

Centre for Mathematical Social Sciences 2014 Summer Workshop

The University of Auckland

December 9th & 10th, 2014

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Timetable

Day One

Time	Chair	Presenter	Title
9:00–9:15			Welcome
9:15–10:15	Mark C. Wilson	Matt Jackson	Identifying Central Individuals in Networks and Diffusion Processes
10:15–10:45		Coffee Break	Level 4, Blg 303
10:45–11:10	Kim Hang Pham Do	Shaun Hendy	Regional Innovation Favours the Diverse
11:10–11:35		Elsa Guillot	Modelling the Influence of Human Social Rules on Population Genetics
11:35–12:00		Jonathan Newton	The Evolution of Shared Intentions
12:00–12:20		Francois Vallee	Modelling History in Islands of Southeast Asia
12:20–13:30		Lunch	Level 4, Blg 303
13:30–13:55	Dion O’Neale	Richard Vale	Imputing Attitude Scores on a Network
13:55–14:20		Mark C. Wilson	Experimental Study of Belief Diffusion
14:20–15:00		Isabelle Sin	People, Books, and Flows of Knowledge
15:00–15:30		Coffee Break	Level 4, Blg 303
15:30–15:50	Fraser Morgan	Matthew Ryan	Binary Choice Probabilities on Mixture Sets
16:45–18:45		Recovery Drinks	Old Government House, Waterloo Quadrant (In the gardens opposite the Quadrant Hotel)
19:00–		Workshop Dinner	Mai Thai, 57 Victoria St (opposite the Sky Tower)

Day Two

Time	Chair	Presenter	Title
9:00-9:15			Welcome Back
9:15-10:15	Patrick Girard	Damon Centola	The Origins of Social Order: New Theory and Experiments
10:15-10:45		Coffee Break	Level 4, Blg 303
10:45-11:10	Holly Darling	Catriona Sissons	Collaboration Networks for Innovation
11:10-11:35		Nina Anchugina	A new (and simpler) axiomatization of exponential and quasi-hyperbolic discounting
11:35-12:00		Arkadii Slinko	The Single-crossing Property on Median Graphs
12:00-12:20		James Taylor	Cycles and Common Priors Without Full Support
12:20-13:30		Lunch	Level 4, Blg 303
13:30-13:55	Ellen Muir	Mikhail Anufriev	Connecting the Dots: Econometric Methods for Uncovering Networks with an Application to the Australian Financial Institutions
13:55-14:20		Sergey Ozernikov	Axiomatic Approach to Trust Metrics in Certification Networks
14:20-15:00		Tava Olsen	Modelling Emergency Department Patient Flows
15:00-15:30		Coffee Break	Level 4, Blg 303

Abstracts

Nina Anchugina¹

¹ Mathematics Department, University of Auckland

A New (and Simpler) Axiomatization of Exponential and Quasi-hyperbolic Discounting

How can we compare costs and benefits which occur in different periods of time? The standard approach is to convert future values into their present values by attaching some weight to each period. This procedure is known as discounting and a number of possible functional forms of discounting have appeared in the literature so far. In order to understand which rules a decision-maker follows when she uses a particular form of discounting is one of the central issues of the theory of intertemporal choice. To answer this question it is important to reveal which normative requirements, or axioms, lead to each type of discounting.

Exponential discounting remains the most widely used, partially due to its well-established axiomatic foundation, originally developed by Koopmans (1960) with subsequent contributions by several other authors. However, an alternative axiomatic characterization of exponential discounting is possible. In particular, we show that Anscombe and Aumann's result (1963) from Subjective Expected Utility theory can be extended to axiomatize exponential discounting.

In this talk I will demonstrate how it is possible to obtain axiomatic representations for exponential, quasi-hyperbolic and semi-hyperbolic forms of discounting based on the aforementioned Anscombe and Aumann's theorem.

Mikhail Anufriev^{1,2} and **Valentyn Panchenko**²

¹University of Technology, Sydney

²University of New South Wales

Connecting the Dots: Econometric Methods for Uncovering Networks with an Application to the Australian Financial Institutions

This paper connects variance-covariance estimation methods, Gaussian graphical models, principle component analysis and growing literature on economic and financial networks. We construct the network using the concept of partial correlations which captures direct linear dependence between any two entities conditional on dependence between all other entities and investigate the properties of this network. The methodology is applied to construct the perceived network of the publicly traded Australian banks and their connections to the domestic financial sector, real economy and international markets. We also investigate time evolution of the network. We find strong links between the big four Australian banks and the other sectors of the economy and determine how shocks to other sectors and international markets transmit to the Australian banking system.

Damon Centola¹

¹Annenberg School for Communication & School of Engineering, University of Pennsylvania

The Origins of Social Order: New Theory and Experiments

Social conventions are the foundation of social cooperation and productive economic activity, yet very little is known about how and when they form. Prominent theories argue that widely shared social conventions depend up on coordinating mechanisms, such as incentives for global coordination, aggregated information, and social leadership. We explore a competing evolutionary theory of conventions, which hypothesizes that broad social coordination can emerge without any of these mechanisms. We use an Internet experiment to study the real-time evolution of endogenous collective behaviors from a state of nature in which there are an infinite number of possible conventions and no incentives for global coordination. Our results confirm our formal hypotheses, demonstrating that changes to network connectivity can generate the spontaneous formation of global social conventions. The results have unexpected implications for the evolution of collective behaviors in the expanding online domain.

Elsa Guillot¹

¹Institute of Fundamental Sciences, Massey University

Modelling the Influence of Human Social Rules on Population Genetics

Historically humans have lived in small society ruled by stringent marriage rules. Constraining the female and male migration flow between populations these mating systems have a complex effect on the genetics of population. Using simulations we are able to explore the impact of marriage rules on genetic diversity. We also present an investigation into reconstructing the historical mating system from modern genetics.

Shaun Hendy¹ and **Dion O’Neale**¹

¹ Department of Physics and Te Pūnaha Matatini, University of Auckland

Regional Innovation Favours the Diverse

The economic geography of innovation is dominated by the interplay of spillovers. These occur when innovators generate new knowledge that in turn facilitates innovation by others, and by agglomeration effects. Here we analyze over 30 years of patent data from the European Patent Office to investigate patterns of regional specialisation in different technical areas. To do this we make use of International Patent Classification codes. We construct a bipartite network of over 4000 geographic regions and over 600 areas of technology. We find that those regions that exhibit capability in a larger number of technical areas tend to, on average, have less ubiquitous technologies in their patent portfolio than regions with less technical diversity. Furthermore, we find that this effect increases over time with low diversity regions holding patent portfolios whose contents become relatively more ubiquitous. We use a number of null models to distinguish between intra-regional effects due to spillovers and agglomeration and effects due to exogenous factors, such as regional populations and the relative abundance of different technology codes.

Matt Jackson¹

¹ Department of Economics, Stanford University

Identifying Central Individuals in Networks and Diffusion Processes

How can we identify the most influential nodes in a network for initiating diffusion? Are people able to easily identify those people in their communities who are best at spreading information, and if so How? Using theory and recent data, we examine these questions and see how the structure of social networks affects information transmission ranging from gossip to the diffusion of new products. In particular, a model of diffusion is used to define centrality and shown to nest other measures of centrality as extreme special cases. Then it will be shown that by tracking gossip within a network, nodes can easily learn to rank the centrality of other nodes without knowing anything about the network itself. The theoretical predictions are consistent with data from rural India.

Jonathan Newton¹

¹University of Sydney

The Evolution of Shared Intentions

It has been hypothesized that the evolution of modern human cognition was catalyzed by the development of jointly intentional modes of behaviour. From an early age (1-2 years), human infants outperform apes at tasks that involve collaborative activity. Specifically, human infants excel at joint action motivated by reasoning of the form we will do X (shared intentionality), as opposed to reasoning of the form I will do X [because he is doing X] (individual intentionality). The mechanism behind the evolution of human shared intentionality is unknown. Here we formally model the evolution of jointly intentional action and show under what conditions it is likely to have emerged in paleolithic man. Modelling the interaction of paleolithic hunter-gatherers as a coordination game, we find that when the benefits from adopting new technologies or norms are low but positive, shared intentionality does not evolve. When the benefits from adopting new technologies or norms are high, such as may be the case during a period of rapid environmental change, shared intentionality evolves and rapidly becomes dominant in the population. Our results shed new light on how humans evolved into the collaborative species we are today.

Tava Olsen¹

¹Information Systems and Operations Management, University of Auckland

Modelling Emergency Department Patient Flows

We discuss how to model the flow of patients through emergency departments, with a particular focus on modelling patients who leave before being seen by a physician. Using operational data from a hospital emergency department, we examine three key factors that affect a patients propensity for leaving the waiting area without being seen by a physician (LWBS), namely, waiting time, queue-length, and service rate. These factors are chosen for both for their appeal as drivers of abandonment, as noted in previous literature, and also their modelling tractability. The factors are shown to interact with each other in a non-linear fashion. We use these findings to make recommendations for simulating patient flows in general and LWBS behaviour in particular. Further, we discuss the state-of-the-art for existing queueing models of such systems and translate how our findings affect the utility of these models; the results point to the need for further queueing model development.

Sergey Ozernikov¹

¹Mathematics Department, University of Auckland

Axiomatic Approach to Trust Metrics in Certification Networks

Public Key Infrastructure (PKI) is an arrangement that provides its users with means for confident and effective utilisation of public-key cryptography. Certification network is one of the main parts of it, which can be described as a directed graph with the vertices representing users' certificates and edges - signatures, the acts of certification. A user A of a PKI before sending a message to another user X must calculate the validity of the other user's certificate using the public information about the network and their private information about the trustworthiness of the users on the certification paths from A to X . This is normally done on the basis of the so-called trust metric. Apart from x.509 and Pretty Good Privacy (PGP), which are widely deployed in practice, numerous other trust metrics exist.

In this talk axiomatic approach to the study of trust metrics will be presented, covering both normative and descriptive perspectives. Axiomatic basis and pertinent representation theorems for x.509 and PGP trust metrics will be given. A number of classic Social Choice axioms, which may denote some desirable properties of a trust metric (e.g., attack resistance), will be formulated in our framework. Further research directions, including criteria of comparison of trust metrics and complexity of the algorithms of their calculation will be presented.

Matthew Ryan¹

¹ Department of Economics, Auckland University of Technology

Binary Choice Probabilities on Mixture Sets

Experimental evidence suggests that choice behaviour has a stochastic element. Much of this evidence is based on studying choices between lotteries – choice under risk. Binary choice probabilities admit a strong utility representation (SUR) if there is a utility function such that the probability of choosing option A over option B is a strictly increasing function of the utility difference between A and B. Debreu (1958) obtained a simple set of sufficient conditions on binary choice probabilities for the existence of a SUR. More recently, Dagsvik (2008) considered binary choices between lotteries and provided axiomatic foundations for a SUR in which the underlying utility function is linear (i.e., conforms to expected utility). Our paper strengthens and generalises Dagsvik's result. We show that one of Dagsvik's axioms can be weakened, and we extend his analysis to encompass choices between uncertain prospects, as well as various non-linear specifications of utility.

Isabelle Sin¹

¹ Motu Economic and Public Policy Research, and Te Pūnaha Matatini

People, Books, and Flows of Knowledge

Knowledge is central to the behaviour of individuals and firms at the micro level, and the performance of economies at the macro level. Arguably as important as the processes and incentives that shape the creation of new knowledge are those that affect the diffusion of knowledge, both between societies and within societies to the

individuals or organisations that can make use of it. Knowledge may be transmitted by people or carried in other storage devices; movements of these provide measures of knowledge flows that can be analysed empirically. An alternative empirical approach is to infer knowledge flows by studying their effects. I will discuss some recent research that approaches the issue of knowledge diffusion from several disparate angles: what flows of book translations can tell us about knowledge flows between countries; how employees past experiences affects their firms activities; and how individuals social networks affect where they choose to live and their labour market outcomes.

Catriona Sissons¹

¹Department of Physics, University of Auckland

Collaboration Networks for Innovation

There has been significant recent interest in collaboration networks, for example networks of co-authors for scientific collaborations. Here we use a database of millions of patent records to construct a network of co-applicants (i.e. organisations who have filed a patent application together). We find that the network has a largest connected component (LCC) which contains around 10% of all applicants. The applicants in the LCC are highly productive, accounting for over 2/3 of all patents that are filed. We investigate how some properties of this network evolve over time.

Adam Clearwater¹, Clemens Puppe² and Arkadii Slinko¹

¹University of Auckland

²KIT, Germany

The Single-crossing Property on Median Graphs

We generalize the classical single-crossing property to single-crossing property on median graphs. Examples of median graphs are trees and grid graphs. We assume that agents are located at the vertices of a median graph and each is endowed with a linear preference order over a set of alternatives A . The single-crossing property stipulates that if two agents situated at vertices U and V agree on their assessment of two alternatives, say a and b , then all voters on the shortest path between U and V also agree with them in assessment of these alternatives.

For such a society the majority relation is always transitive, hence the respective linear orders form the so-called Condorcet domain. Condorcet domains are sets of linear orders which possess the property that every profile composed from those orders have transitive majority relation. We show that maximal Condorcet domains are single-crossing on a certain median graph. We also prove that for any median graph there exist profiles that are single-crossing on that graph and we provide a polynomial-time algorithm to recognize whether or not a given profile is single-crossing with respect to some median graph. We also show that finding winners for the NP-hard Chamberlin-Courant rule is polynomial for profiles that are single-crossing on median graphs.

Jose Rodrigues-Neto¹ and James Taylor¹

¹ The Research School of Economics, Australian National University

Cycles and Common Priors Without Full Support

When analyzing the possibility of common prior existence, most of the literature focuses only on common priors with full support. This paper extends the cycles approach of Rodrigues-Neto, (J Econ Theory, 2009 and J Math Econ, 2012) used for checking common prior existence to the case of common priors without full support, characterizes the models where a common prior (with any support) exists, and computes the maximal support for a common prior. Checking all cycle equations is still a sufficient condition for the existence of a common prior even when priors and posteriors of some states may be zero. However, this is no longer a necessary condition.

Richard Vale^{1,2}

¹Inland Revenue Department

²University of Canterbury

Imputing Attitude Scores on a Network

Presented with a network and information about the “attitude” of some of the nodes, a scalable algorithm is desired which imputes the attitude of the others. The problem is complicated by an air of mystery surrounding the data and the purpose of the algorithm. A model-based approach is described, which gives a neat way to quantify the uncertainty in the imputed scores. The client is satisfied.

François Vallee¹

¹Institute of Fundamental Sciences, Massey University

Modelling History in Islands of Southeast Asia

The history of human settlement in the geographical region between mainland Asia and New Guinea is multifaceted and complex. From the first wave of Melanesian populations, which arrived around 45 thousand years ago, to a second movement of Asian groups around 4 thousand years ago, an unexpected pattern has emerged in terms of population admixture. We have a particular interest in the second wave (from 4000 years ago to the present). Our focus is on genetic studies that have revealed a steep ancestry cline from west to east, suggesting that human migrations could have been influenced by geographical, demographic and social factors. We are particularly interested in how social behavior and technological advantage might have affected prehistoric human movements. To answer this question, we are designing an agent-based model (ABM) to simulate the colonisation of this island world by humans. This model allows us to model the movements of individual humans on a geographical map, reproducing behaviors such as marriage rules and social advantages. Thus we will be able to understand the influence of each aspect of the model and which one, or more likely which combination has produced the genetic pattern we observe today.

Patrick Girard¹, **Valery Pavlov**² and **Mark C. Wilson**³

¹Philosophy Department, University of Auckland

²Information Systems and Operations Management, University of Auckland

³Computer Science Department, University of Auckland

Experimental Study of Belief Diffusion

We report on exploratory studies using laboratory experiments with human volunteers, designed to elicit discrete beliefs (“yes”, “no”, “dont know”) about factual questions. Our preliminary results indicate that: diffusion does indeed occur; violations of rationality occur, but not often; the type of question (logic- or experience-based) matters; crowds can sometimes be less wise than individuals. Our future goals include refining the analysis and considering specific models such as the linear threshold model.