distribution of patients' lengths of stay in English hospitals is measured by using routinely collected data from 11 years. It is found to be well approximated by a power law distribution spanning over more than three decades. To explain this observation, a theoretical resource allocation model is presented. It is based on iterative long-term scheduling of hospital beds, and its main assumption is that future beds are allocated preferentially. This represents a situation where different parts of the health care system compete for resources, with bargaining powers proportional to current resource levels.

Cumulative advantage in the evolution of a network

Ewan Colman

Mathematics, *ewan.colman@brunel.ac.uk*

Our intuition tells us that links in a networks are more likely to be created between nodes which are already well connected rather than those which have few connections. This maxim has famously been used to explain the large scale structure of many networks found in society and nature. In this talk we examine this phenomenon on a deeper level and give likely explanations as to why well connected nodes have a higher likelihood of attracting new links. We introduce models based around the concepts of triad formation and triadic closure, and derive properties of the large scale structure of the networks. Finally we look at how these models relate to real complex systems using the example of the network of citations in scientific literature.

Moral Elevation and the Up-Regulation of Prosocial Motivation

Amy Monroe

Psychology, *amy.monroe@brunel.ac.uk*

The complex system that my area of work focuses on is the system of human prosocial interaction, and I take an evolutionary approach to exploring it.

Prosocial behaviour is behaviour which produces positive fitness consequences for an individual other than the actor, often at a fitness cost to the actor himself.

A number of evolutionarily focused theories describe how behaviour of this type could be adaptive (i.e. produce a net fitness benefit for the actor), but most, if not all, of them preclude actors indiscriminately benefitting others at a cost to themselves.

There is an optimal level of investment to make in prosocial behaviour; a level below which an actor would be failing to fully capitalise on the fitness enhancing opportunities that prosocial behaviour provides, and above which an actor would be incurring a greater cost than he would necessarily need to to capitalise on these opportunities.

One factor which influences the payoff structure of prosocial behaviours (and is therefore involved in the determination of investment optima) is the level of investment being made by other parties in the behavioural network.

There exists a large volume of literature investigating how we avoid relative over-investment in prosocial behaviour (that is, dialing our investment down in response to cues that it is currently super-optimal), but there has been less focus on how we avoid relative under-investment (dialing our investment up in response to cues that it is currently sub-optimal).

I have been exploring the possibility that an emotion called 'moral elevation' forms part of the cognitive machinery which allows us to avoid the pitfalls of relative under-investment in some circumstances by up-regulating our motivations to behave prosocially when we see others doing so.

The Impacts of Electronic Word of Mouth on Social Media on Consumers' Purchase Intentions

Ismail Erkan

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The influence of Electronic Word of Mouth (eWOM) on consumers' purchase intentions has been known for a long time. However, eWOM has gained a new dimension with the advent of social media. Before this new phenomenon, people were able to talk with anonymous people on the Internet but nowadays social media enable people to talk with friends and acquaintances, on the Internet. This new way of eWOM might be more powerful in terms of triggering purchase intention. This study discusses the electronic word of mouth within the context of social media. The research consists of two phases. First, survey will be conducted to understand the effect of eWOM in social media on purchase intention. Then interviews will be made to reveal that how eWOM in social media affects consumers' purchase intentions. The results should contribute to both researchers and practitioners.

Event-Clustering for Real-Time Data Modelling in Complex Systems

Morad Danishvar

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This paper proposes a unique and novel approach for real time input variable selection (IVS) applicable to large scale complex systems. This approach deploys the Rank Order Clustering (ROC) method to automatically group every relevant system input (e.g. sensor and actuation) within the known boundaries of the system to parameters that define the state of the systems (e.g. Performance Indicators or status).

The proposed event-clustering technique removes all the logical boundaries of isolation that exist in complex systems with the principle that every acquirable knowledge or data (input) affects the output unless proven otherwise. In addition to being able to filter unwanted data, it is capable of including information that was thought irrelevant at the outset. This feature is unique and novel.

The underpinning logic of the proposed EventClustering (EC) technique is building an event cause-effect relationship between the inputs and outputs of the system the technique is not only capable of group inputs with relevant corresponding output, but also in short spans of time (relative real-time) measure the weight of each input variable on the output variables. The proposed method will become the foundation for control and stability operations in large and complex systems.

Our motivation is that components of current complex and organised systems are capable of generating and sharing information within their known domain (network of interrelated devices and systems).

Result of an experiment in a Cement kiln operation shows that about 20% of input sensors have little effect on productivity of the Kiln; therefore they can be totally ignored when measuring the kiln's production rate.

Towards an improved approach for Banking Crisis Prediction

Georgia Melaki

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Existing literature uses market events to identify banking crises, that is, the dependent variable of the logit-regression. Besides the outperformance of these events method against signal extraction in terms of type I errors and type II errors (Barrel, Davis, Karim and Liadze, 2010), logit Early Warning System (EWS) has several shortcomings (Hagen and Ho, 2004). For instance, it tends to identify crises too late, cannot identify the crises that are successfully fend off by the government measures, and most importantly, the crises dates are subject to arbitrariness (Hagen and Ho, 2003). Another shortcoming includes the issue of the limited data arising from the occurrence of inadequate number of crisis within the sample. In order to mitigate the above shortcomings, this statement proposes the development of a Markov Switching GARCH model for predicting banking crises.

The amalgamation of weaving and electronic circuits for woven e-textile materials via design led processes

Priti Veja

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Electronic textiles (e-textiles) have extensive application and potential in wearable technology and soft interactive products. Key interest groups developing e-textile include defence, health, sports, gaming, transport and fashion. The future markets for these industries will see considerable growth in e-textiles to meet their higher demands; hence, requiring advanced research and development that can address both design and function.

E-textile research development in the past, has struggled to find a balance between true integration of textile design form and electronic function. Previous attempts of e-textile developments have predominantly been via technical materials approaches, where textile architectures are not fully utilised. Although more recent outcomes in e-textiles have proved to be successful (e.g. printable electronics, conductive threads, arduino lilypad), they have presented further opportunities to expand e-textiles research. Thus, by understanding the core fundamentals of textile design, this can be used to integrate e-textiles into the construction of textile materials.

This research is an experimental enquiry of woven e-textiles materials development through a design process and weaving practice. The complex languages of weaving and electronics are amalgamated for integrated e-textile materials through design led processes. Electronic circuitry is simultaneously integrating during the weaving process, into the textile construction for e-textile materials. The main research interest is to enhance and advance the progression of e-textile soft circuits, for more considered design through woven structural manipulations. Multifunctional e-textile design forms have been woven as complex one piece constructions as demonstrators of this approach.

Applying Complex Systems to Climate Change and Agriculture

Stanley Okom

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The issue of climate change on its own is a complex and multidimensional one which includes but not limited to environmental, political, socio-economic and cultural challenges.

Generally, climate change is problematic for agriculture because agriculture is inherently sensitive to climate. Approaches to addressing current challenges, such as the impacts of climate change on agricultural productivity, will have to account for the complex interdependency that exists among the areas such as the environment, agriculture, geography, physics, ecology, etc. This sort of accounting is possible using the complex system approach as it encompasses an integrative multi scale and inter-disciplinary approach which accounts for the need of stakeholders in the agriculture and food domains. This presentation will attempt to evaluate the impacts of potential game changers/ benefits that could be derived from the complex system approach.

A Spatio-Temporal Bayesian Network Approach for Revealing Functional Ecological Networks in Fisheries

Neda Trifonova

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Ecosystems consist of complex dynamic interactions among species and the environment, the understanding of which has implications for predicting the environmental response to changes in climate and biodiversity. Machine learning techniques can allow such complex, spatially varying interactions to be recovered from collected field data. In this study, we apply structure learning techniques to identify functional relationships between trophic groups of species that vary across space and time. Specifically, Bayesian networks are created on a window of data for each of the 20 geographically different and temporally varied sub-regions within an oceanic area. In addition, we explored the spatial and temporal variation of pre-defined functions (like predation, competition) that are generalizable by experts' knowledge. We were able to discover meaningful networks of functional relationships that were more precisely spatially-specific rather than temporally. To validate the discovered networks, we predict the biomass of the trophic groups by using dynamic Bayesian networks, and correcting for spatial autocorrelation by including a spatial node in our models.

Spatio-temporal modelling and analysis of biological systems

Ovidiu Pârvu

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Computational models play an increasingly important role in systems biology for generating predictions of how biological systems change when perturbed, and in synthetic biology as executable prototypes/designs employed for engineering useful synthetic biological systems. Due to the inherent stochastic nature and high complexity of biological systems most of the currently existing models are limited to small scale biological subsystems. However for real clinical (e.g. personalised medicine) and biotechnological (e.g. biofuel production) applications there is a need to scale up and build more complex multidimensional (i.e. spatio-temporal) and multiscale models. The challenges of spatio- temporal modelling and analysis are illustrated based on a biological case study namely phase variation patterning in bacterial colony growth. A model of the system was constructed using Coloured Stochastic Petri Nets and space was represented in pseudo-3D dimensions i.e. the discretised Euclidean 2D space was represented explicitly and height was represented implicitly using two different geometries (rectangular and circular). Spatial patterns and clusters of such patterns are automatically detected and analysed in the model simulation output using parameterised image processing algorithms. The developed methodology is generic, can be applied to other case studies and is a precursor to the development of more complex multiscale computational models.