



# AUSTRALIAN SOCIAL NETWORK ANALYSIS CONFERENCE (ASNAC) 2023



**27–29 November 2023**

**University of New South Wales  
Sydney, Australia**

<https://www.ansna.org.au/asnac2023>



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## ASNAC

The Australian Social Network Analysis Conference (ASNAC) is an annual multidisciplinary conference organised by the Australian Network for Social Network Analysis. It seeks to bring together social network researchers from Australia, New Zealand, and the greater Asia-Pacific region.

## ANSNA

The Australian Network for Social Network Analysis (ANSNA) aims to build greater coordination and collaboration among social network researchers and practitioners in Australia and overseas and raise the profile of Australian social network research nationally and internationally.

<https://www.ansna.org.au/>

## Organising committee

Pavel Krivitsky (chair, UNSW)   Kirsten Martinus (UWA)  
Peter Braunsteins (UNSW)   Dan Chamberlain (La Trobe)

### *Student members*

Arya Karami (Sharif)   Yunhe Pan (UNSW)

## Awards committee

Lucia Falzon (Adelaide)   Margaret Hellard (Burnet)  
Garry Robins (Melbourne)   Dan Chamberlain (ASNAC Board rep., La Trobe)

## Acknowledgements

The Organising Committee thanks the School of Mathematics and Statistics at UNSW and its staff members, including Ms Suzie Scandurra, Ms Jan Lin, Ms Kaye Sedgers, Mr Benjamin Lyall, Ms Susannah Waters, Ms Jing Xie, Mr Yohans Bastian, Mr Christian Bagshaw, Mr Alexander Gilbert, and Prof Frances Kuo; and the Faculty of Science at UNSW and its staff members, including Ms Merrin Browne and Ms Marjorie Fox-Owens, for helping organise and supporting this conference.

We acknowledge the Bedegal people, who are the Traditional Custodians of the Land on which this conference takes place, and pay respects to Elders past and present.

# Useful Information

## Contact

asnac2023@unsw.edu.au

## Venue and Directions

The conference sessions will take place in the **Anita B. Lawrence Centre (H13)**. Note that the centre has two wings; please use the east entrance, indicated on the map on the next page.

**Room 4082** Announcements, keynotes, oral presentations, and panels

→ Take lift or stairs up to the 4th floor, then walk all the way down the hallway to your left.

**Room 3082** Poster session and refreshments

→ Take lift or stairs up to the 3rd floor, then walk all the way down the hallway to your left.

*Workshop locations will be provided to the registrants individually.*

Nearby public transit includes:

**Bus:** lines 303, 348, 358, 399, 397, 399, 370, 390X, 396, and others

**Light rail:** L2 Randwick line UNSW High St stop and L3 Kingsford line UNSW Anzac Parade stop

## Refreshments

*If attending in person, please indicate any dietary needs and restrictions you may have during registration. If you have not done so, please contact the organisers at [asnac2023@unsw.edu.au](mailto:asnac2023@unsw.edu.au) as soon as possible.*

The following meals and refreshments will be provided:

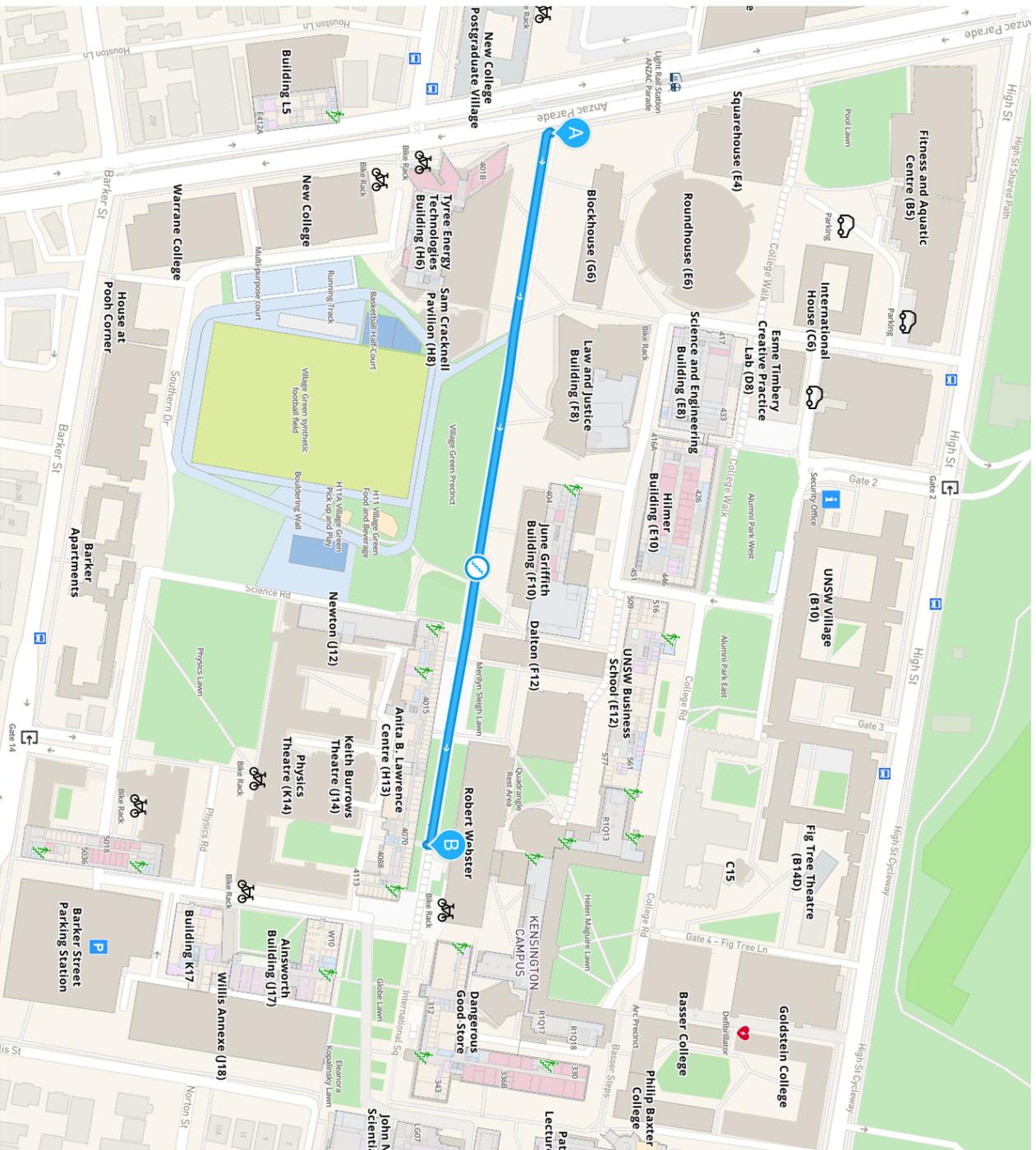
- Morning tea, lunch, and afternoon tea will be provided at the 27–28 November sessions.
- Non-alcoholic drinks and finger foods will be provided at the poster session on 27 November.

## Other resources

**Wi-Fi** is available via the eduroam network (unrestricted) and UNSW Guest network (restricted).



- A** UNSW Campus Main Entrance
- B** Anita B. Lawrence East Entrance



# Timetable

## Monday, 27 November

9:00	<b>Registration</b>	
9:15	<b>Opening remarks</b>	
9:30	<b>Mark S. Handcock</b> UCLA	<i>Keynote:</i> Some New Models for Social Networks
10:30	<b>Morning tea</b>	
11:00	<b>Theory and Methods I</b>	
	<b>Garry Robins</b> Melbourne, Swinburne	Multi-Level Networks: Duality and Individualism
	<b>Jonathan Januar</b> Melbourne	Representing Missingness in Covert Network Data with Missing Data Models
	<b>Kevin Pan</b> UNSW	Model Based Estimation of the Graph Total from a Sample
	<b>Francesco Bailo</b> Sydney	Measuring Information Disorder
	<b>Li Guan</b> UTS	Applying Social Network Analysis to Risk Management of Complex Projects
12:30	<b>Lunch</b>	
13:30	<b>Health and Wellbeing</b>	
	<b>Dean Lusher</b> Swinburne	Effective Networks in Schools
	<b>Rebecca R. Langdon</b> Queensland	We Built This Network: Analysing Construction Worker Egonets for Social Support and Psychological Distress
	<b>Theory and Methods II</b>	
	<b>Malcolm Alexander</b> ACSPRI	From Surveys to Network Visualisation: The Challenges of Egonet Research Methods
	<b>Pavel N. Krivitsky</b> UNSW	Generalised Method of Moments Estimation for Exponential-Family Random Graph Models

## Monday, 27 November (continued)

14:40	<b>Afternoon tea</b>	
15:10	<b>Environment and Governance</b>	
	<b>Petr Matous</b> Sydney	Formal and Informal Emergency Network Structures: A Comparison of Three Australian Community Responses to Disasters
	<b>Bridget McGlynn</b> QUT	Navigating Complexity and Effectiveness: A Study of Collaborative Decision-Making in Flood Planning
	<b>Vitor Hirata Sanches</b> ANU	Navigating Governance Networks for Forest Landscape Restoration: Insights from Brazilian Atlantic Forest Watersheds
	<b>Michele L. Barnes</b> James Cook	'Bunkering Down': How Communities are Tightening Social-Ecological Network Structures in the Context of Global Change
16:20	<b>Poster session set-up</b>	
16:30	<b>Poster session</b>	
- 17:30	<b>Francisca Borquez</b> ANU	Exploring Decentralised Online Social Networks: The Case of Mastodon
	<b>Arya Karami</b> Sharif	Application of Nonparametric Approaches for Change Point Detection in Social Networks
	<b>Stephen Ong</b> Sydney	Stakeholder Network Variables and Factors: A Performance Analysis
	<b>Tracey Potts</b> ANU	Knowledge Networks of Farmers in the Central Tablelands of NSW
	<b>John Salazar</b> Sydney	Corruption in Networks of Infrastructure Concession Programs

## Tuesday, 28 November

9:00	<b>Opening remarks</b>	
9:05	<b>Award presentations</b>	
9:20	<b>Johan H. Koskinen</b> Stockholm	<i>Pip Pattison Award Lecture:</i> Causality, Networks, and the Titanic
10:20	<b>Morning tea</b>	

## Tuesday, 28 November (continued)

10:50	<b>Networks in the Humanities</b>	
	<b>Trisnasari Fraser</b> Melbourne	The Role of Homophily, Diversity Ideology and Music Collaboration in Resolving Tensions Between Community and Diversity
	<b>Tayla Newland</b> Melbourne	Social Network Dynamics in pre-Roman Italy: Approaching New Digital Methodologies
	<b>Business and Innovation I</b>	
	<b>Patience P. Gambah</b> Kumasi Technical	Local Trade Networks among Farmers and Traders
	<b>Dan Chamberlain</b> La Trobe	Locating Power in Inter-Organisational Collaboration
	<b>Shakir Karim</b> Sydney	Network Effects on Healthcare Providers' Cost Performance
	<b>Peng Wang</b> Swinburne	Organizational Vocabularies and Interpersonal Trust in Organisations: A Multilevel Network Perspective.
12:30	<b>Lunch</b>	
13:30	<b>Business and Innovation II</b>	
	<b>Colin Gallagher</b> Melbourne	Interorganisational Collaboration in the HIV/Hepatitis C Sector: An Application of Bayesian ERGM
	<b>Jin Xue</b> Sydney	An Integrated Topic-Network Model for Stakeholder Management in the Dynamic and Complex Mega Infrastructure Projects
	<b>Kirsten Martinus</b> UWA	Navigating Danger: Knowledge Flows across Refinery Crews and Workers
	<b>Online Networks</b>	
	<b>Robert Ackland</b> ANU	Identifying Echo Chambers in Political Discussion Networks on Twitter
	<b>Xiaolan Cai</b> Canberra	Researcher Contributions to R Packages Development: Evidence from GitHub
15:00	<b>Afternoon tea</b>	

## Tuesday, 28 November (continued)

15:30	<b>Panel discussion</b>
	<p>Michele Barnes (moderator), Robert Ackland, Malcolm Alexander, Johan H. Koskinen, Dean Lusher</p> <p>Teaching Social Network Analysis</p>
16:50	<b>Closing remarks</b>

## Wednesday, 29 November

9:00	<b>AM Workshops (contemporaneous)</b>
- 12:00	<p><b>Peng Wang</b> ERGM Analysis for Multilevel Networks with MPNet</p> <p><b>Malcolm Alexander, Rebecca R. Langdon</b> Survey and Interview Methods in Social and Personal Network Research (Egonets)</p> <p><b>Pavel N. Krivitsky</b> Introduction to ERGMs with Statnet</p>
12:00	<b>Lunch (on your own)</b>
13:00	<b>PM Workshops (contemporaneous)</b>
- 16:00	<p><b>Robert Ackland</b> Collecting and Analysing Online Networks with VOSON R tools</p> <p><b>Pavel N. Krivitsky</b> Advanced Exponential-Family Random Graph Modelling with Statnet</p> <p><b>Johan H. Koskinen</b> Estimating Auto-Logistic Actor Attribute Models in R</p>

# Keynotes

## Some New Models for Social Networks

**Mark S. Handcock**

University of California, Los Angeles, CA, USA

Exponential-family Random Graph Models (ERGMs) have long been at the forefront of the analysis of relational data. The exponential-family form allows complex network dependencies to be represented. Models in this class are interpretable, flexible and have a strong theoretical foundation. The availability of powerful user-friendly open-source software allows broad accessibility and use. However, ERGMs sometimes suffer from a serious condition known as near-degeneracy, in which the model exhibits unrealistic probabilistic behavior or a severe lack-of-fit to real network data.

As such we need new models that build on the ERGM class while expanding their range. In this talk I will consider three such classes of models. The first is the Tapered ERGM class, which circumvents the issue of near-degeneracy while maintaining the desirable features of ERGMs. The second is the class of Exponential-family random network models (ERNM) that are capable of specifying a joint statistical representation of both the ties of a network and individual attributes. This class of models allow the nodal attributes to be modeled as stochastic processes, expanding the range and realism of exponential-family approaches to network modeling. The third is the Latent Order Logistic (LOLOG) model class that is based on a latent dynamic network formation process. Each of these classes is due to work by Ian E. Fellows. As one application of these classes, I will show how the ERNM class leads to a model for causality in a networked population when the underlying network is endogenous.

This is joint work with Ian E. Fellows, Bart Blackburn and Duncan A. Clark.

Mark S. Handcock is Distinguished Professor of Statistics in the Department of Statistics and Data Science at the University of California, Los Angeles. His work focuses on statistical models for social networks, the development of statistical methodology for the collection and analysis of social network data, surveying of hard-to-sample populations, spatial processes and demography. His research is based largely on motivation from questions in the social sciences, social epidemiology and environmetrics. For details, see his web page <https://faculty.stat.ucla.edu/handcock>.

## ***Pip Pattison Award Lecture***

### **Causality, Networks, and the Titanic – Why did Jack die, did he have to die, and when would he have died?**

***Johan H. Koskinen***

University of Stockholm, Stockholm, Sweden

You could argue that the basic tenet of policy in research is answering what the effect of a specific intervention would be on an outcome. This notion relies on the classic principles of experiments, where you have a treatment and a control. The history of methodological research for observational studies is by and large the history of attempting to emulate the classical notion of causal effects under non-experimental conditions - in the wild. The key to succeeding in this endeavour is to account for that which we can no longer control in the wild, the potential competing explanations, or endogeneities. If we can account for these endogeneities, we can indirectly measure the causal effect of a treatment/intervention and interpret it as a change in the outcome induced by some treatment variable. Network research is, by definition, the scientific study of endogeneities – we are interested in the contingencies of ties – the very phenomenon that the classic causal framework is trying to explain away. In network research, neither do we seek to generalise from outcomes to the population that the outcome represents. So, is there any hope for policy-relevant network research or are we doomed to revert to “mothering statements” and post-hoc explanations? In order to even begin to address this question, we need to ask ourselves what the relevant ‘outcome’ is, whether we are talking about individuals or systems or processes, but we also need to ask ourselves what the counterfactuals actually mean. For this discussion, we will take as our point of departure, the question of whether ‘the network’ had any ‘effect’ on who survived the Titanic.

Johan obtained his PhD in statistics at Stockholm University, working on Bayesian estimation for statistical models for social networks under the supervision of Ove Frank. He has largely continued in this area, for example proposing approaches for handling missing network data and techniques for likelihood-based inference for network panel data of different types. Together with colleagues in Melbourne, he edited a book on exponential random graph models that has become the standard reference in the field. He previously has held positions at the universities of Melbourne, Oxford, and Manchester and is currently holding a position in the Department of Statistics at Stockholm University. In-between stints being employed at the University of Melbourne, he has been a reliable visitor to these shores, maintaining an honorary position throughout, and he keeps up close collaborations with the Australian network community. He has been in Melbourne for every Ashes Boxing day test since the 2006/7 series. Throughout his career he has maintained an interest in fundamental network issues, such as how we can represent networks, what network dependencies are, and how many observations we have in a network.

# Invited Panel Discussions

## Teaching Social Network Analysis

*Michele Barnes*<sup>1</sup> (moderator), *Robert Ackland*<sup>2</sup>, *Malcolm Alexander*<sup>3</sup>, *Johan H. Koskinen*<sup>4</sup>, and *Dean Lusher*<sup>5</sup>

<sup>1</sup> James Cook University, Townsville, QLD, Australia, <sup>2</sup> Australian National University, Canberra, ACT, Australia,

<sup>3</sup> Australian Consortium for Social and Political Research Incorporated, Alphington VIC, Australia, <sup>4</sup> University of Stockholm, Stockholm, Sweden, <sup>5</sup> Swinburne University of Technology, Swinburne, VIC, Australia

Growing the community of social network researchers in Australasia means teaching the theories, methods, and analytical techniques to a new set of researchers. Our panel will discuss the challenges involved in making SNA accessible to people new to the field, including undergraduate and postgraduate audiences with little research experience, researchers with specific projects or tools in mind, and researchers interested in the field of social network analysis. The panel will discuss issues around engaging universities and researchers more broadly, looking at how we as a community of researchers can highlight the value in learning about SNA.

## Oral Presentations

### Theory and Methods

#### Multi-Level Networks: Duality and Individualism

Garry Robins<sup>\*,1,2</sup>

<sup>1</sup> University of Melbourne, Melbourne, VIC, Australia, <sup>2</sup> Swinburne University, Melbourne, VIC, Australia

Methodological individualism, despite its continuing grip in some social science disciplines, is the antithesis of network theory. Breiger's (1974) arguments about duality are a lucid network-based response to the postulates of individualism. With developments in multi-level network theory, these arguments can be extended beyond the bipartite focus of Breiger to multi-level networks, permitting different types of relational action at different levels. I argue that this approach dovetails with recent critiques of methodological individualism, emphasizing multiple levels of description. The conjunction or disjunction between higher and lower-level realizations and causality is an essential element of these critiques.

Certain social systems strongly embody duality. The higher levels (i.e., the groups in Breiger's account) only act based on what is determined at the lower level (the individuals). Even so, group action is still not necessarily reducible to a simple aggregation of individual behaviors. For instance, government policy in a parliamentary democracy may be totally determined by the individuals within a ministerial cabinet. Yet a major government action (e.g., going to war) is nevertheless a single act by a state, more than just aggregated individual actions, and has explanatory and causal force in its own right. This point emphasizes the need for multiple levels of description. Here we have a situation of what might be called "tight" duality, where the action at one level is completely determined by the action at the other, yet is not reducible to that. Duality here is an understanding of the conjunction of social process and social structure.

But there are systems of association that go beyond group memberships, where duality is "looser". In social ecological systems, such as a fishery system, action at the ecological level (e.g., a food web) is not fully determined by the other level (the fishers), but nevertheless the ecological system is affected – often dramatically – by the actions of the fishers; and vice versa. Here, single level causality is not a sufficient explanation, for cross-level outcomes and processes come into play.

A multi-level network itself can be analyzed at multiple levels (locally, cross-level, globally), mirroring a classical micro-meso-macro understanding. This permits a kind of multi-multilevel network analysis, where cross-level network configurations represent social processes that affect global system outcomes. Although "tight" duality may not apply, the insight that Breiger's duality brings to these looser systems is fundamental: explanation, understanding, and description cannot be reduced to individual responses or to a single level.

**Keywords:** Multi-level networks, duality, methodological individualism

#### Representing Missingness in Covert Network Data with Missing Data Models

Jonathan Januar<sup>\*,1</sup>, Johan Koskinen<sup>2</sup>, Colin Gallagher<sup>1</sup>

<sup>1</sup> University of Melbourne, Melbourne, VIC, Australia, <sup>2</sup> Stockholm University, Stockholm, Sweden

Missing data is a prominent issue wherever data are collected and is an especially notable problem when dealing with covert network data. On top of the possibility of inaccurate inferential claims resulting from missing tie information, as covert networks are involved in secretive activities, conventional data collection

methods cannot be used. As a result, covert network researchers usually construct a possible version of the covert network through secondhand observations of the covert network. These can be through criminal justice records, qualitative interviews, or working with surveillance organisations. Regardless, it is evident that covert network data are mired in many observational biases from multiple stakeholders.

This project aims to discuss the considerations and nuances of missing data in covert networks. By acknowledging the various sources of observational biases when covert networks are constructed with data available to covert network researchers, we can more accurately represent how missing data occur in covert network data. We propose to represent these observational biases using statistical models representing missingness, or conversely observation, of the covert network data.

Multiple candidate network models were used to simulate missingness mechanisms. These models included increasingly complex dependency assumptions to represent possible sources of observational biases in the process of constructing a covert network. These models were specified to simulate a variety of missingness assumptions missing-at-random and missing-not-at-random on top of various dependencies between missing tie variables. After simulating possible missingness mechanisms, they were used to deplete different covert network datasets. Various metrics of the degraded covert networks were calculated and compared to the true networks. These degraded networks were also re-estimated with an ERGM to identify biases in model parameter estimates.

**Keywords:** missing data, covert networks

## **Model Based Estimation of the Graph Total from a Sample**

**Kevin Pan<sup>\*,1</sup>, Pavel N. Krivitsky<sup>1</sup>, Feng Chen<sup>1</sup>**

<sup>1</sup> University of New South Wales, Sydney, NSW, Australia

The size of large networks, combined with data collection constraints, may make it infeasible to observe all the relations. We consider incomplete observation of networks generated under an Exponential Random Graph Model and propose methods for estimation of the graph total from a sample. Techniques for estimation of the Graph Total goes back to Frank (1977); there, the Horvitz-Thompson estimator was introduced in the design based setting. By contrast, we focus on estimation under in the model based sampling framework. In this framework, the model is assumed, but its parameters are unknown. For a network generating model with block structure, we introduce and derive the Best Linear Unbiased Predictor, which is the minimal variance estimator in the class of linear unbiased estimators. More generally, under an ERGM we propose a point estimate of the graph total and present a variance estimate from the sample.

**Keywords:** network sampling, missing data, Exponential Random Graph

## **Measuring Information Disorder**

**Francesco Bailo<sup>\*,1</sup>**

<sup>1</sup> University of Sydney, Sydney, NSW, Australia

In this paper, I introduce a robust framework for quantifying 'information disorder' within diverse information spaces, detailing its measurement methodology and demonstrating its applicability through two case studies. I define 'information disorder' as the probability of encountering consistent information for effective decision-making. An 'information space' is conceptualised as a multilayer graph, where each node signifies semantic content, such as a sentence in a Wikipedia article or a social media post.

Nodes within this graph are connected through four types of edges that signify 1) agreement, 2) disagreement, 3) redundancy (i.e. equivalence), and 4) shared reference (i.e. pointing to the same domain/content). We calculate the disorder metric based on a weighted sample of content, where weights are determined by the (approximated) probability that a recommender system will serve the content. This sampling approach not only reduces computational effort but also enables assessment when full data access is unavailable (which, of course, is generally the case).

The density of each layer of the multilayer graph resulting from the sampling is used to compute a measure

of information disorder using this simple formula: (agreement - disagreement) + redundant + SameSource. By definition, a negative score will indicate information disorder, as conflicting information outweighs concordant and redundant information and the presence of common sources. The same sample is also used to measure the degree of singularism and pluralism, providing additional insights about information diffusion within an information space. The degree of singularism/pluralism is computed by dividing the number of communities of a graph resulting from flattening the agreement, redundant and SameSource layers by the number of nodes. A value approaching zero will indicate extreme pluralism, and conversely, a value approaching 1 extreme singularism.

We apply this methodology to assess information disorder at multiple time points in different information spaces: the entire English Wikipedia at the onset of the COVID-19 pandemic and selected Reddit threaded conversations. The relations between semantic content nodes needed to define layers 1), 2) and 3) are coded using the text-embedding-ada-002 through OpenAI's API using this prompt: "Considering their meaning, are the following two sentences in agreement, disagreement, or equivalent?". Instead, the relations of layer 4) are defined by comparing the domain of the embedded URLs (when present).

A measure of the disorder of an information system like a social media platform that is scalable because automatically generated leveraging the growing capabilities of LLMs is useful as it allows monitoring in near-real-time the overall health of an information space. But it becomes critical during an information crisis (e.g. a pandemic or an election) when disorders can cause severe harm to people and institutions.

**Keywords:** Internet, Semantic networks, Misinformation

## Applying Social Network Analysis to Risk Management of Complex Projects

Li Guan<sup>\*,1</sup>, Alireza Abbasi<sup>2</sup>, José M. Merigó<sup>1</sup>

<sup>1</sup> University of Technology Sydney, Sydney, NSW, Australia, <sup>2</sup> University of New South Wales, Canberra, ACT, Australia

A complex project, characterised by large number of activities and stakeholders involved, capital-intensive investments, and intricate interactions among the project elements, is potentially exposed to numerous risks throughout a project life cycle. In such case, project risks are usually interdependent, represented by cause-effect relationships among interrelated risks. However, traditional risk management methods mainly based on the Probability-Impact risk model cannot account for risk interdependencies and risk propagation behaviour, leading to inaccurate project risk assessment (PRA) results and subsequently, reduced efficacy of risk treatment actions. To assure the success of complex projects, an effective risk management practice must be able to model and analyse interdependent risks from a "systems thinking" perspective. The Social Network Analysis (SNA) has gained increasing attention in the project risk management research to help with analysing the structure and pattern of relationships among project risks. This work aims to develop an SNA-based PRA model to support decision-making processes in risk evaluation and risk treatment, where the SNA method is tailored properly to the analysis of a project risk interdependency network (RIN). Firstly, the Interpretive Structural Modelling process is adopted to develop a hierarchical project RIN, where possible risk loops are also presented. Then, to evaluate risk paths more appropriately, we replace the "distance" concept in SNA with "path probability strength" represented by the product of transition probabilities associated with all the edges in one risk path. A series of risk indicators are thus proposed. Specifically, a weighted edge betweenness centrality is devised to evaluate the importance of a risk interdependency; risk betweenness centrality is used to globally measure the importance of a risk from the level of control over the influence passing through it; and risk structural centrality is proposed for the first time to comprehensively measure the global structural importance of a risk within a project RIN. Additionally, project local risk loss (LRL) and project global risk loss (GRL) are developed to evaluate the overall project risk, respectively, at local and global levels, considering risk occurrence probability and risk impact on project objectives. Based on the proposed risk indicators, the prioritisation results in terms of risks and risk interdependencies can equip project decision-makers with evidence to mitigate critical risks and weaken critical risk interdependencies

more effectively according to predefined risk attitude and risk appetite during the implementation of project risk treatment. Moreover, the performances of different risk treatment options are evaluated and compared through the reduced project LRL and GRL. An illustrative example is used to demonstrate the applicability and validity of the proposed approach for PRA and risk treatment in engineering practice.

**Keywords:** Risk interdependency network, Risk assessment, Risk treatment, Social Network Analysis, Interpretive Structural Modelling.

### **From Surveys to Network Visualisation: The Challenges of Egonet Research Methods**

**Malcolm Alexander<sup>\*,1</sup>, Rebecca R. Langdon<sup>2</sup>**

<sup>1</sup> Australian Consortium for Social and Political Research Incorporated, Melbourne, VIC, Australia, <sup>2</sup> University of Queensland, Brisbane, QLD, Australia

Egonet analysis focuses on examining the connections, relationships, and structural patterns within an ego's network of personal contacts, such as friends, family members, colleagues, or acquaintances. Egonet studies allow us to sample social relations within a whole population and explore the sociology of social networks across that population. Many egonet studies work from small scale population samples using face-to-face or computer assisted interviews. The implementation of self-administered surveys to collect large numbers of egonets is best done with established and popular survey tools (such as SurveyMonkey or Qualtrix). The collection of egonet data, particularly alter-alter relations, requires some coding that may be unfamiliar to many social researchers. We present our solutions for collecting egonet data using Qualtrics, its screening and cleaning, and the options for immediate analysis. We then describe how to import network data into E-net and, beyond that, into Ucinet and NetDraw and demonstrate the visualisations and network procedures made available this way. We believe these techniques will help and encourage social researchers to use egonet analysis to study the sociology of personal social networks.

**Keywords:** Egonet Data Visualisation, E-Net, Netdraw, Sociogram, Ucinet

### **Generalised Method of Moments Estimation for Exponential-Family Random Graph Models**

**Pavel N. Krivitsky<sup>\*,1</sup>, Andrew Murphy<sup>1</sup>**

<sup>1</sup> University of New South Wales, Sydney, NSW, Australia

Exponential-family Random Graph Models (ERGMs) possess the property that if their sufficient statistics are observed, we do not need to observe the actual network in order to fit the model. This has been exploited for both computational improvements and in inference, such as for some types of egocentrically sampled data in which it is not possible to observe the network itself or even a part of it but is possible to estimate the network statistics such as number of edges, mixing matrix, and the degree frequencies.

In this work, we consider a situation in which the sufficient statistics are not available but a set of statistics informative about the parameters are. This arises in a variety of scenarios; for example, when only censored degree (e.g., "list up to 5 friends") is observed.

An estimator for which observed statistics are not sufficient is a Generalised Method of Moments Estimator (GMME). It has previously been applied to Stochastic Actor-Oriented Models (SAOMs) and Separable Temporal ERGMs (STERGMs). We derive the properties of a GMME for an ERGM and propose a technique for computationally efficient estimation of for arbitrary identifiable combinations of sufficient and observed statistics and for quantifying the uncertainty in the estimate.

**Keywords:** ERGM, method of moments, estimation, censored data, inference

## Health and Wellbeing

### Effective Networks in Schools

*Dean Lusher*<sup>\*,1</sup>, *Ray Swann*<sup>2</sup>, *Peng Wang*<sup>1</sup>

<sup>1</sup> Swinburne University of Technology, Melbourne, VIC, Australia, <sup>2</sup> Brighton Grammar School, Melbourne, VIC, Australia

Male violence and negative treatment of women are global concerns that have gained much attention internationally, but particularly in Australia where a number of incidents have gained significant media coverage and public discussion. Schools are one social context in which boys and young men embody, contest and 'do' masculinity, making schools a key site for the construction of masculinities. This theoretical and empirical paper explores what constitutes effective network structures for the development of positive masculinities in the school context. We assert a range of structures we expect to see that would support a masculinity that is pro-gender equity, respectful and focused on academic achievement within a school environment. For example, if there was a pro-studious culture among students then we would expect to see high achieving students more highly nominated as friends within the friendship network. Using data collected in a private all-boys school, we apply exponential random graph models to a friendship network and a disrespect network for a year level of students to test if there is empirical support for the presence of these structures. Overall, our results show general support for a culture of a positive masculinity in the school we observed. We conclude with a discuss these results in regards to what constitutes effective network structures in schools for positive masculinities.

**Keywords:** network effectiveness, schools, ERGM

### We Built This Network: Analysing Construction Worker Egonets for Social Support and Psychological Distress

*Rebecca R. Langdon*<sup>\*,1</sup>, *Malcolm Alexander*<sup>2</sup>

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Construction workers have high suicide rates and previous research has indicated a relationship between low social support and higher rates of psychological distress. This study aimed to explore the statistical outcomes between social support and distress along with egonet data to provide data visualisation on the ego-centric relations in the provision of social support. Construction workers (N = 295) were categorised as either distressed (n = 116) or not distressed (n = 179) based on the cut-off scores according to the Kessler-10. Statistical analyses found higher average network closeness, more perceived emotional support, more practical support, and more overall emotional support for those who were not distressed. There were no statistically significant differences in network size or diversity for these workers. Egonets created using Ucinet Netdraw on a random selection of distressed and non-distressed workers to visualise differences in the networks were also conducted and are presented.

**Keywords:** Egonet, Social capital, Social network analysis, Social support, Sociogram

## Environment and Governance

### Formal and Informal Emergency Network Structures: A Comparison of Three Australian Community Responses to Disasters

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With weather-related disasters expected to increase in intensity and frequency under the changing climate, there is a growing recognition of the role that informal, self-organised / spontaneous networks play in supporting communities to respond to, and recover from, such adverse events. There is a need to understand, how these informal local networks emerge, relate to networks and organisations that pre-existed disaster events, get mobilised in different contexts and how these interact with the formal national emergency system. Drawing on interviews with individual actors and representatives of formal and informal organisations that emerged in response to 2019-2020 bushfires and 2020-2022 floods, we describe and compare the topologies of disaster response networks in three areas of New South Wales, Australia: Blue Mountains (58 organisations), Hawkesbury (59 organisations), and Northern Rivers (70 organisations). The interviewees were asked open-ended questions about their interactions in the aftermath of the recent floods and fires and about the nature of their pre-existing relations, which were then coded for analysis. The interviews revealed network actors' multiple roles across groups. We analysed the emergent network-level structural characteristics and compared centrality of different types of formal and informal organizations in these three contexts. We found high differences in the relative centralities of formal versus informal organizations in the three cases and high differences in the role of pre-existing relations and virtual platforms in mobilizing networks of spontaneous emergency response. These findings suggest different types of effective entry points for network interventions in different contexts. However, despite the diverse pre-existing relational structures in the three locations, and the differences in the type of actors in the respective cores of each network, the relational structures emerging through the disaster shocks had similar topological features in all three areas in terms of common network metrics. We combine the quantitative results with qualitative insights from the interviews to discuss strategies for better recognizing and fostering effective informal interorganizational collaboration, and to orchestrate improved formal-informal network interfaces in rural communities to face future external shocks in more resilient and just ways.

**Keywords:** disaster response, community networks

### Navigating Complexity and Effectiveness: A Study of Collaborative Decision-Making in Flood Planning

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Recommendations for further collaborative initiatives to address environmental challenges are plentiful. However, there is a subsequent caveat that more nuanced recommendations are needed to effectively utilize collaboration in different contexts. Addressing complex environmental challenges requires building relationships that will allow decision-making to reflect ecological complexity, institutional fragmentation, and operational logistics. Previous research has analyzed if and how collaborative networks align with the characteristics of the problem assigned to the network, such as watershed connectivity or policy interdependency (known as institutional or social-ecological fit). This research will incorporate both ecological and operational complexity through networks to examine the effectiveness of a decision-making system to address flood planning. A multilevel network was constructed from a collaboration network connected to a task-interconnectedness network, with additional sub-sets of the social network filtered by ecological

connectivity. This study will employ a network autocorrelation model to assess how structural and influence effects impact perceived effectiveness in addressing flood planning tasks. We postulate that collaborative relationships that reflect both ecological and task interconnectedness will increase effectiveness.

**Keywords:** multilevel network, network autocorrelation model, social-ecological fit

## **Navigating Governance Networks for Forest Landscape Restoration: Insights from Brazilian Atlantic Forest Watersheds**

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Forest landscape restoration (FLR) is an important action to mitigate climate change and help countries achieve their Nationally Determined Contributions (NDCs) to the Paris Agreement. Within this context, Brazil possesses vast expanses of potentially restorable land, having committed to an ambitious goal of restoring 12 million hectares in the Atlantic Forest biome by 2030. However, this poses a serious challenge from a governance perspective, as FLR takes place in both public and private domains and necessitates collaboration among stakeholders with divergent interests. This study uses social network analysis to examine the governance of forest landscape restoration across three watersheds in Brazil's Atlantic Forest region. Based on a literature review, participatory workshops, interviews with key stakeholders, and network analysis we mapped more than 100 actors and four networks in each region. These networks encompass financial transactions, information dissemination, monitoring, audit initiatives, and the provision of reforestation resources. This dataset enabled us to identify the main actors and initiatives of restoration within these regions. Moreover, through a comparative assessment, we have detected obstacles and prospects for upscaling restoration efforts within each region. Our findings underscore the importance of watershed management committees, local not-for-profit organisations, and private companies, each assuming distinct roles within the network. Furthermore, employing blockmodelling alongside a polycentric governance approach, we analyse whether the networks integrate actors from different types and scales, synergising responsibilities and information exchange.

**Keywords:** forest landscape restoration, governance, social network analysis, blockmodelling, centrality analysis

## **'Bunkering Down': How Communities are Tightening Social-Ecological Network Structures in the Context of Global Change**

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Complex networks of relationships among and between people and nature (social-ecological networks) play an important role in sustainability; yet we have limited empirical understanding of their temporal dynamics. Here we empirically examine the evolution of a social-ecological network in a common-pool resource system faced with escalating social and environmental change over the past two decades. We first draw on quantitative and qualitative data collected between 2002–2018 in a Papua New Guinean reef fishing community to provide contextual evidence regarding the extent of social and environmental change being experienced. We then develop a temporal multilevel exponential random graph model using complete social-ecological network data, collected in 2016 and 2018, to test key hypotheses regarding how fishing households have adapted their social ties in this context of change given their relationships with reef resources (i.e., social-ecological ties). Specifically, we hypothesized that households will increasingly form tight-knit, bonding social and social-ecological network structures (H1 and H3, respectively) with similar others (H2), and that they will seek out resourceful actors with specialized knowledge that can promote learning and spur innovation (H4). Our results depict a community that is largely 'bunkering down' and

looking inward in response to mounting risk to resource-dependent livelihoods and a breakdown in the collaborative processes that traditionally sustained them. Community members are increasingly choosing to interact with others more like themselves (H2), with friends of friends (H1), and with those connected to interdependent ecological resources (H3) – in other words, they are showing a strong, increasing preference for forming bonding social-ecological network structures and interacting with like-minded, similar others. We did not find strong support for H4. Bonding network structures may decrease the risk associated with unmonitored behaviour and help to build trust, thereby increasing the probability of sustaining cooperation over time. Yet increasing homophily and bonding ties can stifle innovation, reducing the ability to adapt to changing conditions. It can also lead to clustering, creating fault lines in the network which can negatively impact the community's ability to mobilize and agree on/enforce social norms, which are key for managing common resources.

**Keywords:** Social networks, agency, network exposure, climate change, adaptation

## Networks in the Humanities

### The Role of Homophily, Diversity Ideology and Music Collaboration in Resolving Tensions Between Community and Diversity

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Tensions between sense of community and cultural diversity were explored through a study of Australian musicians – an open boundary community that draws on complementary competencies for collaboration. As well as music collaboration ties and affiliations to different nationalities, cultural identities, music genres and instruments, consideration was given to musicians' beliefs about intergroup relations. Endorsement of three diversity ideologies were measured, including: multiculturalism – the idea that the traditions and values of people's cultural group memberships is a central aspect of appreciation for diversity; colourblindness – the idea that cultural distinctions should be downplayed; and polyculturalism – the idea that cultures interact and influence each other.

Recruitment to the study was via a snowball sampling approach with 120 musicians taking part and a network of over 1500 musicians detected through collaboration ties. Social network data visualisation captures multiple ways in which diversity is reflected in the community, based on objective, subjective and intersubjective features. Together with affiliations to hybrid cultural music genres, these variable features hint at the role of shared social practice and experiences in resolving tensions between community and diversity. Initial exponential random graph modelling based on a conditional estimate from two waves of the snowball sample (n= 613) suggests actor-relation effects associated with migrant status, speaking languages other than English, practicing the same genre and sharing organisational membership and geographical location.

Within the sample there was stronger endorsement for multiculturalism and polyculturalism, than for colourblindness. The modelling suggests musicians with similar opinions on polyculturalism tend not to play together, whereas musicians with similar opinions on colourblindness tend to play together. Given the distribution of responses to diversity ideology statements in this sample, a likely interpretation is that musicians who score low on colourblindness are more likely to play together, whereas musicians who endorse polyculturalism are open to playing with musicians supporting any of the three ideological positions.

Research into diversity ideologies has employed a range of observational and self-report measures to investigate their effect on intergroup contact and interaction, but this study makes a unique contribution to the literature using social network analysis to investigate their effect on relational ties.

**Keywords:** community, diversity, ideology, music, culture

### Social Network Dynamics in pre-Roman Italy: Approaching New Digital Methodologies

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In the context of ancient southern Italy, the study of burial goods has been coloured by long-held assumptions drawn from the Classical archaeological tradition. From trade and exchange to mobility and migration, the Greek and Italic communities of the region have been subject to an outdated interpretive framework that not only limits our understanding of their identities, but also obscures the connections between them. In the same vein, social interaction amongst these groups has largely been viewed through a Hellenised lens, and while network research has proliferated in recent years, south Italian archaeological data has seldom been subject to contemporary methods of digital analysis.

The following paper brings the study of Italian connectivity up to date through a systematic network analysis of mortuary data, spanning from 700-300 BC. Drawing together network science and spatial data, it seeks to identify networks between a diverse range of artefacts and burial sites, distributed from Campania in

the west to Puglia in the east. It also explores the application of the R programming language for social network analysis and visualisation, utilising a novel methodology to locate connections at various regional and interpersonal scales. While this research will shed light on social exchange across the ancient Italian peninsula, the broader project seeks to reconcile the social, geographic and agent-based factors that drove cross-cultural interaction in the ancient world. This paper, then, has the potential to contribute to the development of network analysis techniques in the broader archaeological discipline, and to enliven the current digital humanities landscape.

**Keywords:** Archaeology, Italy, artefacts, identity, interaction

## Business and Innovation

### Local Trade Networks among Farmers and Traders

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Both farmers and traders benefit from trade networking, which is crucial for the local economy. Therefore, it is crucial to understand how these networks operate, and how they can be managed more effectively. Throughout this study, we examine the economic networks formed between farmers and traders through the trade of food products. These networks are analyzed from the perspective of their structure and the factors that influence their development. Using data from 18 farmers and 15 traders, we applied exponential random graph models. The results of our study showed that connectivity, Popularity Spread, activity spread, good transportation systems, and high yields all affected the development of networks. Therefore, farmers' productivity and high market demand can contribute to local food-crop trade. The network was not affected by reciprocity, open markets, proximity to locations, or trade experience of actors. Policy makers should consider these five factors when formulating policies for local food-crop trade. Additionally, local actors should be encouraged to use these factors to improve their network development. However, it is important to note that these factors alone cannot guarantee success. Policy makers and actors must also consider other factors such as legal frameworks, economic policies, and resource availability. Our approach can be used in future research to determine how traders and farmers can enhance productivity and profit in West Africa. This study addresses a research gap by examining factors influencing local food trade in a developing country.

**Keywords:** Local Trade, Social Network Analysis, Food Trade, Exponential Random Graph Models (ERGM), Food Security

### Locating Power in Inter-Organisational Collaboration

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Any article on power is seemingly required to start with a statement about how hard it is to define power as a concept. While there are numerous texts discussing power and its different conceptualisations (Lukes 1974; Scott 2001), discussions of power in the social network literature are more limited. Social network influence theory (Friedkin 1986, Friedkin and Johnsen 2011) and network exchange theory (Cook 1977, 1982; Cook and Emerson 1978), and research on intra-organizational networks (e.g. Brass and Burkhardt 1993; Brass and Krackhardt 2012) have the most explicit discussions of power, though they are predominantly concerned with conflict, and the power of individuals.

Power in collaborative networks, such as those involved in inter-organisational collaborations, includes power granted through relationships and cohesion, as well as the power of individuals. Thematic analysis of 30 in-depth interviews with key stakeholders in Victoria's HIV and HCV collaboration ("The Partnership"), reveals five common themes in their discussions on where 'power in the network' is located: the ability to give out or obtain funding; the role of peak bodies; the capacity of the network to work together and advocate for change; the use of evidence backing up actions taken; and the power within the relationships themselves, particularly in aligning the sector towards common goals. This paper highlights power's place across different levels in the network, with individual, group and global network effects.

**Keywords:** power, collaboration, governance networks

## Network Effects on Healthcare Providers' Cost Performance

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Effective and efficient healthcare services require the comprehensive connection of healthcare professionals and complex inter-reliant activities. Effective collaboration for the patient-sharing provider network can ensure the best possible health outcome and value. Therefore, understanding the dynamics of the patient-sharing provider network among healthcare providers is essential to measure the efficiency of healthcare delivery services. This study aims to analyse PSNs for different suburbs of the Macarthur and Parramatta-Hills district region in New South Wales (NSW), Australia, and explore the effects of their attributes on healthcare providers' cost performance. This study uses administrative claim data to construct and develop a PSN, and social network analysis is used to analyse PSN. The corresponding literature suggests that the structure of patient-sharing networks is significantly associated with healthcare providers' cost and care intensity. Therefore, based on the social network analysis methodology, this paper analyses the healthcare providers' cost performance in the Macarthur and Parramatta-Hills district regions. This paper also measures the connections between gender, age, family status, level of education, income, living quality, and patient satisfaction in the Macarthur and Parramatta-Hills district regions. This research's findings can help healthcare stakeholders formulate better policies, ultimately improving the healthcare quality in Australia. The results of this study show that patient-sharing network analysis has the most influence on the providers' cost performance of the Australian healthcare system.

**Keywords:** Administrative claim data, Macarthur and Parramatta-Hills district region-NSW, Patient-sharing provider network, Social network analysis, and Providers' cost performance.

## Organizational Vocabularies and Interpersonal Trust in Organisations: A Multilevel Network Perspective.

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We examine how the presence of interpersonal trust relations within organisations is facilitated by the tendency of participants to share organisational vocabularies – sets of words that participants adopt to make sense of their organisational environment, and to negotiate and communicate its intersubjective meaning. We specify and estimate statistical models that capture the effect of shared organisational vocabularies on the likelihood of observing interpersonal trust relations among participants within and across the formal boundaries around intraorganisational units. We derive and test hypotheses about the effect of organisational vocabularies on interpersonal trust relations among members of the top management team in an international corporation containing five independent subsidiary companies. Results generally show that expressions of trust are more likely to be observed between managers sharing a common organisational vocabulary. However, the segregating effect produced by organisational design confines this tendency within the formal boundaries of organisational units. This effect is weakened when participants describe their personal experience using words contained in the in the vocabulary of corporate identity. The study demonstrates that developing a shared understanding is not sufficient to sustain trust within hierarchical organisations. Interpersonal trust relations are more likely to cross-cut intraorganisational boundaries, when the shared understanding of participants is articulated in terms of core concepts used by the organisation to delineate its own identity, history, and purpose.

**Keywords:** interpersonal trust, multilevel networks, organizational design, organizational vocabularies, exponential random graph models (ERGMs).

## Interorganisational Collaboration in the HIV/Hepatitis C Sector: An Application of Bayesian ERGM

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Treatments for both HIV and hepatitis C have undergone significant advancements in recent years, representing an incredible milestone for the health sector and affected communities. At the same time, these drugs also present a new climate and relative new challenges for the HIV and HCV sectors. A greater understanding of what interorganisational network structures look like is needed to maintain cooperation across community, government, research, and clinically focused organisations in this rapidly evolving climate, further speeding scientific advances and bringing new treatments to the public.

The Networks in Flux project is an ARC-funded investigation of interorganisational collaboration, comprised of both longitudinal network investigations and qualitative interviews. We present initial network findings from the first round of network data collection. We focus on the use of Bayesian inference scheme for the exponential random graph model (ERGM) to estimate tie formation processes among organisation actors in the HIV and Hepatitis C sector in Melbourne Australia. A Bayesian data augmentation approach allows for more credible inference of endogenous in the presence of missing network data. We discuss ERGM results, as well as the practical application of ERGM using High Performance Computing (HPC) systems.

**Keywords:** ERGM; health systems; collaboration; interorganisational networks; missing data

## An Integrated Topic-Network Model for Stakeholder Management in the Dynamic and Complex Mega Infrastructure Projects

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Managing stakeholders in the complex and dynamic environment of large-scale infrastructure projects poses significant challenges, yet efficient methods are lacking in this regard. Our study addresses this gap by developing an integrated model that leverages timestamped text project documents to provide automated guidance for stakeholder management. The model incorporates three key functions. Firstly, a dynamic topic model is employed to identify and monitor the criticality of stakeholder issues over time. Secondly, applying network analysis enables to evaluate the intricate connections and interactions among stakeholders, providing a comprehensive understanding of their involvement in relation to the identified stakeholder issues. This network perspective enhances decision-making by highlighting the relationships and dependencies that exist within the stakeholder landscape. Lastly, a stakeholder management map is proposed to assist decision-makers in prioritizing and effectively addressing the identified stakeholder issues. To facilitate stakeholder evaluation, an automated system is established based on the topic-network model. To validate the effectiveness of our model, we apply it to the case of XRL, successfully exploring 14 stakeholder issues and their trends from 2008 to 2021. Furthermore, we detect the top three stakeholder issues with high levels of stakeholder involvement for each year. Additionally, we provide management strategies and identify the most relevant stakeholders for decision-makers to effectively address each identified stakeholder issue. This research contributes to the implementation of stakeholder management in dynamic and complex contexts by utilizing text-mining and network techniques. It also extends the application of big data analytics in organizational studies, specifically within the realm of large-scale infrastructure projects.

**Keywords:** Stakeholder management, Network model, Topic model, Mega infrastructure projects

## **Navigating Danger: Knowledge Flows across Refinery Crews and Workers**

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Mineral refining is the process by which mined material is converted via several stages into a product for end users. There are strict occupational health and safety (OHS) and environmental regulatory processes across a refinery, its work crews, and in neighbouring areas to mitigate risks of death, permanent health issues or environmental catastrophe. For example, refineries often have their own firefighters and emergency responders specially trained in chemical and high temperature injuries; as well as stringent guidelines and regulations on how information is passed between workers on the same shift and between work crews at shift changeover to ensure 24/7 operations. The executive and management teams are key in monitoring and ensuring that correct policies are adopted and followed to maintain safe working conditions and equipment. We present the results of a survey asking employees of an Australian refinery to outline critical information networks for their work across the ten different work departments. We classify these departments via three work motivation types: management, daily task-oriented or long-term planning for refinery viability. We use Bayesian analysis of partially observed network data and exponential random graphs models (Koskinen et al, 2019) to understand the current critical information network structure and its implication for risk management. Our modelling results suggest that information sharing is de-centralised but forms local groups or clusters. Daily task-oriented employees are less likely to be seen as sources of information, while staff in long term planning are less active in seeking information from others. People with longer tenure or experience are more active in seeking information from others; at the same time, they are also seen as sources of information by others. Information seeking are also more likely to take place among people serving the same functions in the organisation.

Our findings provide insight into the patterns of knowledge sharing across the refinery, identifying especially key facilitators brokering between roles responsible for, on the one hand, immediate integrity and, on the other hand, long-term safety. Our final results highlight the importance of risk management organization on the structuration of the network, with particular emphasis on crews operating across departments.

**Keywords:** knowledge sharing, mineral refinery, work teams, Bayesian analysis, exponential random graph model

## Online Networks

### Identifying Echo Chambers in Political Discussion Networks on Twitter

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Echo chambers are understood to involve the fragmentation of online populations into narrowly-focused groups, where dissenting opinions are rejected, and beliefs become solidified and potentially radicalised. However, academic consensus on the existence and impact of echo chambers is lacking. Some researchers point to evidence of political homophily (actors with the same political stance are more likely to be connected) as supporting the existence of echo chambers, while others suggest that given the average web user is exposed to cross-cutting information, then this is evidence that echo chambers do not exist.

We contend that a limitation with previous network-analytic approaches to studying echo chambers on platforms such as Twitter is that there has been a focus on information diffusion (retweets) rather than reciprocal communication such as discussion. Reciprocal communication allows for users to directly address one another, articulate (political) opinions, and express agreement or disagreement. Reciprocal communication is supported on Twitter via replies and the Twitter API v2 enables the construction of “conversation trees” where the root node is an initial tweet and branches contain all replies (and replies to replies) to that initial tweet.

We present a new network dataset based on a large-scale collection of tweets authored during the first 2020 US presidential debate. Importantly, while we used a set of target debate- and election-related hashtags to collect an initial set of tweets authored during the debate, we then used the Twitter API v2 to collect all of the associated reply activity (these additional replies do not need to contain a target hashtag). Our dataset contains 13K conversation trees and 2.6M replies, a nearly 100-fold increase in the number of replies compared to the hashtag-based collection alone.

We use this new dataset to explore dynamic network- and text-analytic approaches for finding evidence of echo chambers, focusing on identifying network “structural signatures” of mutual affirmation or contestation, and delegitimisation of dissenting positions.

**Keywords:** echo chambers, political discussion, Twitter, homophily

### Researcher Contributions to R Packages Development: Evidence from GitHub

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Free and open source software is ubiquitous in academia and industry. R, a popular open source statistical programming language, is favoured by researchers and data analysts due to its diverse packages. Research on software package ecosystems focuses on growth, dependency networks, licensing, security, and individual contributions to packages. However, no study has been conducted on the labour of researchers and how it fits in the contemporary distributed industrial production system in relation to the R package development. To investigate this academic labour issue, we employed a mixed approach to study the commits and issues of CRAN package repositories on GitHub.

We collected a dataset of 2,339,669 commits to 8,924 CRAN R package repositories from GitHub. Building on the methodology used to map the network of firm employee contributions to highly active GitHub repositories (O'Neil et al 2021), we used the email address domains of commit authors, committers, and issue contributors as proxies for their affiliations. We created a 2-mode network of contributors' affiliations and packages to understand organisational contributions. We then derived an individual level network to understand how researchers fit into the distributed development system.

To understand researcher contributions beyond committing, we collected a dataset of 22,272 issues in 6,790 R packages repositories. We derived 3 networks from issues using issue labels: (1) a network of users who reported bugs and who were assigned to debug; (2) a network of users requesting new features and

who were assigned to add features; (3) a network of users asking and answering questions. Finally, we isolated issues with titles featuring “maintainer/developer/contributor” to conduct qualitative analyses to understand labour issues in R package development.

A group of universities and a few foundations (for example: Debian and Aroma) were in the centre of the organisation-package network. When projected this 2-mode network to a 1-mode organisational network, two major collaboration clusters emerged. One was a European-North American cluster of universities, Debian, Google and GitHub. The other was a geo-dispersed cluster of universities, firms and foundations. Excepted for non-affiliation users, researchers were the leading contributors by committing. Beyond committing, researchers were also prominent in terms of bug reporting, debugging and feature development. They were also the only category providing answers to user questions. Qualitative findings uncovered two labour issues: a lack of staff to maintain packages and respond to repository issues, and unstable teams of maintainers. In sum, non-affiliation users were leading contributors followed by researchers in R package development. In addition to committing, researchers were organisers, coordinators and help providers. All these roles place a heavy weight on their shoulders, and the lack of staff and unstable teams worsens their situation.

**Keywords:** R package, labour, researcher, academic labour, industrial innovation

## Posters

### Exploring Decentralised Online Social Networks: The Case of Mastodon

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There is increasing potential to study social interaction and network behaviour in decentralised online social networks. Mastodon is a decentralised microblogging platform, where users join an instance (server) typically established around an existing community or area of interest. Users on different instances can interact with each other, and thus the instances collectively comprise a federated social network, which is in turn part of a larger federated universe ('Fediverse') of decentralised social media platforms.

Consistent with its architecture, Mastodon has been found to be formed by well separated and sparsely interconnected groups (Zignany et al., 2018). Its unique architecture provides opportunities to explore diverse network structures, such as those constructed using threaded conversation data, and to observe how those interactions enable connections between servers (community networks). In this poster we present exploratory research and methods into collecting Mastodon data using the VOSON lab tools and other R packages, and generating networks for analysis.

Additionally, the Mastodon federated governance of instances results in local rules and moderation, in which users and other instances can be silenced or suspended. Using instance log data, we explore the presence of negative ties between servers and their impact on network structure in terms of the emergence of group boundaries and the strengthening of local community (Everett & Borgatti, 2014; Stadtfeld et al., 2020).

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**Keywords:** online social networks, decentralised social media, online communities, online conversation networks, signed networks

### Corruption in Networks of Infrastructure Concession Programs

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Corruption in infrastructure projects leads to economic losses and cost overruns, with large negative societal implications. Research on infrastructure projects has considered the relational nature of project contractual agreements in the construction sector in complex networks of competition and cooperation. However, the relations of networks with project performance and the propensity of stakeholders to engage in corrupt practices, has remained underexplored. Building on institutional and power theories, we explore datasets of contractual relationships of firms participating in two road concession markets (e.g., Peru and Colombia) and one social infrastructure market (e.g., Brazil's 2014 World Cup stadiums). These datasets contain information on 17, 33, and 12 projects for Peru, Colombia, and Brazil, respectively. Fifteen of these 62 projects were investigated for corruption. We quantitatively examine the changing network centrality of project stakeholders engaged in corrupt conduct and we apply content analysis of legal documents and news reports to better understand how bribing firms position themselves in multiple infrastructure market networks. Preliminary results suggest that companies engaged in corrupt practices attempt to legitimize their conduct through contractual agreements with the biggest construction companies in each market. These resulting cliques of companies exercise collective agency that has the potential to become coercive

over other stakeholders in the market. We conclude with sharing plans for further research.

**Keywords:** Infrastructures projects, Concessions, Corruption, Construction industry, Power.

## **Application of Nonparametric Approaches for Change Point Detection in Social Networks**

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Nowadays, social network platforms have become essential components of human life. The significance of social networks in diverse applications stems from the vast amount of data they generate, which is relevant to events occurring in both the virtual and real world. To fully harness the benefits of social networks, researchers have extensively employed social network graph modeling tools for network analysis, particularly in tasks related to human behavior analysis, such as change point detection. The problem of network change point detection has garnered substantial attention from researchers in statistical process control. However, conventional methods of statistical change point detection, typically used in industrial processes, exhibit certain drawbacks when applied to social networks. These limitations primarily include the assumption of independence among evolving networks and the neglect of the dynamic nature of social networks in monitoring algorithm. Consequently, novel and tailored approaches are required to effectively address change point detection in social network analysis. In this research, we aim to overcome these limitations by demonstrating the benefits of nonparametric approaches for change point detection in social networks. To evaluate the effectiveness of the proposed nonparametric approach, we employ the Average Run Length (ARL) criteria and conduct a comprehensive comparative analysis against other state-of-the-art methods. The experimental results illustrate the efficiency of using nonparametric approaches in detecting change points within online social networks.

**Keywords:** Social Network Analysis, Change Point Detection, Dynamic Social Networks, Nonparametric Approaches, Average Run Length (ARL)

## **Knowledge Networks of Farmers in the Central Tablelands of NSW**

**Tracey Potts<sup>\*,1</sup>**

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Farmers and other land managers' practices have impacts both within and beyond the farm gate, the implications of which may be experienced intergenerationally. There are multiple observed instances of farmers and land managers within the same landscape demonstrating significantly different practices resulting in varying levels of landscape health and function, which become more apparent during times of environmental stress such as drought. This study aims to understand the influence of psycho-social and biophysical phenomena on natural resource management practices in the Central Tablelands region of New South Wales (NSW).

My PhD research project commenced in October 2019 and since then, the people and landscapes in the study area have experienced numerous environmental and societal shocks and stressors e.g., drought, flood, bushfires fires and COVID, each with their own impacts on land managers and the extension staff that support them. These successive and cumulative shocks and stressors demonstrate that minor or incremental adaptation may no longer be sufficient to navigate the impacts of climate change and that transformational capacity is a critical limiting factor in securing sustainable food and fibre production in years to come. My research aims to understand how these shocks and stressors influence the capacity of farmers to contemplate and implement more sustainable practices. It also seeks to gain insights into what informs their management of natural and agricultural resources, so engagement and extension initiatives may be adapted accordingly. An understanding of the social context of agriculture and the social nature of farming is key to gaining insights into how information and new practices move through communities. This poster maps the knowledge network of 34 farmers and the extension professionals who support them. Our results show four farmer archetypes, and we present an overview of these four groups and explore opportunities for improving

natural resource management extension effectiveness.

**Keywords:** Knowledge networks, natural resource management, adaptive capacity

## **Stakeholder Network Variables and Factors: A Performance Analysis**

**Stephen Ong<sup>\*,1</sup>, Shahadat Uddin<sup>1</sup>**

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The management of Projects require an in-depth understanding of the relevant systems in order to improve the delivery of projects and foresee complications. This need is becoming more imperative within the current ever-changing project landscape with variables becoming increasingly complex. This study aims to interpret projects in light of Stakeholder and Social Network Analyses. Node-level and network-level explorations have uncovered trends which predict the optimal conditions of stakeholder interactions and conditions for project success. Information collected also includes various factors contributing to the complexity of projects in the contemporary environment as well as in understanding the various definitions of project success. Collection of primary industry data had occurred through a questionnaire available online as well as respondent communications. The measures of network density and centralisations have unveiled results consisting of statistically significant p-values and low one-way ANOVA values indicating great significance. The findings within this research are undoubtedly beneficial to industry as it allows project consultants to understand how individuals should interact within various project delivery environments.

**Keywords:** Stakeholder Networks, Performance, Primary Source, Social Network Analysis, Stakeholder Analysis

# Workshops

## AM Session

### ERGM Analysis for Multilevel Networks with MPNet — CANCELLED

*Peng Wang*<sup>1</sup>

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In this hands-on workshop, participants will learn the fundamentals of estimating Exponential Random Graph Models (ERGMs) and Auto-Logistic Actor Attribute Models (ALAAM) with MPNet – a software developed to investigate the structural features of networks and how such structure may affect individual outcomes.

The workshop will start with a brief introduction to the overall logic of estimating (single-level) ERGMs/ALAAMs before introducing the recently developed multilevel ERGMs/ALAAMs. The latter class of models enables researchers to investigate the influence of structure at one level of analysis on structure at a different level, while taking into account the complex interdependencies that exist within and between levels. For instance, interpersonal networks between managers at the micro-level might interact with alliance networks of the organizations they are nested in. The workshop will also demonstrate how to use MPNet to model temporal network dynamics using Temporal ERGMs.

Throughout the workshop, participants will work through short exercises to get familiar with the graphical user interface and output of the MPNet software. We will discuss various case-study examples that will provide the participants with a good understanding of the possibilities that multilevel ERGMs offer for social scientists.

**Prerequisites:** Some basic familiarity with social network analysis will be helpful. Participants are required to bring their own laptops with MPNet installed. Note that MPNet is not compatible with Mac OS without a compatible Windows parallel.

### Survey and Interview Methods in Social and Personal Network Research (Egonets)

*Malcolm Alexander*<sup>1</sup>, *Rebecca R. Langdon*<sup>2</sup>

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Researchers in psychology, sociology and cognate disciplines use surveys and interviews to study social capital, social support and the sociology of social networks. They face crucial choices in the framing of research questions, strategies of data collection (e.g., Qualtrics), data management and analysis and strategies of publication. This workshop explores these issues and reviews the varied software options for each aspect of this research. The presenters approach this research from business/psychology, survey methods and quantitative methods (Rebecca Langdon) and from sociology, in-depth interviewing and social network analysis (Malcolm Alexander). Example datasets are drawn from both these approaches.

**Prerequisites:** Familiarity with setting up basic surveys in Qualtrics and knowledge of social network analyses and basic statistical procedures (e.g., ANOVA, t-test, correlation, regression) assumed.

## Introduction to ERGMs with Statnet

*Pavel N. Krivitsky*<sup>1</sup>

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This workshop provides a hands-on tutorial to using exponential-family random graph models (ERGMs) for statistical analysis of social networks, using the 'ergm' package in Statnet (<https://statnet.org>). The ergm package provides tools for the specification, estimation, assessment and simulation of ERGMs that incorporate the complex dependencies within networks. Topics covered in this workshop include:

- an overview of the ERGM framework
- types of terms used in ERGMs
- defining and fitting models to empirical data
- interpreting model coefficients
- goodness-of-fit and model adequacy checking
- simulation of networks using fitted ERG models
- degeneracy assessment and avoidance.

**Prerequisites:** Familiarity with R and familiarity with basic concepts of network analysis.

## PM Session

### Collecting and Analysing Online Networks with VOSON R tools

**Robert Ackland**<sup>1</sup>

<sup>1</sup> Australian National University, Canberra, ACT, Australia

This workshop will introduce participants to open source R packages for online network collection and analysis, developed by the Virtual Observatory for the Study of Online Networks (VOSON) Lab (<http://vosonlab.net>) at the Australian National University. The workshop will include an introduction to (depending on workshop participant interest and available API access):

- **vosonSML** <https://github.com/vosonlab/vosonSML> — an R package providing a suite of tools for collecting and constructing networks from social media data. It provides easy-to-use functions for collecting data across popular platforms (Twitter, Reddit, YouTube, WWW hyperlinks) and generating different types of networks for analysis.
- **VOSON Dashboard** <https://github.com/vosonlab/VOSONDash> — an R/Shiny application providing a graphical user interface for collecting and analysing online networks and associated text data. It builds on a number of R packages, in particular *igraph* (for network analysis) and *vosonSML*.
- **voson.tcn** <https://github.com/vosonlab/voson.tcn> — an R package for collection and analysis of Twitter conversation networks. This package uses the Twitter API v2 Early Access endpoints to collect tweets and generate networks for threaded conversations identified using the new tweet conversation identifier.
- Collection and analysis of other social media data sources such as the peer-to-peer microblog site Mastodon.
- Participants will be given instructions on how to install these packages prior to the workshop. Workshop materials will include R scripts, package documentation, notes on analysis of online networks, and examples of research.

**Prerequisites:** It is expected that participants will have some experience using R. R and RStudio will need to be installed on laptop prior to workshop. VOSON tools (R packages) installed prior to workshop (specifics of packages and versions will be given to participants in advance of the workshop).

### Advanced Exponential-Family Random Graph Modelling with Statnet

**Pavel N. Krivitsky**<sup>1</sup>

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This workshop will provide a tutorial of advanced usage of 'ergm' and extension packages, focusing on binary networks. Topics include specifying complex structural constraints, estimation tuning, representing complex effects with term operators, and observational (e.g., missing data) structure. Also included is using the new 'ergm.multi' package for modelling multi-layer and multi-mode networks, as well as joint models for ensembles of networks.

**Prerequisites:** Familiarity with R and 'ergm' required. If you are new to ERGMs, the introductory workshop on ERGMs using statnet is strongly suggested.

## Estimating Auto-Logistic Actor Attribute Models in R — CANCELLED

Johan H. Koskinen<sup>1</sup>

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The auto-logistic actor attribute model (ALAAM) is a model for cross-sectional binary outcomes where dependencies through a binary network is accounted for. In its simplest form, ALAAM is a logistic regression on network summaries and other exogenous covariates. The strength of ALAAM is however the ability to model dependence of nodal outcomes through network tie, for example, are two people that are relationally tied more likely to share the same opinion or belief. As such, ALAAM allows us to model outcomes that are concordant with social influence and social contagion processes. ALAAM can be estimated in the stand-alone statistical software package MPNet but we will focus on routines for estimating ALAAM in R using a Bayesian inference framework. We will cover the entire process from reading in data into R to formatting the data for analysis and then analysis and interpretation. We will touch on common considerations such as missing data and model selection. Most of the workshop will focus on hands-on work on analysing data but some theoretical and conceptual issues will also be covered. The framework is described in detail in Koskinen & Daraganova (2022). *Bayesian Analysis of Social Influence*. JRSSA <https://doi.org/10.1111/rssa.12844>

**Prerequisites:** We assume that you have a good knowledge of social network analysis and a keen interest in networks. Fundamental network concepts and theories will be assumed knowledge as will standard network techniques. Network techniques include basic graph theory, centrality, and clustering measures. It is recommended that you have some experience of using standard statistical models, such as regression models, and it is advantageous to be familiar with binary response models such as logistic regression. You will find it useful to have a working knowledge of the program R.

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*Current as of November 27, 2023*

