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Introduction to Social Network Analysis

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- **What is SNA?**

 - Definition(s)

 - Theory or method

 - History of development

 - Basic concepts

- **Applied use**

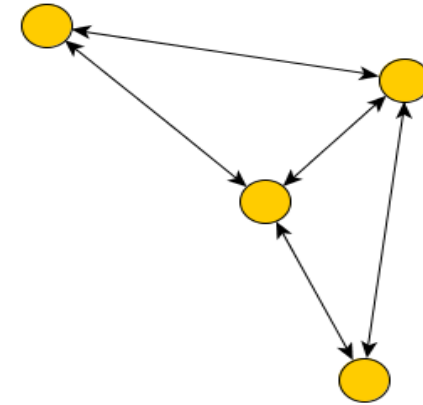
 - Examples of how it has been useful -
issues of mixed methods, temporality

 - Example from my own research

- **Next steps?**

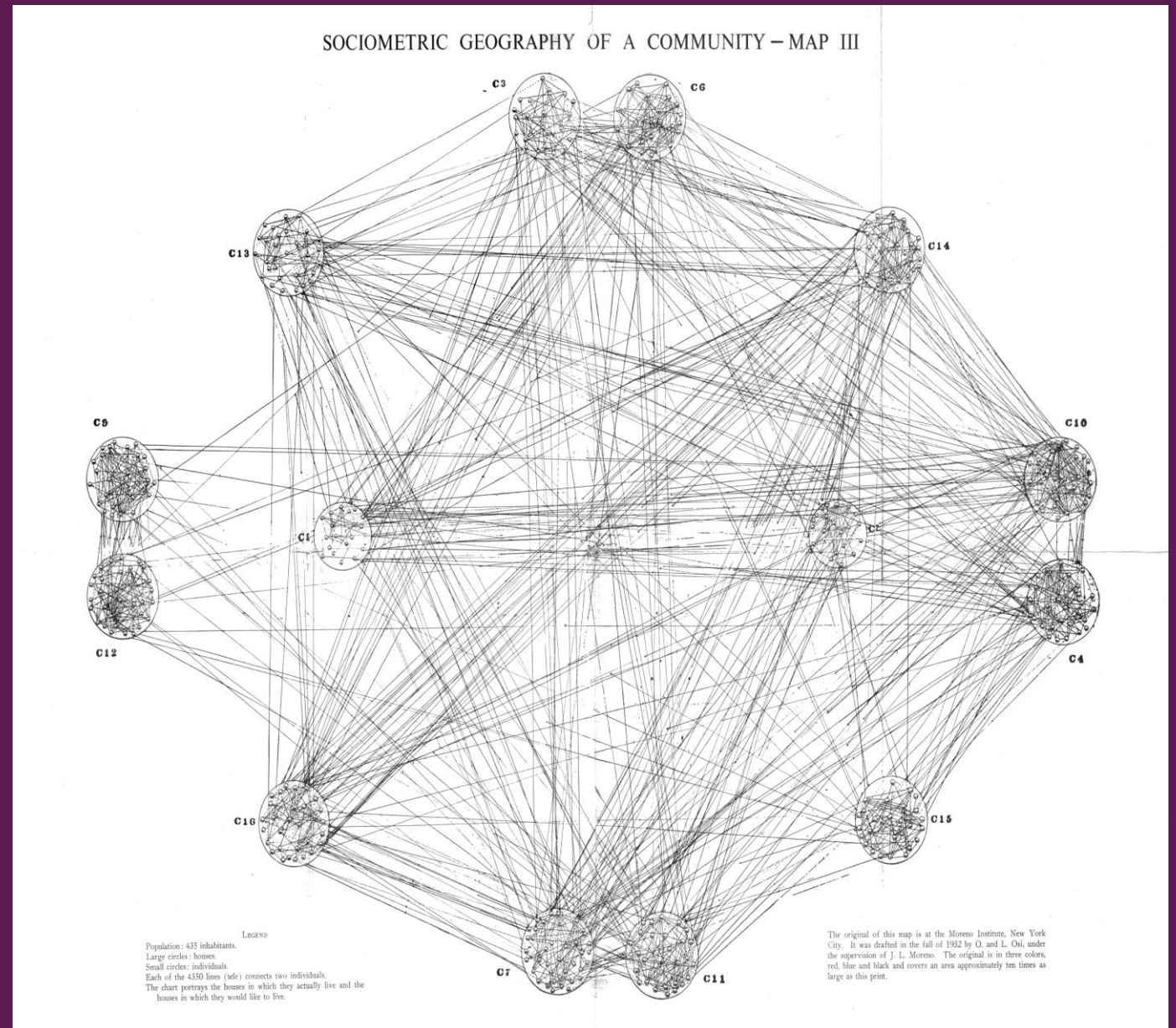
What is SNA?

- Underpinned by Graph Theory but influenced by other disciplines
- Graph theory allows mathematical manipulation of sociograms
- A graph (or sociogram) is a set of vertices (nodes, points) and a set of lines (arcs, edges) between pairs of nodes
- A NETWORK consists of a graph and additional information on the nodes or lines of the graph.



What is SNA

- Or a NETWORK is simply a relationship between objects which could be people, organisations, nations, Google search, or brain cells.
- We study at a basic level a number of points (or 'nodes') that are connected by links. Generally in social network analysis, the nodes are people and the links are any social connection between them
- We are interested in what passes, and how it passes, through these networks – friendship, love, money, power, ideas, and even disease
- The basic unit of analysis is not the individual (gender, ethnicity etc.) – it is the connections they are embedded in



A number of diverse academic strands have shaped, and continue to shape, the development of SNA

Gestalt theory

Field theory

Group dynamics

Graph theory

Structural functional anthropology

Harvard structuralists

Social Network Analysis

Physics



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SNA conceptualises social structure as a network of social ties

'SNA pays attention to the structural relationship between actors'
(Davies , 2009)

'Networks can include actors relationships with other kinds of entities, events or shared interests' (Scott, 2015)

'The main goal of SNA is detecting and interpreting patterns of ties among actors' (Nooy et al, 2005)

' SNA illuminate structural relations usually opaque to lay actors, through delineating the ties between parts of social bodies' (Knox et al, 2006)

It is a set of sociological methods for visualising/mapping and analysing social networks



Mathematical theorems (Barnes, 1983)

Rational choice theory (Lin, 1982)

Social capital (Putnam, 2000)

Actor network theory (Latour, 2005)

The network society (Castells, 1995)

SNA provides a vocabulary and a set of measures for relational analysis but does not imply the acceptance of any one theory of social structure (Scott, 2017)

Central assumption in SNA is that it is appropriate for relational data

Attribute data- attitudes, opinion, behaviour – variable and multi-variate analysis

Relational data – contacts, connections – SNA

Ideational data– meanings, motives, actions - discourse analysis

Mixed methods analysis - can all be part of same investigation, similar methods for collecting these data: surveys, ethnography, document analysis.

A social network has two basic elements and an optional third:

- a set of nodes(aka vertices)
 - objects within the network
- a set or sets of ties (aka relations, connections, edges, arcs)
 - ties can be directed or undirected
- optionally , a set of attributes
 - additional information we have about nodes

Network analysis

- Networks
 - How to represent various social networks
- Tie strengths
 - How to identify strong weak ties in the network
- Key players
 - How to identify key central nodes in the network
- Cohesion
 - Measure of overall network structure

What is SNA? Basic concepts

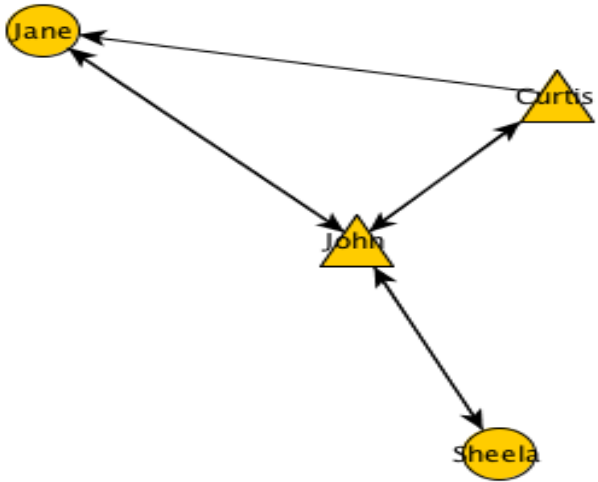
Networks: How to represent various social networks

Adjacency matrix (directed and binary)

	John	Jane	Curtis	Sheela
John	0	1	1	1
Jane	1	0	0	0
Curtis	1	1	0	0
Sheela	1	0	0	0

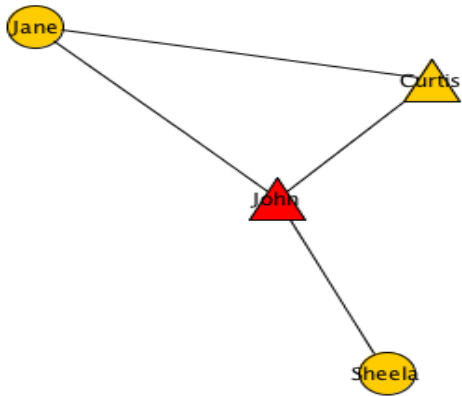
From matrix we create a graph (aka network diagram, sociogram)
Graph theory - so different conception of space to say scatterplots. In SNA space is mapped entirely in connections

Graph of matrix with nodal attributes



Networks: Ego or whole?

Ego-network



- An ego network is centred upon a particular node and its relations with alters
- can be extracted from a whole network
- But can be gathered instead of a whole network
- Useful for analysing network domains (White, 2008)

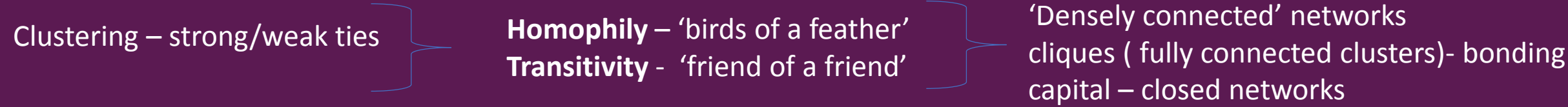
NB networks are never really whole!! Boundary issues etc

Tie strengths: how to identify strong or weak ties

	John	Jane	Curtis	Sheela
John	0	3	1	1
Jane	3	0	0	0
Curtis	1	1	0	0
Sheela	1	0	0	0

- Ties represent interactions, flow of information or goods etc. tie weights can indicate strength of that interaction or
- frequency
- Reciprocity

- Or structure, of and within network, thru patterns of ties :



Bridges – nodes and ties that connect groups – boundary spanners – loosely connected - bridging capital

‘Strength of weak ties’

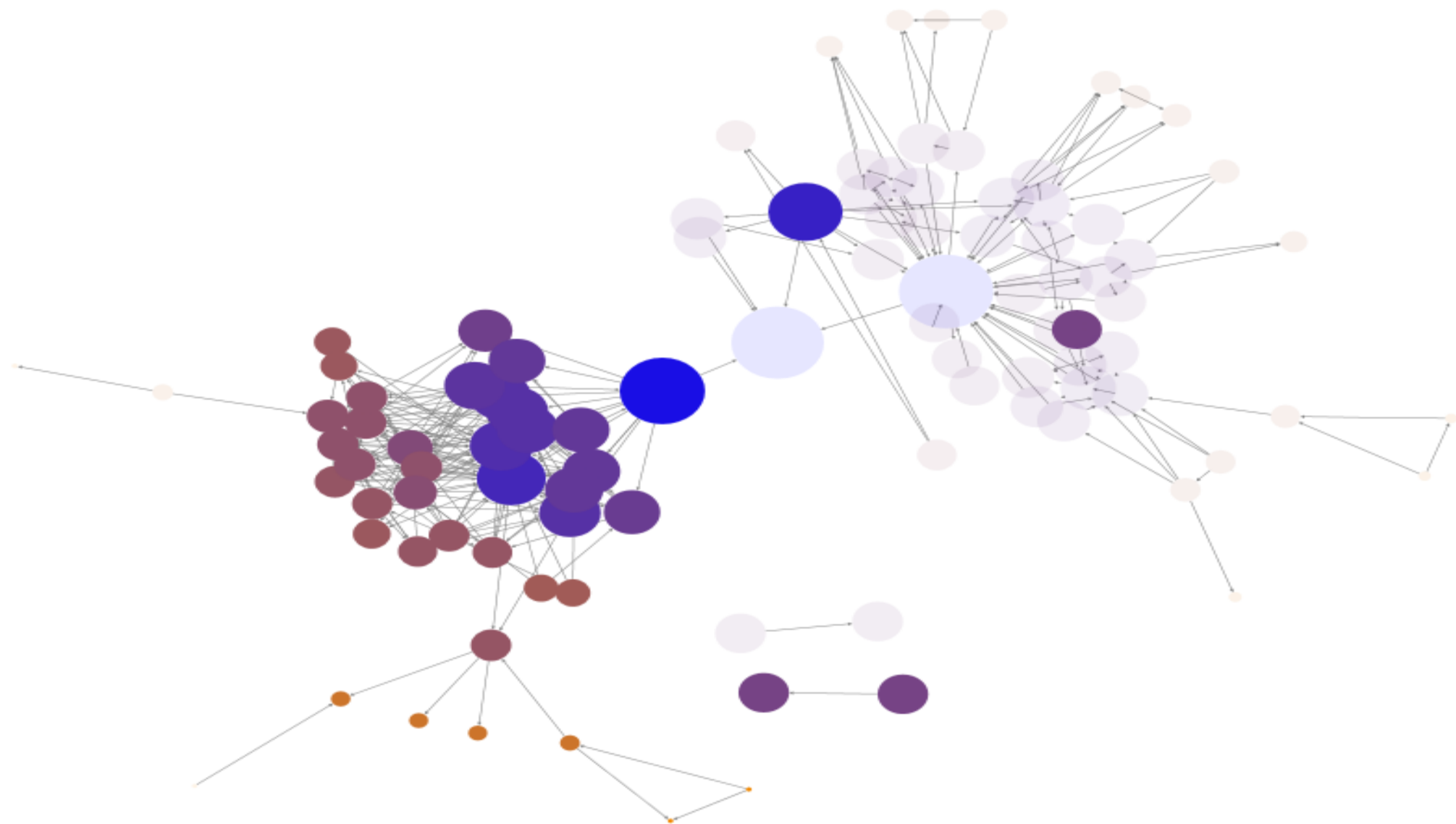
Key players :How to identify key central nodes in the network

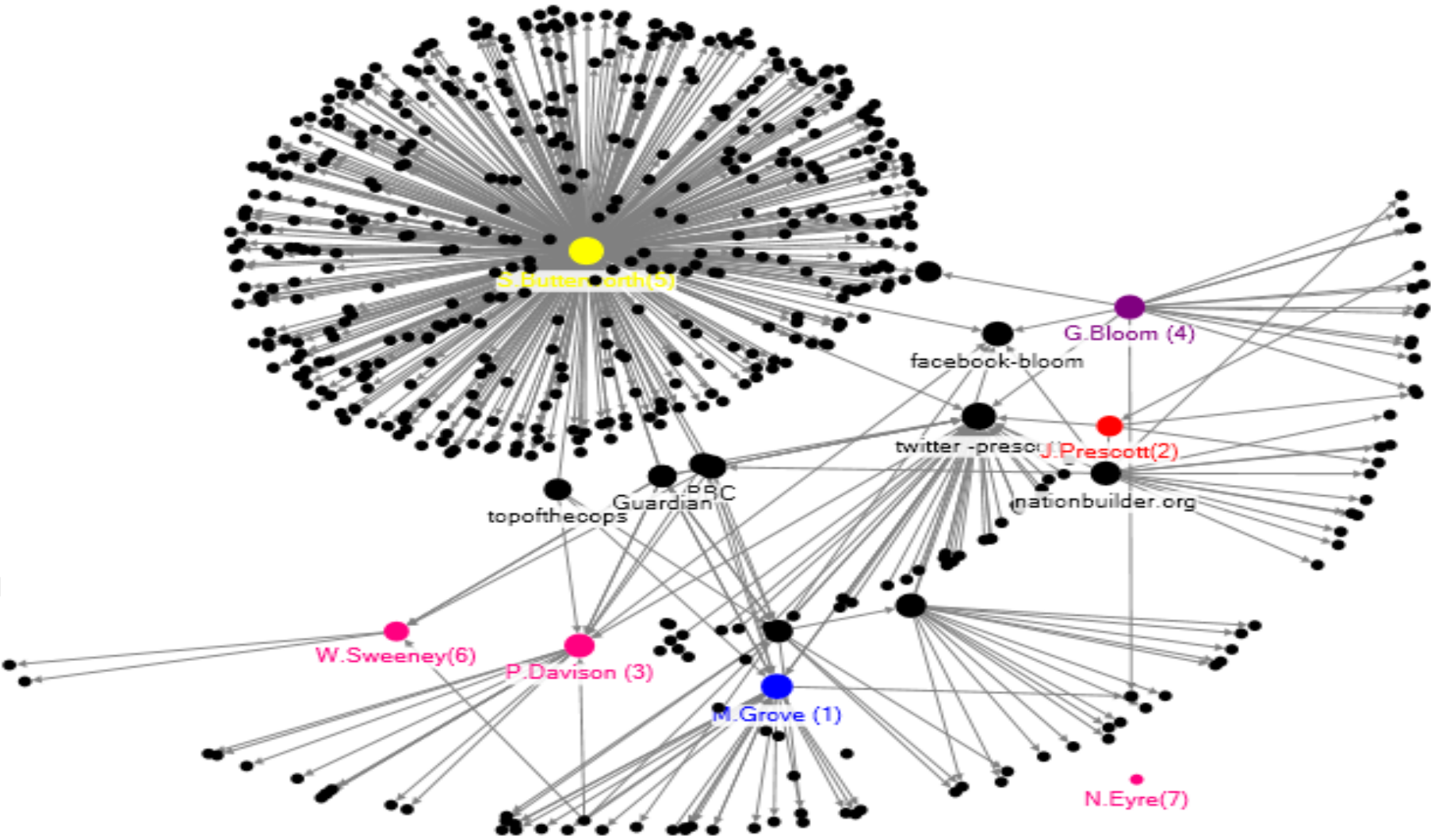
Centrality measures- node level properties

- **Degree** – no of ties that go in/out of node – connectedness/influence/popularity
- **Betweenness**- nodes in communication paths with other nodes – gateway/bridge
- **Closeness** – measure of reach - how fast can this person can reach everyone else in the network
- **Eigenvector centrality** – how much is this node connected to other well connected nodes – power?



Nig's open mic network (closeness anon) all network





HUMBERSIDE: Matthew Grove (Conservative) elected

TURNOUT DOES NOT INCLUDE SPOILT BALLOTS
Turnout: 133,762 (19.15%)

Second round

Candidate	Party	Final total	%	Status
Matthew Grove	Conservative	42,164		Elected
John Prescott	Labour	39,933		

First round

Candidate	Party	1st pref	%	2nd pref
John Prescott	Labour	33,282	24.9%	6,651
Matthew Grove	Conservative	29,440	22%	12,724
Paul Davison	Independent	28,807	21.5%	
Godfrey Bloom	UKIP	21,484	16.1%	
Simone Butterworth	Liberal Democrat	11,655	8.7%	
Walter Sweeney	Independent	5,118	3.8%	
Neil Eyre	Independent	3,976	3%	

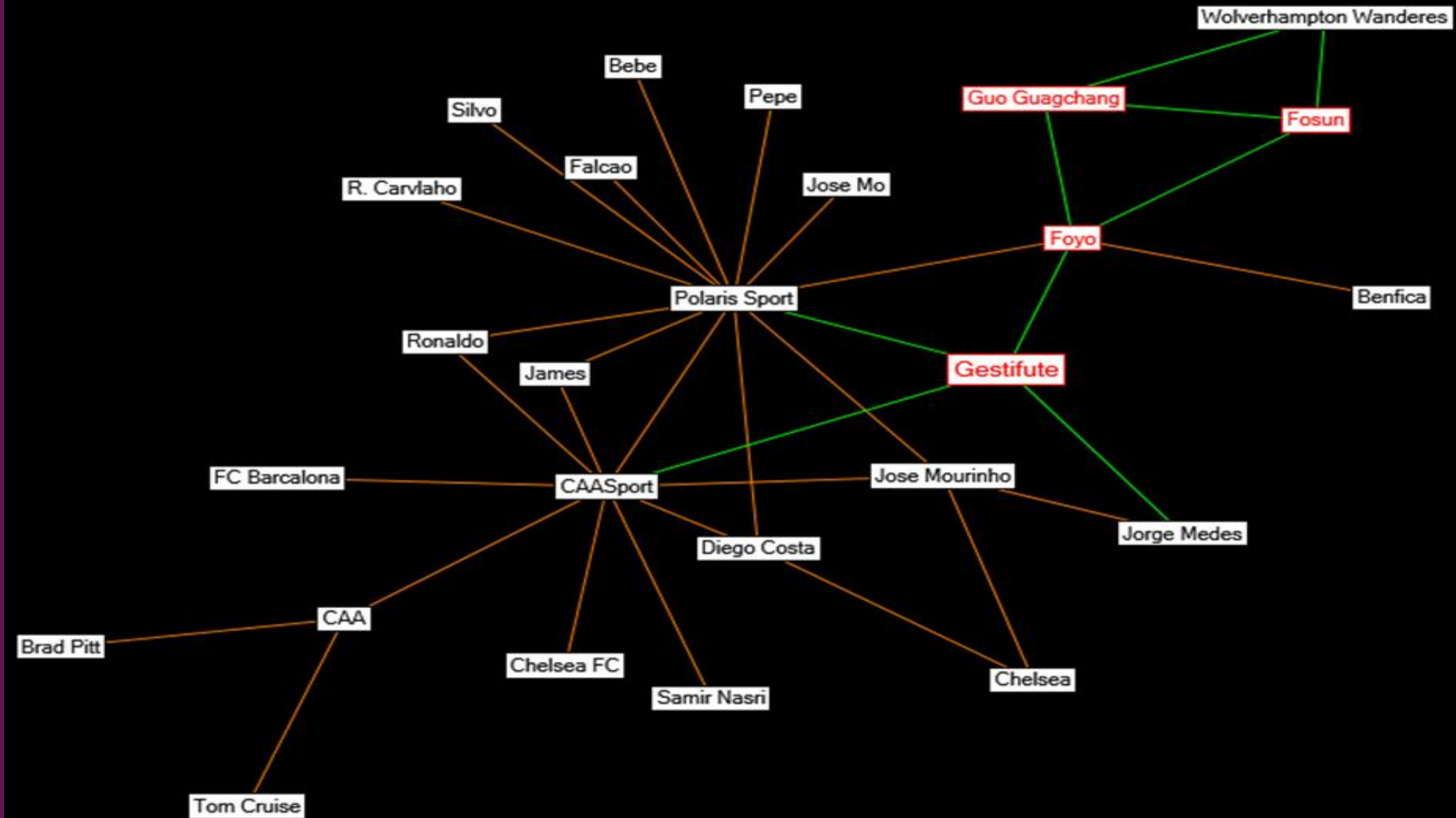
Cohesion: Measure of overall network structure

Structural cohesion - Simmel's notion that cohesion of a social group depends on the 'intersection of social circles'.
Quantified in SNA:

- **Reciprocity** (degree of) – indicator of mutuality and reciprocal exchange - cohesive
- **Density** – how well connected a network is – a perfectly connected, closed, network has a density measure of 1
- **Clustering** – a clustering coefficient is a measure of closed triplets in a network/transitivity
- **Path distance** – path lengths are the number of ties (degrees) to get from one node to another – calculate average distance separating every possible pair of actors to get idea of how far info has to travel in network
- **Small worlds** – networks with high clustering coefficients – '6 degrees of separation'



Six degrees of Wolverhampton Wanderers (P.Widdop@leedsbeckett.ac.uk)



Summary : so far

- Underpinned by Graph Theory but influenced by other disciplines
- A NETWORK is simply a relationship between objects which could be people, organisations, nations, Google search, or brain cells.
- We study at a basic level a number of points (or 'nodes') that are connected by links. Generally in social network analysis, the nodes are people and the links are any social connection between them
- We are interested in what passes, and how it passes, through these networks – friendship, love, money, power, ideas, and even disease
- The basic unit of analysis is not the individual (gender, ethnicity etc.) – it is the connections they are embedded in
- **SNA provides a vocabulary and a set of measures for relational analysis but does not imply the acceptance of any one theory of social structure**
- **Researcher makes informed judgement on applicability of measures to their research subject**



Applied use of SNA

1. 'The small worlds of Ambridge' – Dr N. Headlam, 2017

- Power and influence within networks
- Data gathering
- 2 mode network
- Mixed methods
- Temporality

2. 'The Social World of the Network' - Prof Nick Crossley, 2010

3. Whole-Genome Sequencing and Social-Network Analysis of a Tuberculosis Outbreak - Gardy et al, 2011

- Understanding source and spread of infection
- Data gathering
- Mixed methods

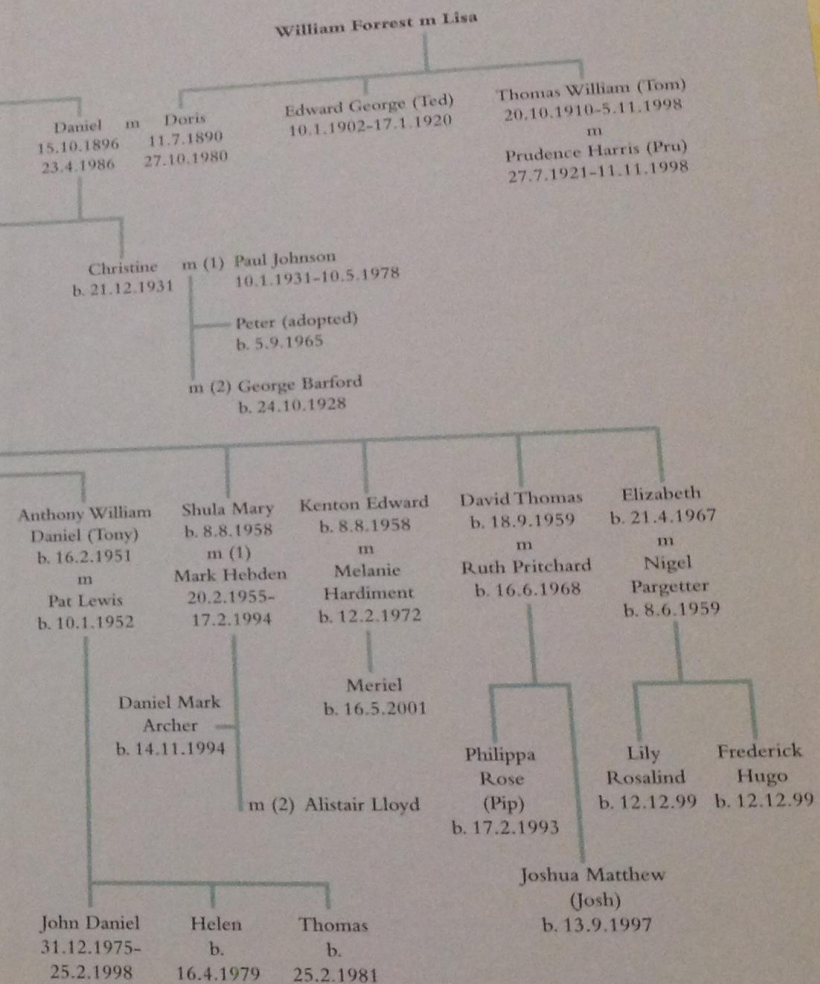
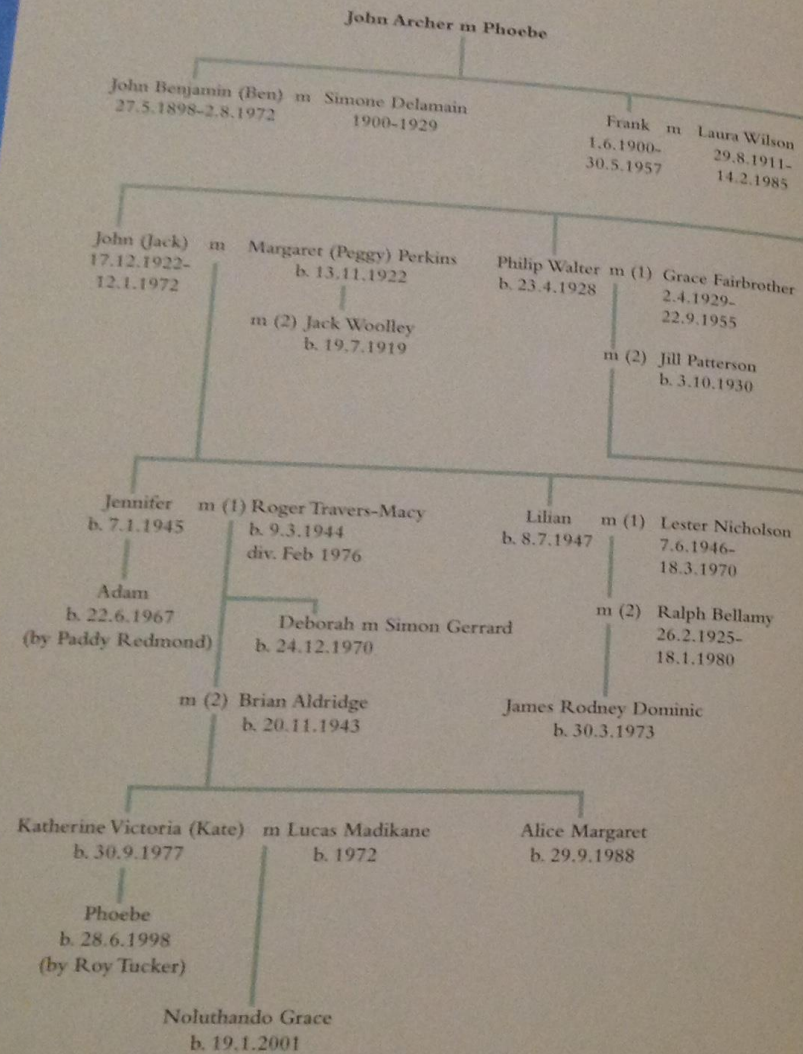


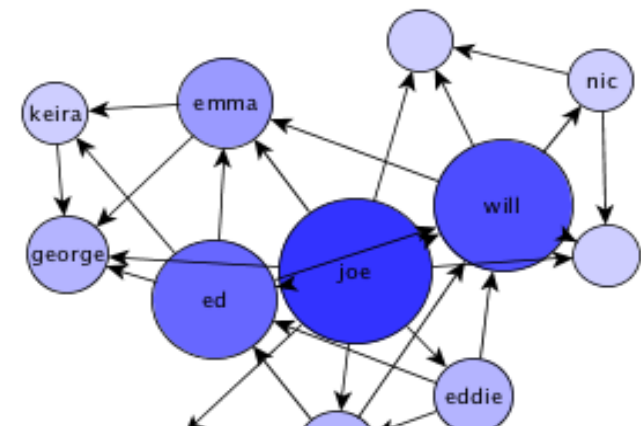
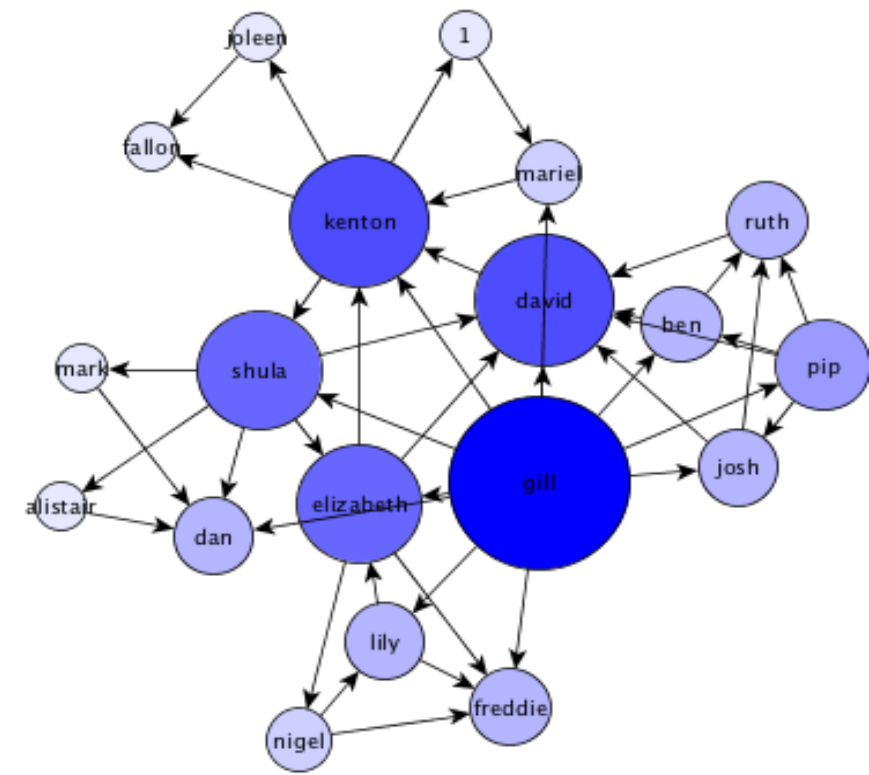
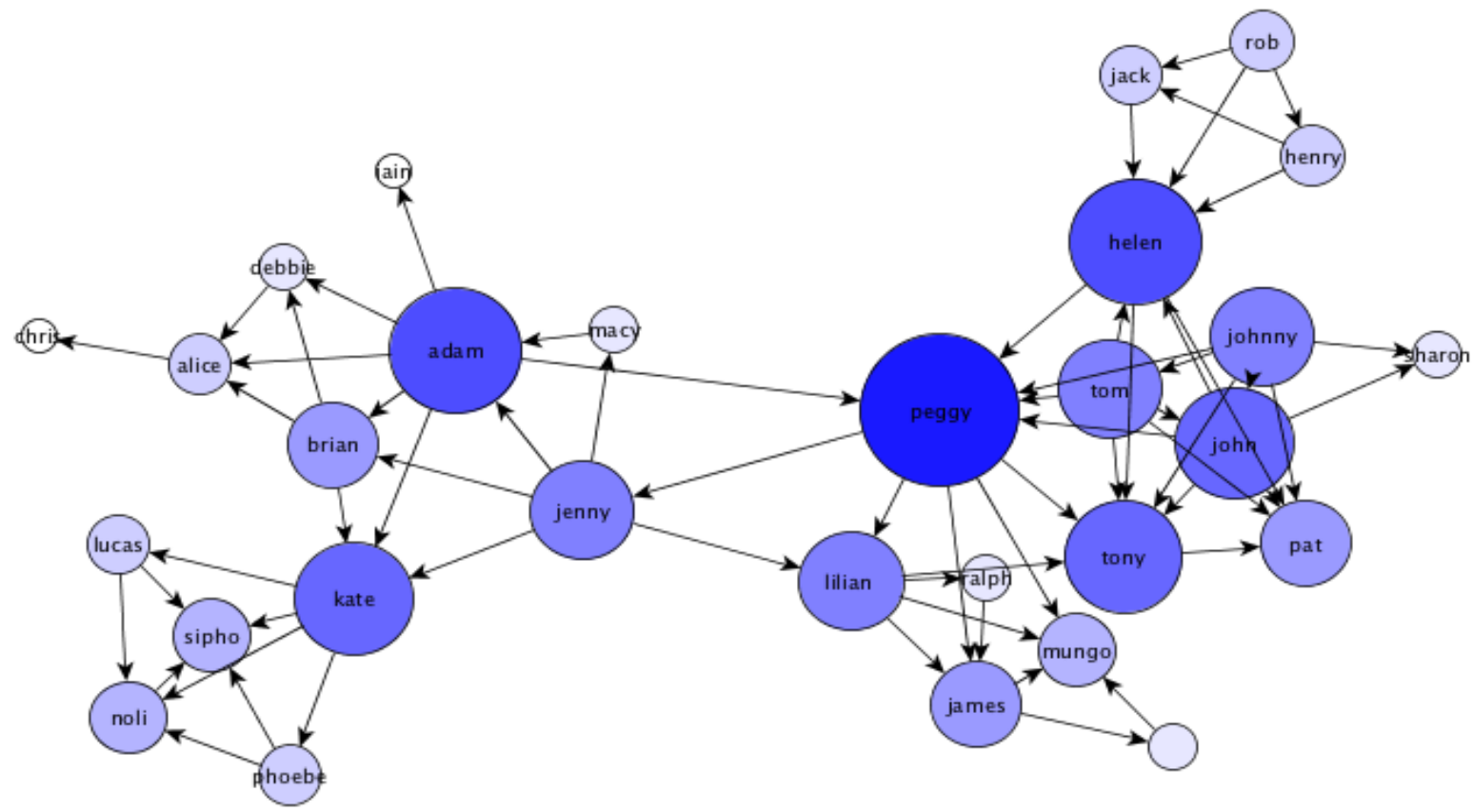
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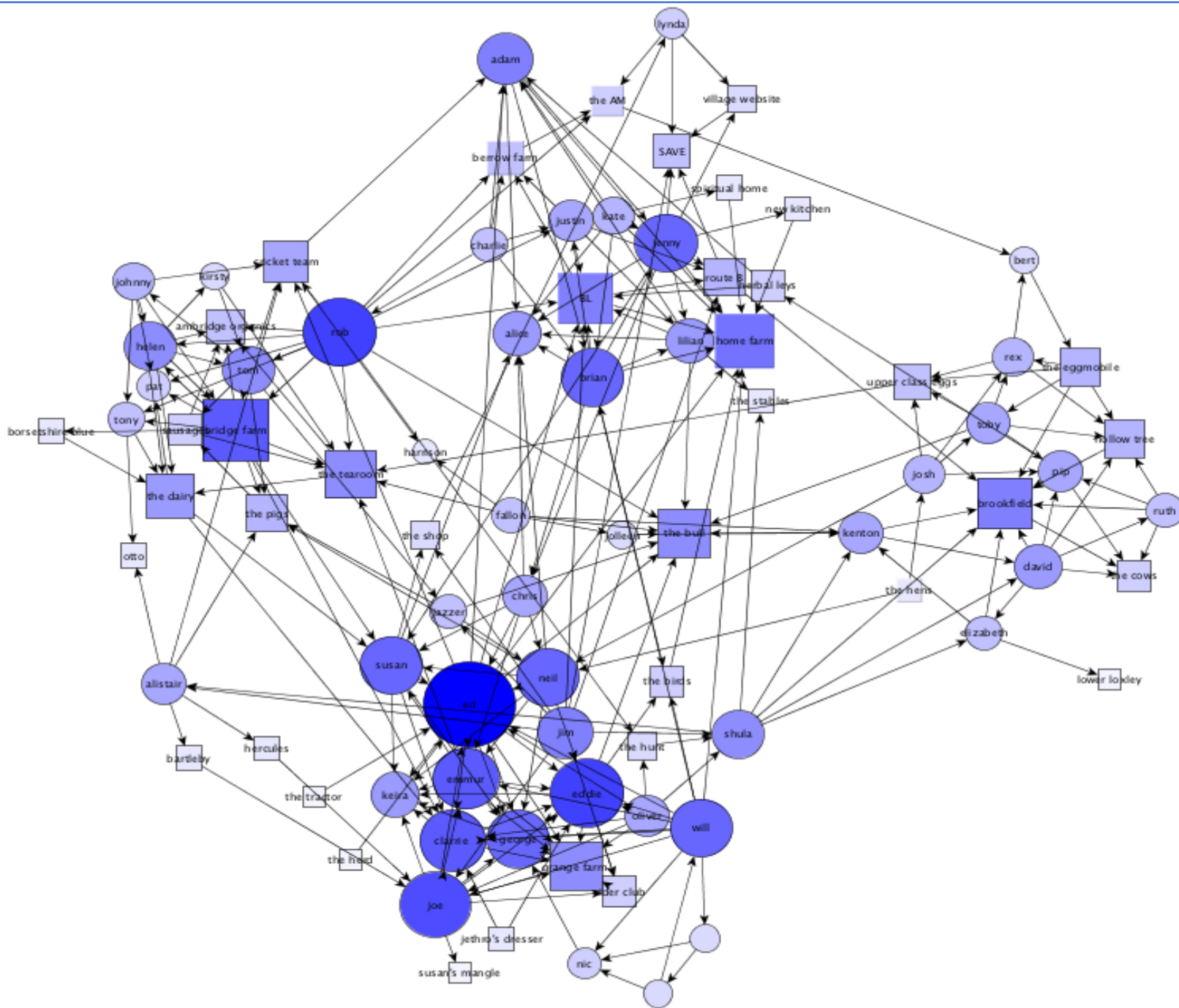
The Archers Family Tree





Map 11. Kinship & the 3 Cliques – disconnected (living only)

- 3) Grundies
- 2) Brookfield Archers
- 1) Wooley/Aldridge &c.



- actants and doing–power not being power
- Nodes are a mixture of human and no-human actants
- 95 nodes with 305 connections
- Similarities and differences in clique formation structure based on
- contract, employment, membership of some formal and informal governance bodies

Applied use of SNA

‘The Social World of the Network’ - Prof Nick Crossley, 2010

‘Relationships are not things which are either absent or present...They are lived histories of iterated interaction which constantly evolve as a function of continued interaction between parties’

‘There is always a story to tell about networks and their participants’

Studied evolution of punk music network in London and Manchester

- Use of qualitative methods
- How to get a handle on temporality in networks

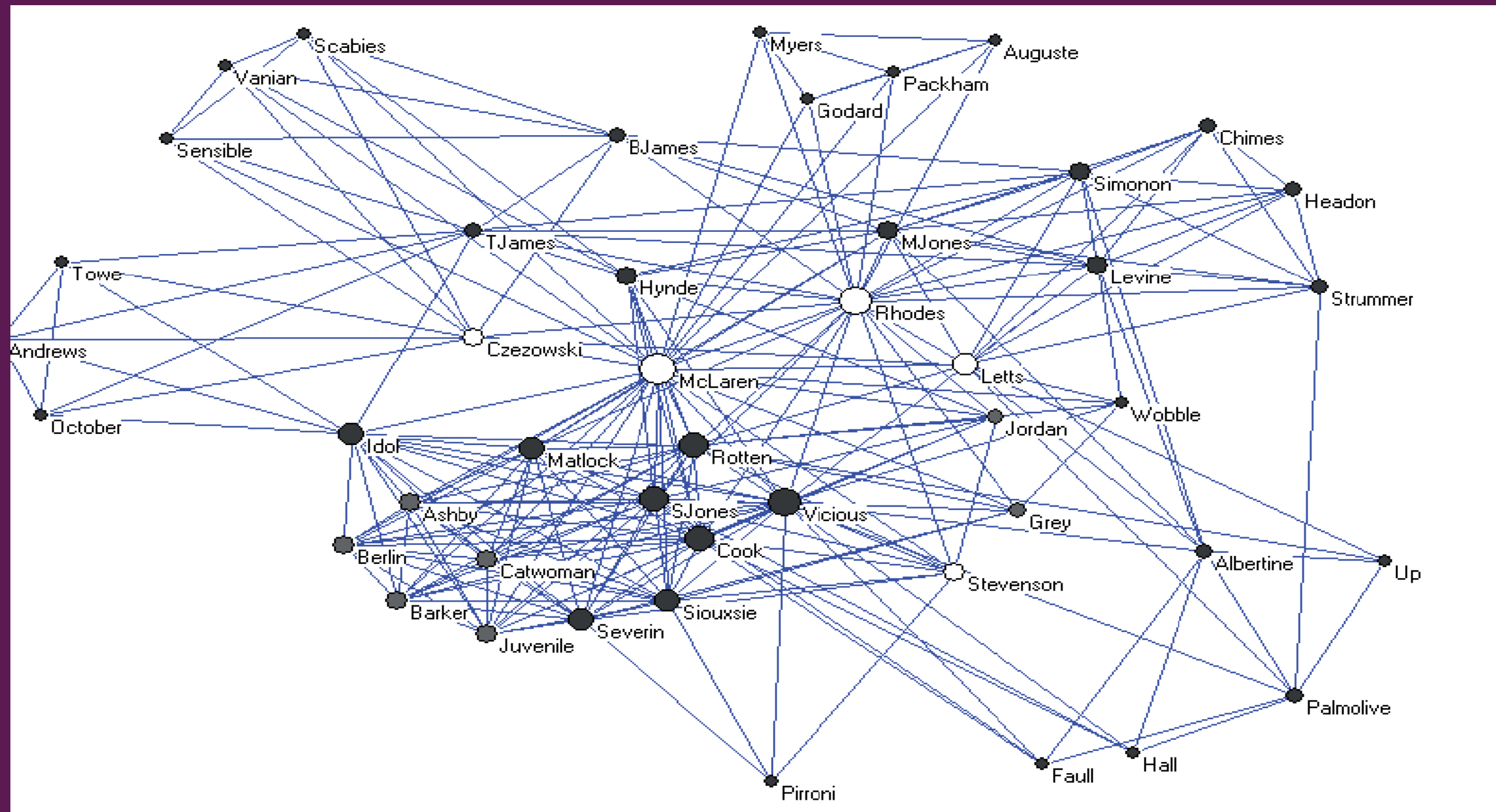


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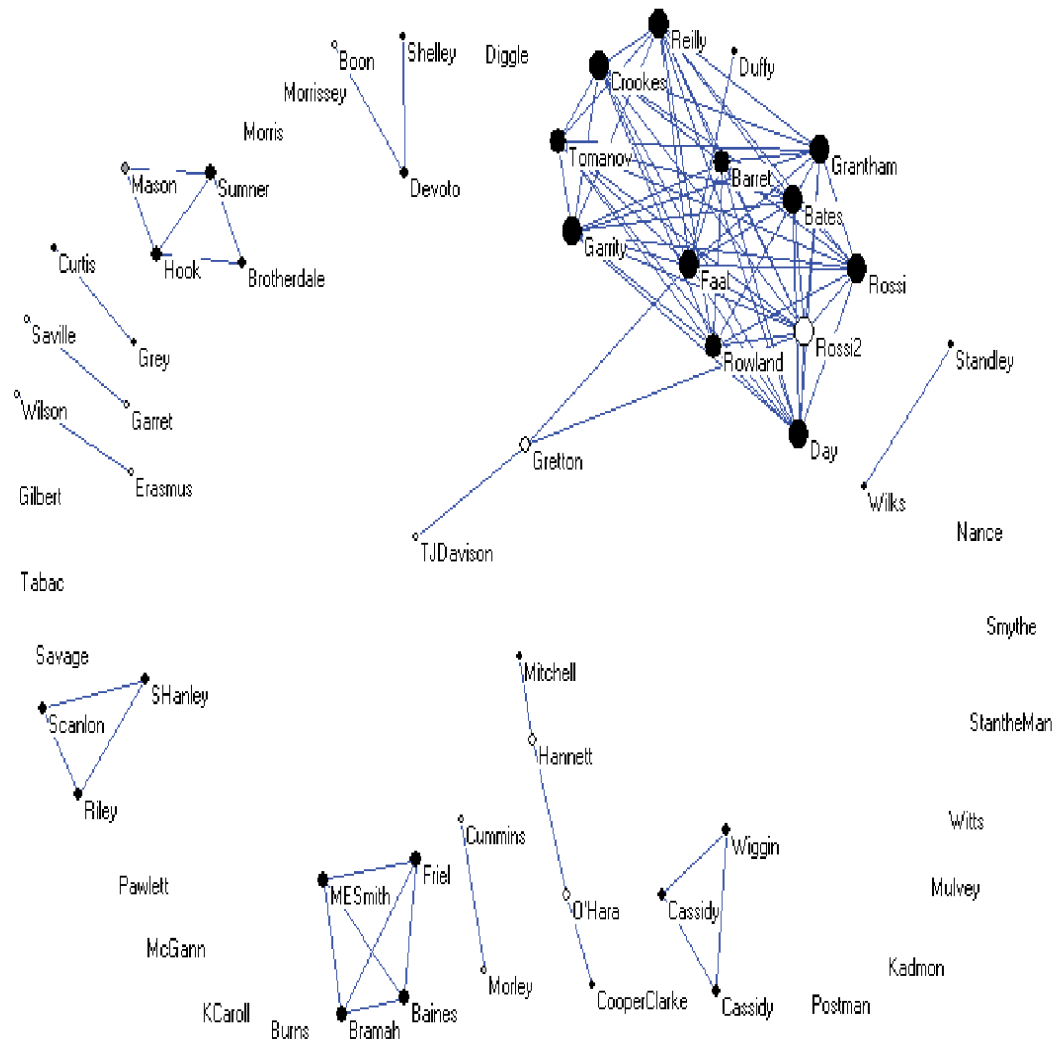
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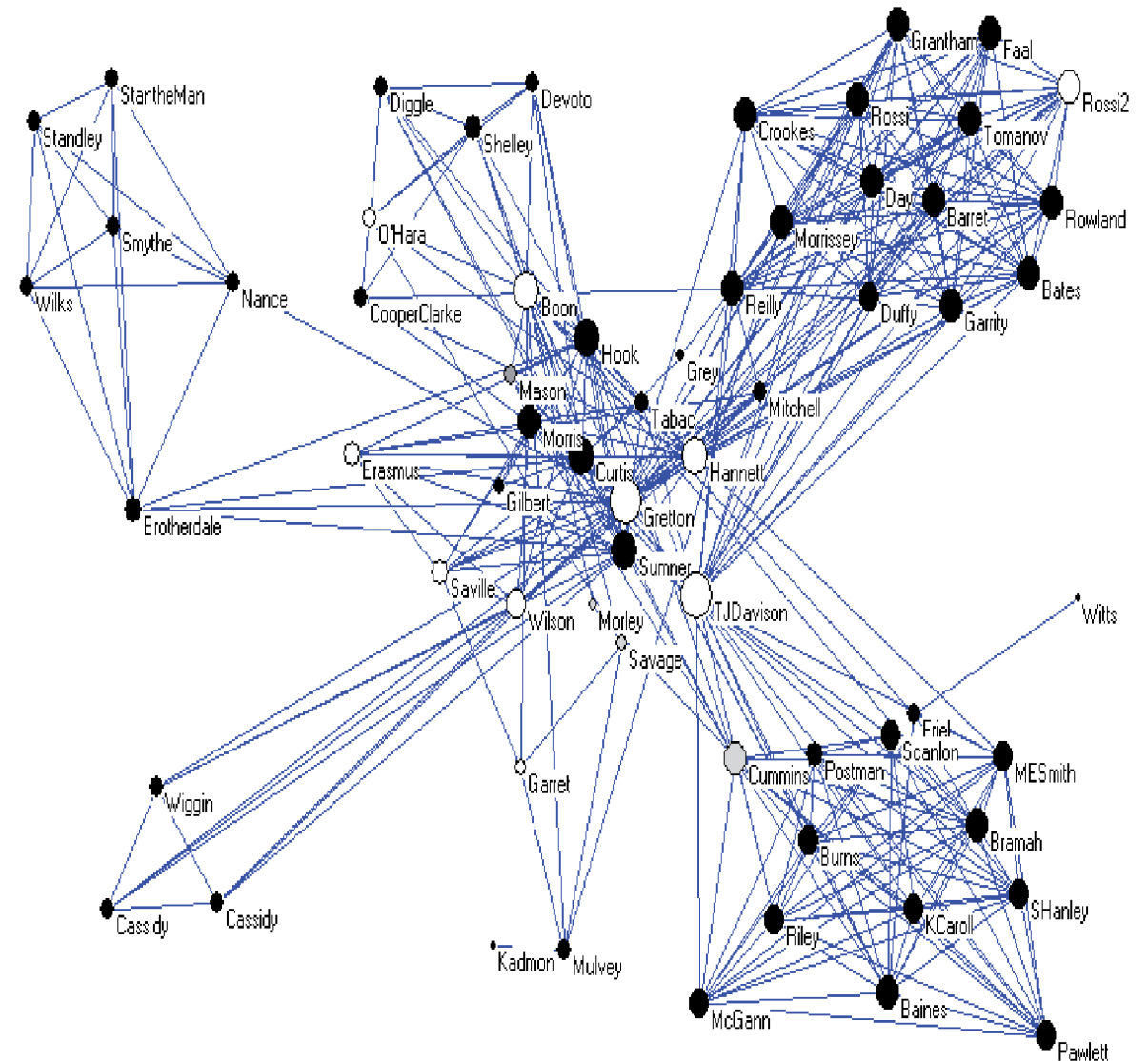
The early London punk scene



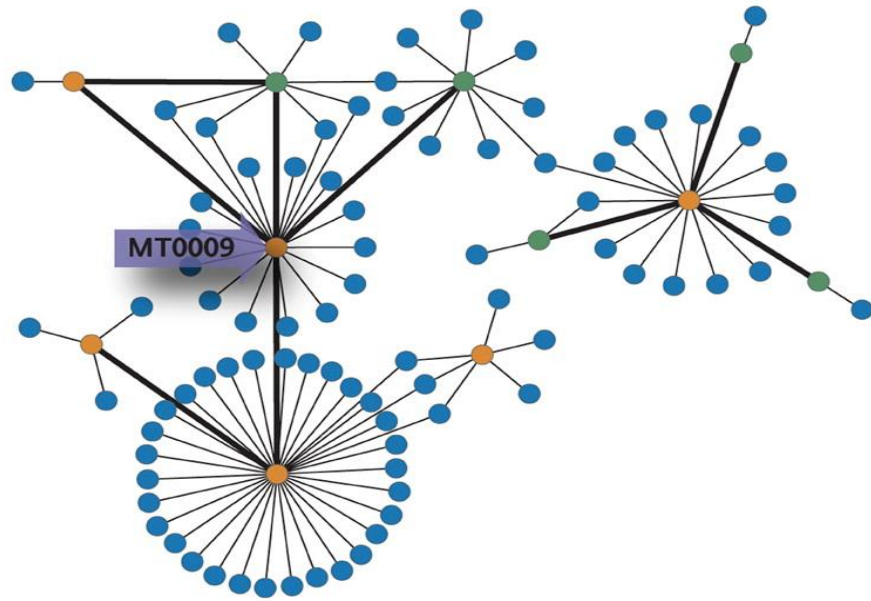
The Future Key Players of the Manchester Post-Punk Scene, June 1976



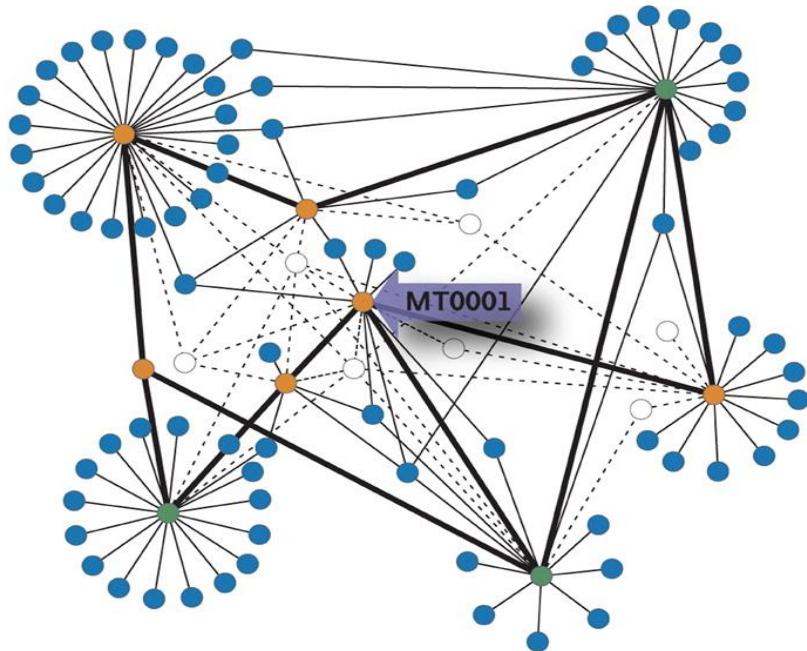
The Same Players in June 1980



A Contact Tracing



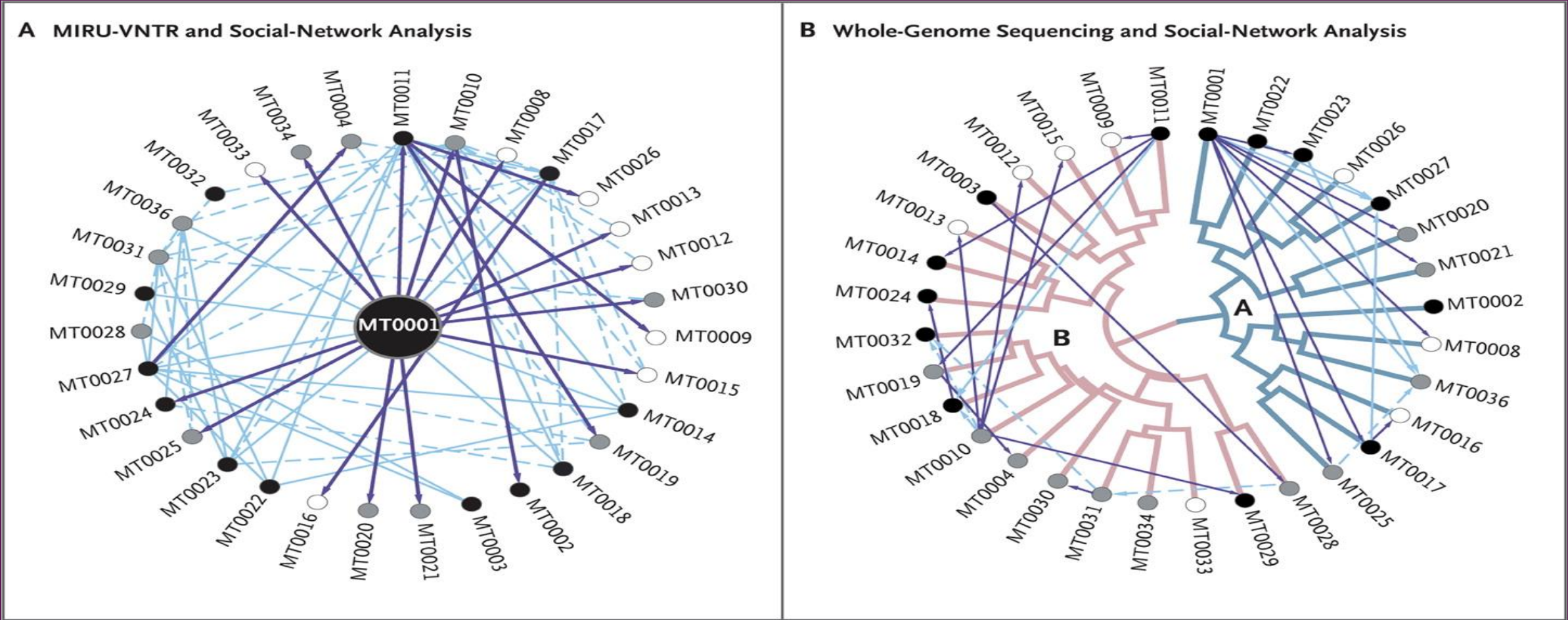
B Social-Network Questionnaire



Social-Network Analysis of a Tuberculosis Outbreak

Between May 2006 and December 2008, a total of 41 cases of tuberculosis were diagnosed in a British Columbia community struggling with the challenges of alcoholism, drug use, and transient housing arrangements. Because of the recognized limitations of contact tracing, field epidemiologists used social-network analysis early in the outbreak. Social-network analysis can improve case finding in vulnerable populations through structured interviews that identify high-risk behaviors, places of social aggregation, and persons not specifically named in traditional contact tracing. In the outbreak we studied, social-network analysis outperformed contact tracing in identifying a probable source case as well as several locations and persons subsequently targeted for follow-up.

The highly transitive nature of the outbreak community's social network made transmission patterns difficult to identify with the use of epidemiologic techniques alone. Our findings show that genome sequencing allows the larger social network to be divided into subnetworks associated with specific genetic lineages of disease. Removal of social relationships that could not have led to transmission according to the genomic data greatly reduced the complexity of the network, increased the usefulness of the existing epidemiologic data, and allowed for the identification of individual transmission events and three coprimary source patients



Local governance and the online networked public sphere

Paul Hepburn

Institute of Political and Economic Governance, University of Manchester

ECPR

Reykjavik August 2011

Research question

- Does a local political online space exist as a Web enabled networked public sphere capable of facilitating communication or discourse on civic issues between local government institutions and the wider civic society?

Context

- Theories of social transformation (Castells, Beck) contend that the post industrial information age is helping to shape a new, uncertain and complex society. Will localities be diminished or enhanced within globalised network society? Can the Web help in
- Habermas's notion of public sphere resonates with those who see potential of Web for democratic renewal (Sparks, Dahlgren, Benkler, Coleman, Sunstein, Hindman)
- Empirical evidence of Web delivering a networked public sphere mixed (Benkler, 2006 v Hindman, 2009)
- Coleman and Blumler see 'vulnerable potential' of Web delivering a networked public sphere within contemporary notions of governance.
- Is this a possibility at the level of local governance?

Case study

Examine through local case study...

- online political activity associated with Manchester Congestion Charge/Referendum
- fiercely contested local civic issue engaging 1.94 million voters, local government, local business, political parties, single issue groups, media and.....new medi
- *‘..the most important issue or story that has effected this area in a long while ..almost everybody had an opinion’.*

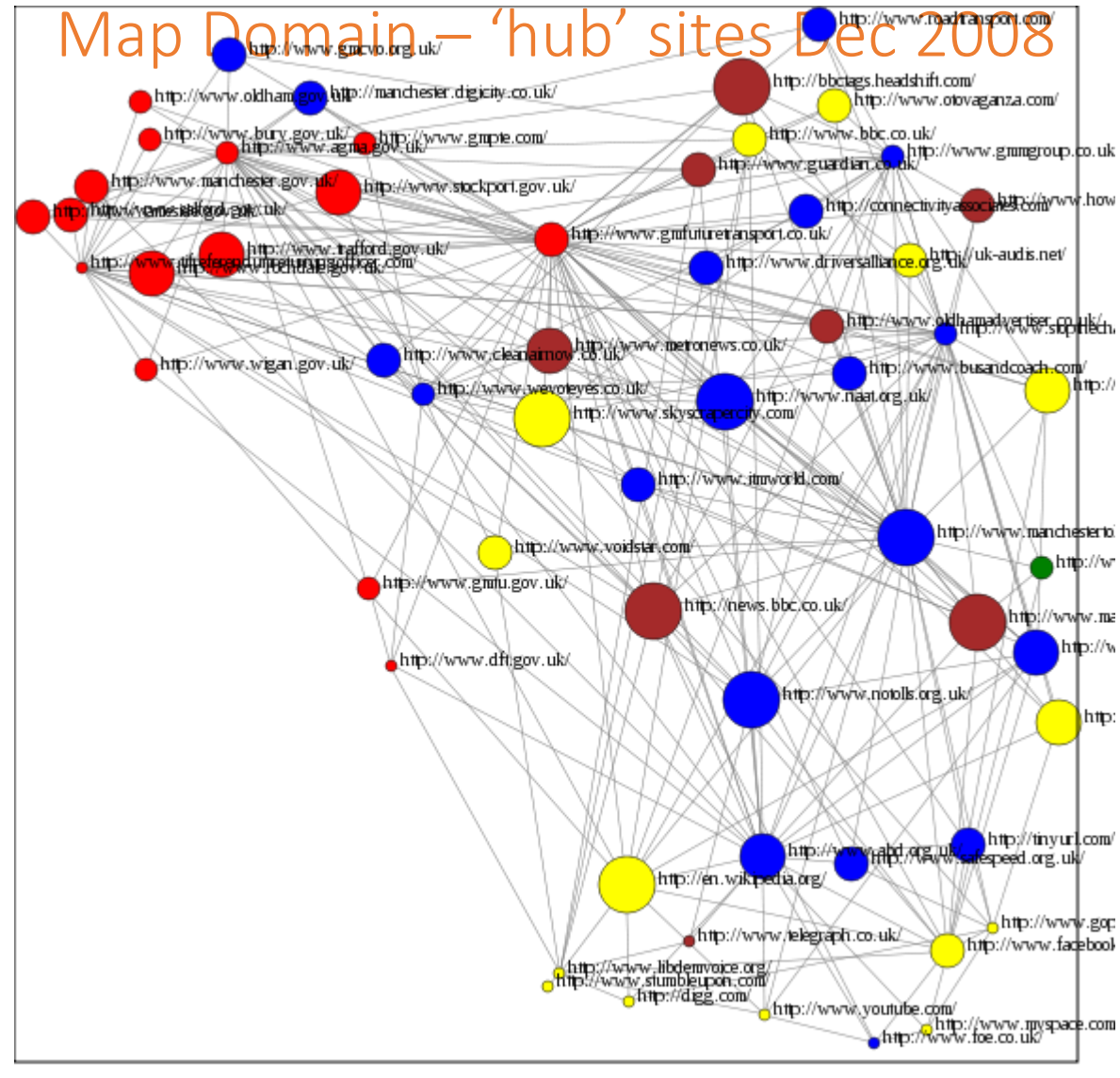
Method

- Explore hyperlinked structure of network thru' Social Network Analysis
 - Map congestion charge domain - using web crawler VOSON to extract hyperlinked network data over a period of time
 - Apply Relational Hyperlink Analysis (Lusher & Ackland 2008) – use of Exponential Random Graph Models to examine statistical significance of hyperlinks
- Examine how actors use network thru' semi-structured interviews based on a network ethnography approach

An online local networked public sphere might exist if....

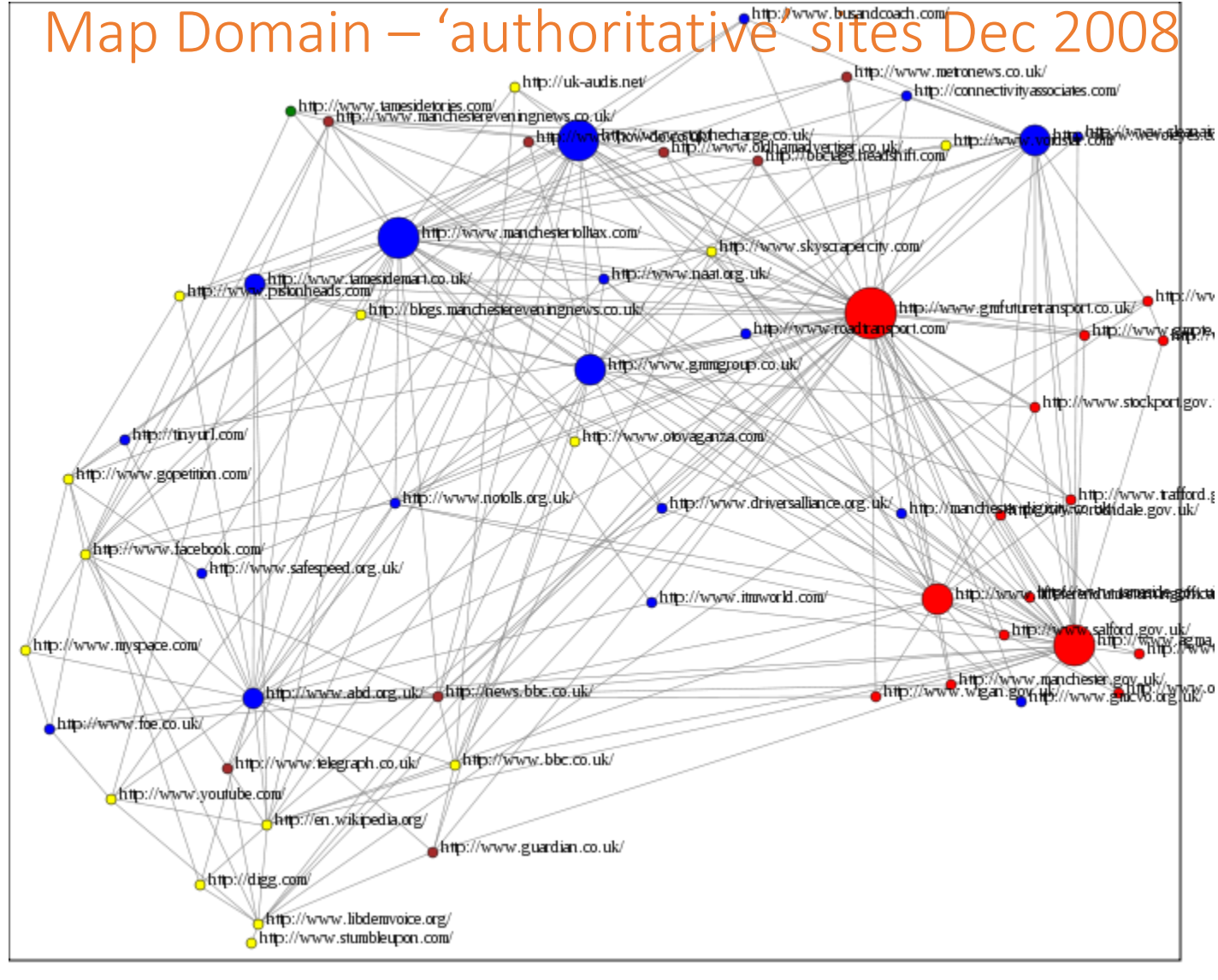
- it exists not as a single unified entity but as a number of interlinked politically relevant Web sites (Keane);
- it exists independently of vested interests but links to local government - the decision making process (Sparks); and,
- there are links to opposing views to enable an informed discussion on the issue in question (Habermas).

Map Domain – 'hub' sites Dec 2008



- Gov
- NGO
- Political Party
- Media
- Web 2

Map Domain – ‘authoritative’ sites Dec 2008



Relational Hyperlink Analysis

Evidence from network maps of 'just enough' links between sites of divergent interest to suggest networked public sphere

What else can we say about these hyperlinks?

- A number of social processes particular to social networks may be driving them (reciprocity, transitivity and homophily)
- May explain why these sites are prominent – site content or random position in network structure?
- RHA employs a set of statistical models associated with Social Network Analysis (Exponential Random Graph Models) to explore these issues.....

Exponential Random Graph Models

- Exponential Random Graph Models allow both individual level variables and structural relations to be examined simultaneously (Robins, Elliott, & Pattison, 2001)
- Works by comparing the configurations in the observed network with a hypothesised distribution of networks of similar qualities. Then see if there are more or less configurations in the observed network than might be expected by chance. If this is the case then it can be inferred that the observed network structures are not just coincidental observations but consistent patterns of social relations

**Summary of parameter estimates and standard error (p > 0.05)
for online network at close of referendum****

Parameter	<u>Model A</u>	<u>Model B</u>
	Estimate (SE)	Estimate (SE)
<u>Structural</u>		
Arc	-3.79 (1.37) *	-5.58 (1.10) *
Reciprocity		0.99 (0.29) *
Simple connectivity (Mixed 2 star)		0.01 (0.01)
Popularity (K-in-Star)		1.46 (0.21) *
Expansiveness (K-out-star)		-0.79 (0.34) *
Clustering (AKT-T)		0.52 (0.10) *
<u>Actor attributes</u>		
Interactive/ Homophily Rb		
Gov	2.61 (0.38) *	1.99 (0.34) *
NGO	-0.49 (0.30)	-0.60 (0.29) *
Political Party		
Web 2	1.76 (0.41) *	1.60 (0.39) *
Media		
Sender Rs		
Gov	0.33 (0.91)	0.55 (1.02)
NGO	2.25 (0.86) *	2.38 (1.01)*
Political Party	0.86 (0.40) *	1.07 (0.42)*
Web 2	1.51 (0.85)	1.97 (1.00)
Media	1.93 (0.88) *	2.41 (1.02) *
Receiver Rr		
Gov	-0.29 (1.07)	-1.02 (0.67)
NGO	0.23 (1.09)	-0.51 (0.69)
Political Party	-0.85 (0.94)	-0.76 (0.59)
Web 2	-1.76 (1.09)	-1.74 (0.70) *
Media	-1.32 (1.09)	-1.24 (0.69)

** The Goodness of fit for this model is not perfect. However, the vast majority of statistics did fit (100 out of 105) and this was the best fitting model for this data.

Results

- Distinct homophily effect - Gov sites were mainly linking to other Gov sites and Web 2.0 site users were, in the main, linking to other Web 2.0 sites
- These links were made because of attributes of the site(s) and not a consequence of the particular structure of the network.
- By contrast NGO, Political Party, and Media sites displayed a greater propensity to link to other sites different to theirs

How are actors using this network?

- semi structured interviews
- based upon network ethnography approach (Howard, Park)
 - 11 identified via measures network centrality
 - 6 others identified by their absence from the network
 - all interviewees shown network maps

Emerging themes

- Internet largely viewed as secondary medium by campaign leaders – but activists
- ... effectively exploited online interest in issue - Facebook group 20,000 members, forums with threads of 4,000 pages
- Local govt structurally and politically ill-equipped to engage in medium
- General view from local govt that social media is 'immature', 'anonymous', 'faceless' – difficult to assign political significance
- However 'Local' is hard to achieve online: what is a legitimate enactment of local online citizenship?
- Lack of trust amongst anti-congestion charge campaigners in local govt sites
- 'politics as usual'? – evidence of vested interests dominating online as well as off

Conclusion

- Local online networked public sphere might exist structurally but not used as such by social and political actors
- A 'local' online discourse more likely occurs within two different civic 'communities' but not between them.
- Undue influence by vested economic interests in online sphere
- Local is still important - policy intervention required around enacting inclusive conception of local online citizenship and developing independent networked, local online sphere of influence.

Source material

SNA software

- yED <https://www.yworks.com/products/yed>
- NodeXL <https://nodexl.codeplex.com>
- UCINET <https://sites.google.com/site/ucinetsoftware/>
- VOSON <http://www.uberlink.com>
- PAJEK <https://casmodeling.springeropen.com/articles/10.1186/s40294-016-0017-8>

Books and articles

Wasserman, S., Faust K (1994) Social network analysis: methods and applications. Cambridge University Press

Scott, J (2017) Social Network Analysis , SAGE

Kadushin, C (2012) Understanding Social Networks, Oxford

Crossley, N (2010) The social world of the network. Combining Qualitative and Quantitative elements in Network Analysis. Socologica

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Next Steps?



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