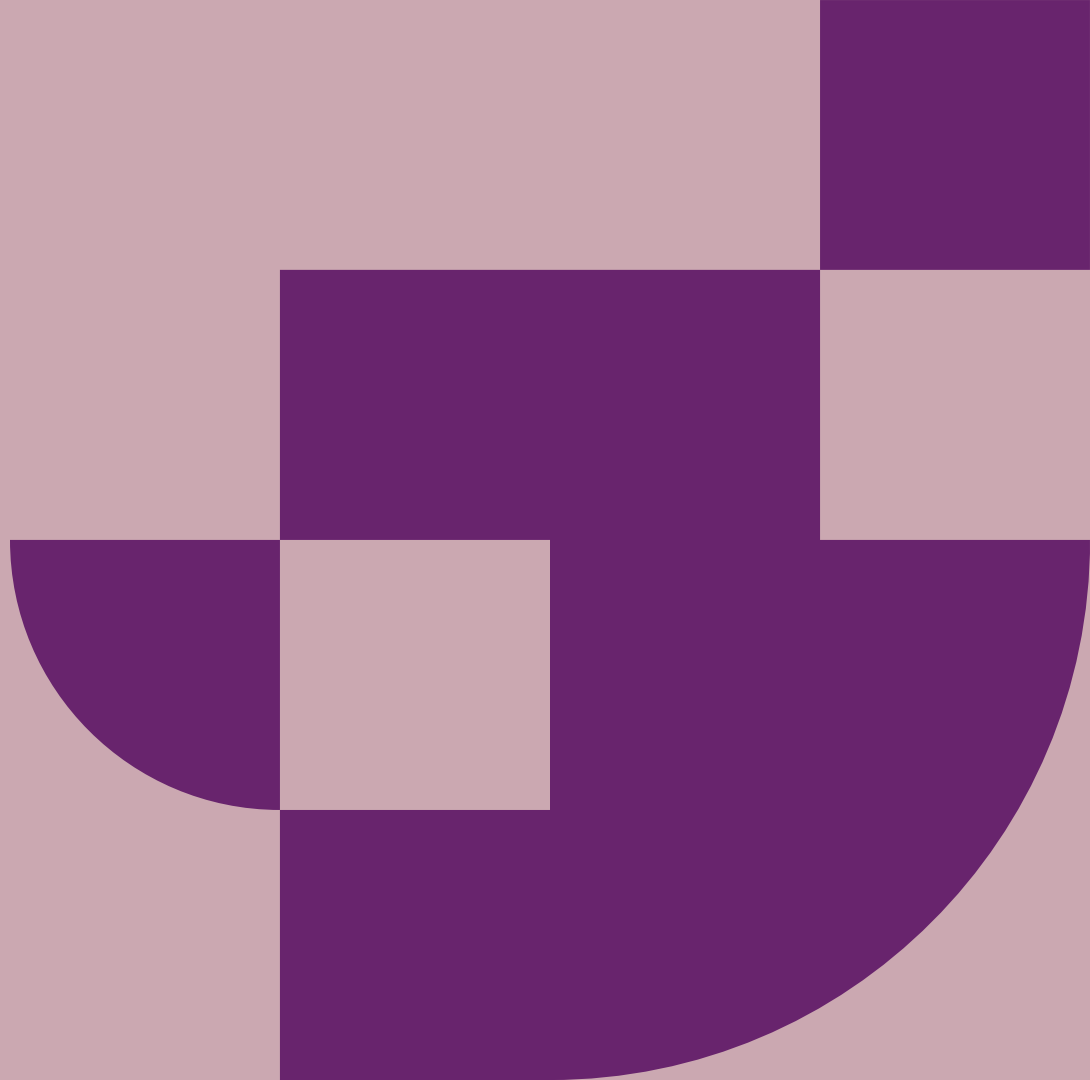




Durham
University

Synthesis

Computational Social Science
Lecture 10



Overview

Social science deals with complex problems

- Revisit ideas from Lecture 1

Computational social science provides a set of methods that are suited to complex problems

- Combine data and complexity-aware theory

Compare how methods incorporate complexity

- Complexity methods: to statistical models
- Four focus methods: to each other

One thing...

At the end of lecture, I will ask you

- Something(s) you learned in this module that you think is important
- Something(s) you learned in this module that you found interesting

It would be great if you can think of more than one!

Giving you some warning so you can think about it



Particularly important to not read
ahead this week

Complex Realism

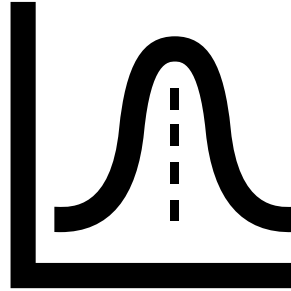
*It is a nuisance, but God has
chosen to give the easy
problems to the physicists.*

Lave & March (1993). *An Introduction to Models in the Social Sciences*.
University Press of America. Lanham, MD

Weaver's organisation of scientific problems

Phase 1: to 1900

- Physical sciences
 - Problems of simplicity
 - Experimental methods isolate and compare
 - Technological advancement
- Life sciences
 - Classify and describe



Phase 2: to 1948

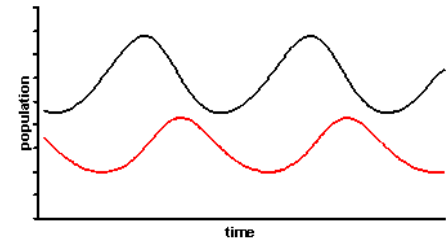
- Problems of disorganised complexity
- Statistical methods effective as average meaningful

Phase 3: after 1948

- Organised complexity: *sizeable number of factors which are interrelated into an organic whole*
- Common in social and life sciences

Require

- Computing power
- Multidisciplinary teams



Current social problems less amenable to traditional methods

Global population overload

Global warming and climate change

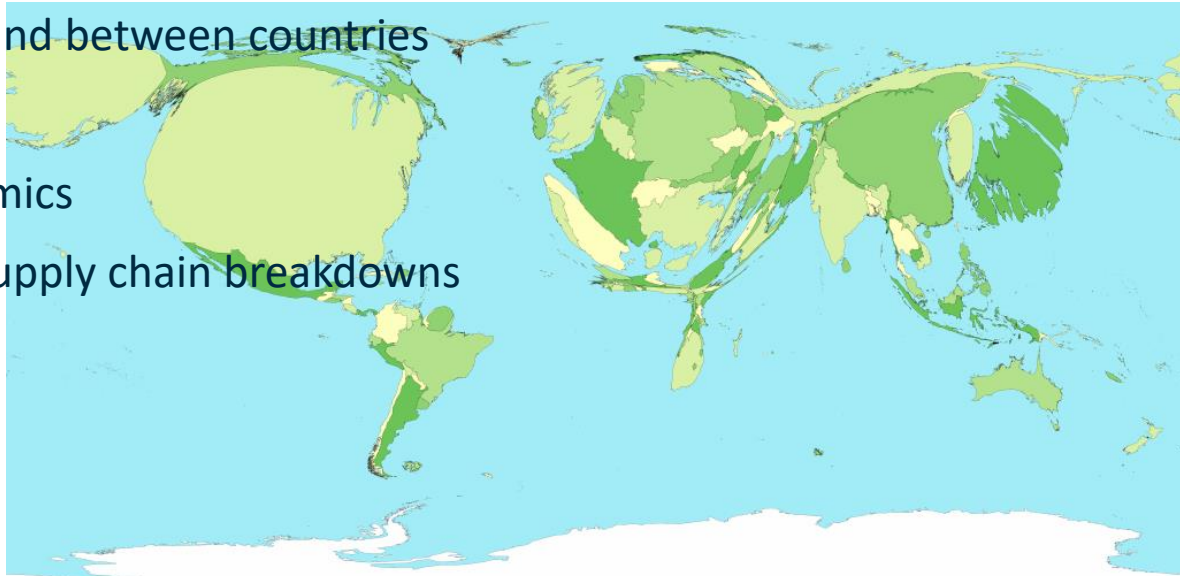
Increasing ecological challenges – access to water, food

Entrenched inequality, within and between countries

Cultural conflict and terrorism

Fast moving epidemics, pandemics

Fragile infrastructure such as supply chain breakdowns



Social problems are qualitatively different: complex

A system is complex if the *system's behaviour of interest is driven by the interactions* between the individual parts, not simply the behaviour of the parts independently.

Something 'more' than having many parts that are linked in complicated ways



Interaction at the core of complexity gives rise to characteristic properties

THE VISUAL REPRESENTATION OF COMPLEXITY

* Definitions, Examples & Learning Points *

Sustainability practitioners have long relied on images to display relationships in complex adaptive systems on various scales and across different domains. These images facilitate communication, learning, collaboration and evaluation as they contribute to shared understanding of systemic processes. This research addresses the need for images that are widely understood across different fields and sectors for researchers, policy makers, design practitioners and evaluators with varying degrees of familiarity with the complexity sciences. The research identifies, defines and illustrates 16 key features of complex systems and contributes to an evolving visual language of complexity. Ultimately the work supports learning as a basis for informed decision-making at CECAN (Centre for the Evaluation of Complexity Ideas and the Nexus) and other communities engaged with the analysis of complex problems.

A research process was designed to identify sixteen key characteristics of complexity and to inform the development of new images and descriptions. In order to gather ideas from academics, sustainability practitioners and designers with expertise in the complexity sciences, systems mapping and design, I collected 50 surveys at The Environment, Economy, Democracy, Flourishing Together RSDX (Relating Systems Thinking and Design) conference in Oslo (10-11 London (November and December 2017). The images developed with this research process. The text below Martha Bicket and Dione Hines. Many thanks to RSDX ideas in the surveys and workshops.

1. Feedback

When a result or output of a process influences the input either directly or indirectly, this can accelerate or suppress change.

- Examples:
 - A thermostat in a room, an individual plant, an animal (such as a predator-prey relationship).
 - The need to share to maintain a constant body temperature (negative feedback).
 - The climate change, permafrost melts and releases more greenhouse gases. These feed back into the climate system (positive feedback).

LEARNING POINTS

- Feedback loops can lead to runaway effects, or can create limits through dampening of effects.
- Feedback loops are modifying and accelerating change.
- Negative feedback supports change and stabilising regulating.

2. Emergence

New, unexpected higher-level properties can arise from the interaction of components. These properties are said to be emergent if they cannot easily be described, explained, or predicted from the properties of the lower-level components.

- Examples:
 - A market price is an emergent property, arising from the interaction of buyers and sellers.
 - A traffic jam is an emergent phenomenon, resulting from the interaction of many cars.
 - Consensus is an emergent property of the collective mind of the members of a team.

LEARNING POINTS

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9. Tipping points

The point beyond which system outcomes change dramatically may take place slowly initially, but suddenly increase in pace after the point beyond which system behaviour suddenly changes.

- Examples:
 - The global climate system (melting of ice sheets).
 - Local climate change leading to a regime change.
 - A species population reaching a threshold to the extent that it cannot be sustained.

LEARNING POINTS

- Feedback loops can lead to runaway effects, or can create limits through dampening of effects.
- Feedback loops are modifying and accelerating change.
- Negative feedback supports change and stabilising regulating.

10. Change over time

Complex systems inevitably develop and change their behaviour. This is due to their openness and the adaptation of their parts, but also the fact that these systems are open to external influences and are continuously changing.

- Examples:
 - A local community gathering (change in behaviour when the community part is changed).
 - A traffic jam (change in behaviour when the community part is changed).
 - A traffic jam (change in behaviour when the community part is changed).

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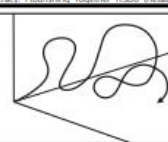
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5. Non-linearity

A system is non-linear when the effect of inputs on outcomes are not proportional. The behaviour of a system may exhibit exponential changes, or changes in direction (i.e. increases in some measure becoming decreases), despite small or consistent changes in inputs.

- Examples:
 - A small change in a car's speed is more than twice that at 200km/h.
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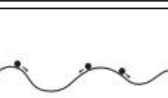
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6. Domains of stability

Complex systems may have multiple stable states which can change as the context evolves. Systems gravitate towards such states, remaining there unless significantly perturbed. If change in a system passes a threshold, it may slide rapidly into another stable state, making change very difficult to reverse.

- Examples:
 - The melting of glaciers (the glacier may be stable with or without ice caps, but once it starts melting, it will continue to melt).
 - The melting of glaciers (the glacier may be stable with or without ice caps, but once it starts melting, it will continue to melt).
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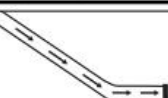
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8. Path dependency

Current and future states, actions, or decisions depend on the sequence of states, actions, or decisions that preceded them – namely their typically temporary paths.

- Examples:
 - The choice of a path of a person's path, determines which that person is possible to reach in a given path dependency.
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13. Unknowns

Because of their complex causal structure and openness, there are many factors which influence (or can influence) a system of which we are not aware. The inevitable existence of such unknowns means we often see unexpected indirect effects of our interventions.

- Examples:
 - A small change in a car's speed is more than twice that at 200km/h.
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Complex systems involve Collective Behaviour

Emergence

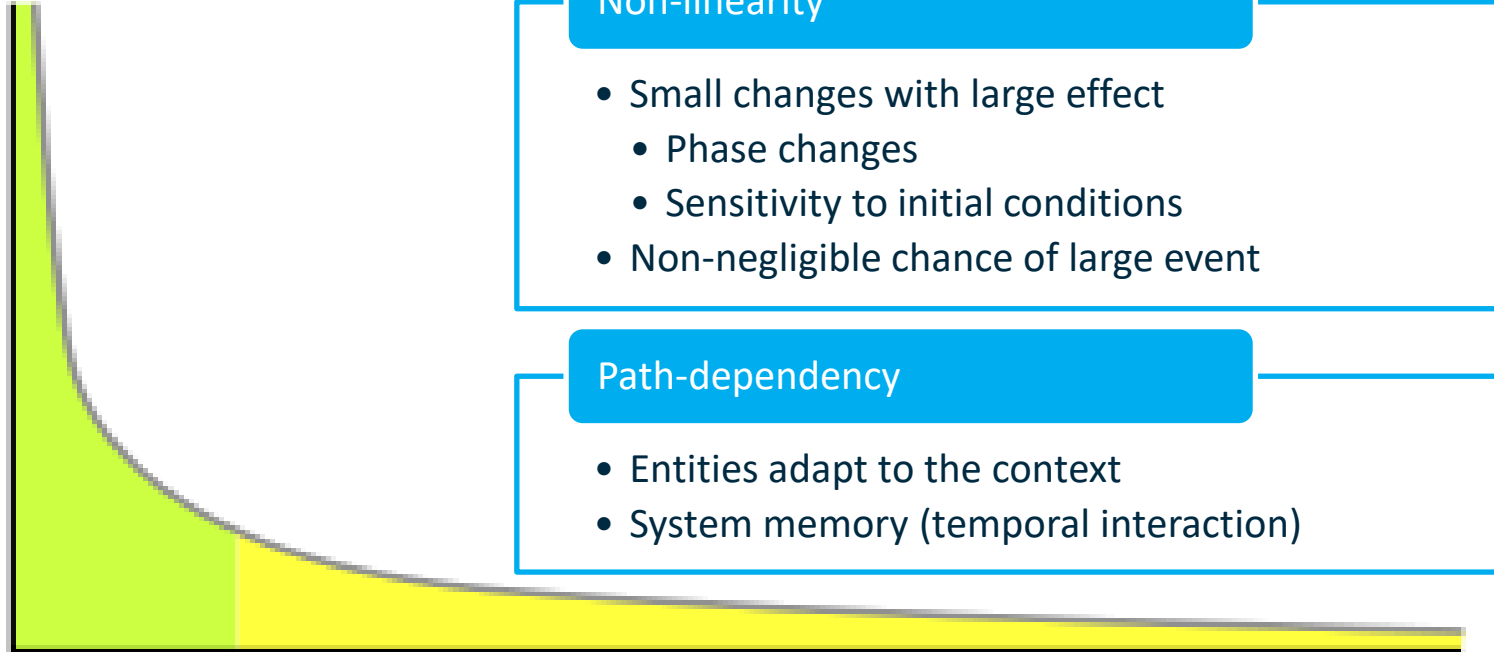
- Formal term for the system having properties that the parts do not have

Self-organisation

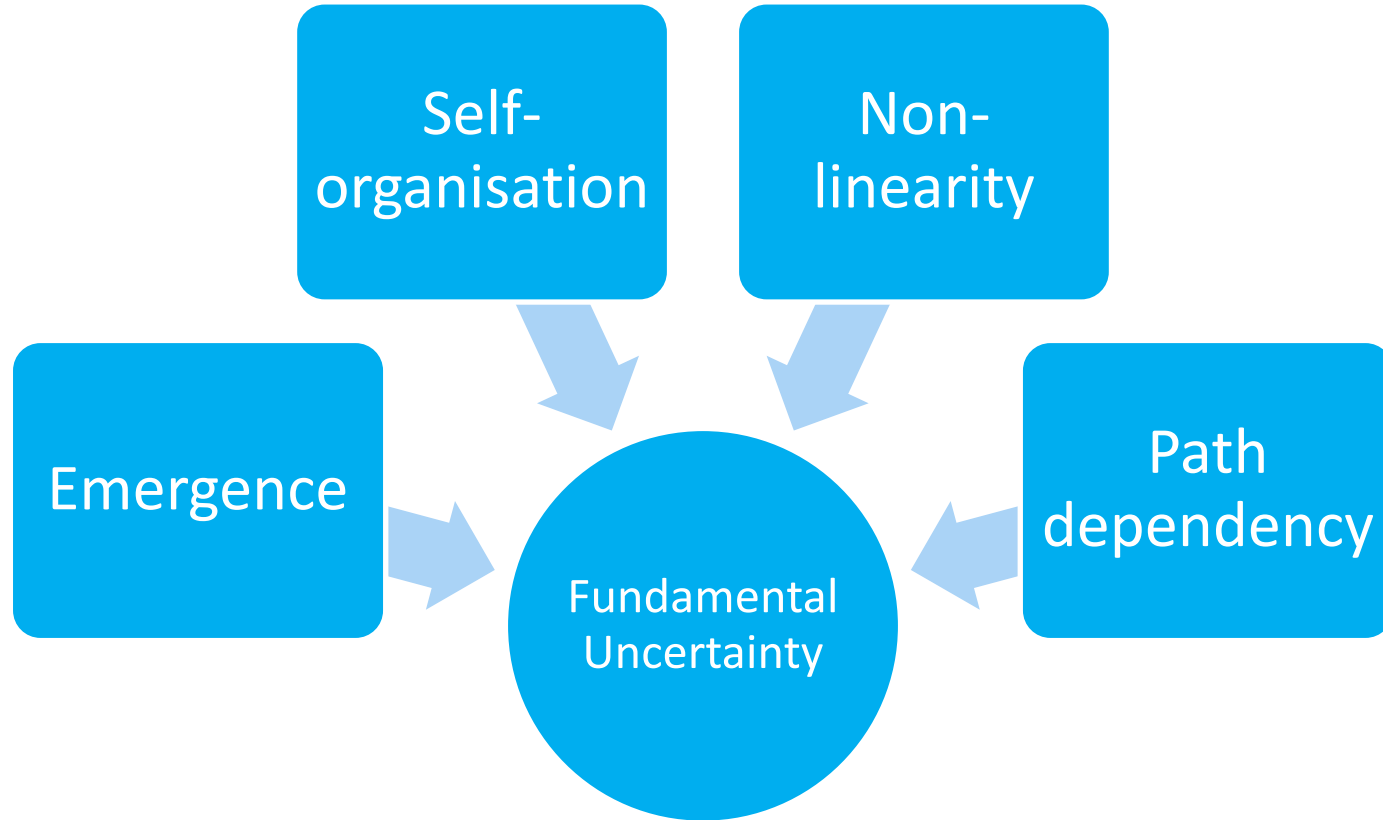
- The system exhibits order
- Parts (entities) are autonomous, without central control



Complex Systems involve Feedback



Complex systems difficult to understand and predict



Positivism and Empiricism

The role of social science is to uncover the rules that govern the social world

- Emulates natural sciences with proof, methods
- Experience, observation are only source of knowledge

These rules describe the way in which the macro-structure and norms of society lead to the behaviour of people

- Attributes of individuals (eg gender) expose them to different norms

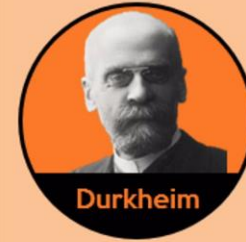
Positivists (unlike strict empiricists) allow logic to supplement observation

Positivism

as is sociology
a science?

as yes! it is 'the
queen of the
sciences' (Comte)

social facts



Durkheim



Comte

as behaviour
explained by:

as cause and
effect
relationships



quantitative

objectivity and measurement

macro / structural theories



key study: Durkheim –
Suicide (1897)

Interpretivism and Constructivism

Multiple realities

- Individuals experience and understand the same event differently

Interpretivism: How are these realities experienced and perceived?

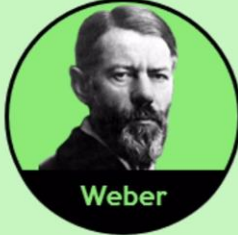
- People are experts in their own reality

Constructivism: How are realities constructed through interaction with others?


s. **Interpretivism**

as is sociology a science? as no! it is about meaning, which can't be measured


verstehen

 **Mead**  **Weber**

as behaviour explained by: as free-will, not external causes

 **qualitative**
subjectivity and understanding

micro / social action theories

 **key study: Atkinson – Discovering suicide (1978)** as all sociology

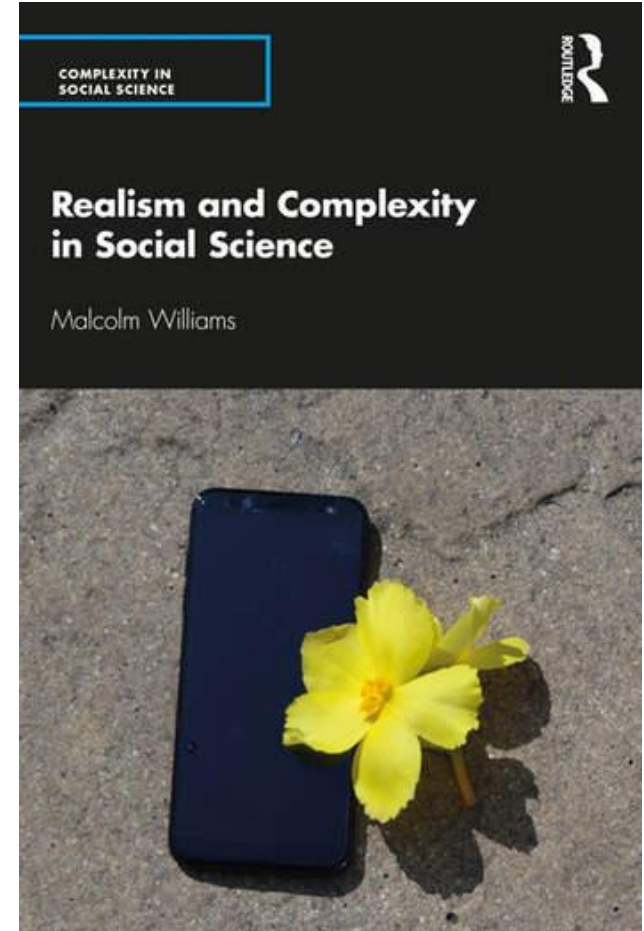
Complex Realism

Realism lies between positivism and interpretivism

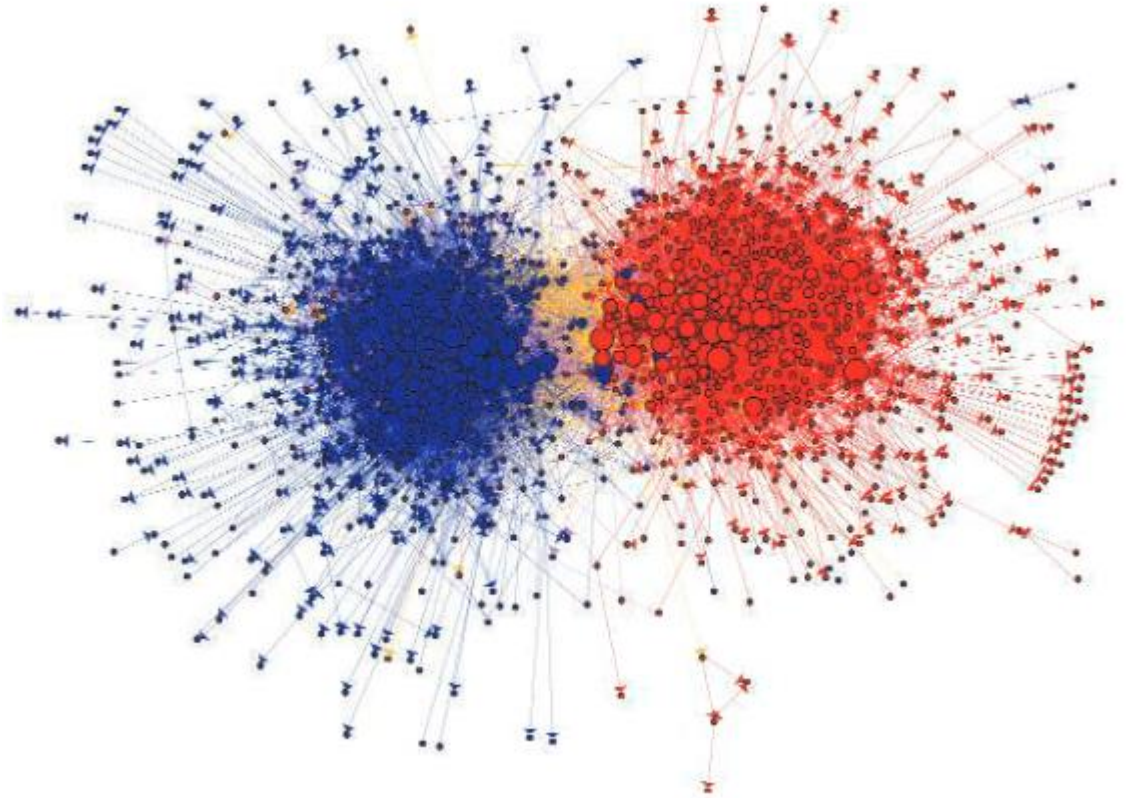
- There is a real social world to measure and understand that exists independently of our minds (Positivism)
 - Otherwise could not get things wrong (Sayer 2000)
- Actions have an effect on society (Constructivism)
- Combines quantitative and qualitative methods

That real social world is complex

- Social structures emergent property of social relations
- Social systems are open and evolve



What is computational social science?



Competing definitions of CSS: Lazer et al

Lazer et al (2009), Computational Social Science
doi: 10.1126/science.1167742

Substantial social data available

- Communication networks
- Social media
- Contents of searches
- Virtual worlds for experiments

Why not (yet) transformed social science

- Privacy concerns
- Limited resources
- Interdisciplinary: training, academic careers, journals

SOCIAL SCIENCE

Computational Social Science

David Lazer,¹ Alex Pentland,² Lada Adamic,³ Sinan Aral,^{2,4} Albert-László Barabási,⁵
Devon Brewer,⁶ Nicholas Christakis,¹ Noshir Contractor,⁷ James Fowler,⁸ Myron Gutmann,³
Tony Jebara,⁹ Gary King,¹ Michael Macy,¹⁰ Deb Roy,² Marshall Van Alstyne^{2,11}

A field is emerging that leverages the capacity to collect and analyze data at a scale that may reveal patterns of individual and group behaviors.

We live life in the network. We check our e-mails regularly, make mobile phone calls from almost any location, swipe transit cards to use public transportation, and make purchases with credit cards. Our movements in public places may be

ment agencies such as the U.S. National Security Agency. Computational social science could become the exclusive domain of private companies and government agencies. Alternatively, there might emerge a privileged set of academic researchers providing open access to data

critiqued or replicated. Neither scenario will serve the long-term public interest of accumulating, verifying, and disseminating knowledge.

What value might a computational social science—based in an open academic environment—offer society by enhancing understand

Competing definitions of CSS: Conte et al

Conte et al (2012), Manifesto of computational social science. doi: 10.1140/epjst/e2012-01697-8

Formidable social problems

Digital and data are changing society

Generative explanations combine theoretically based models with data

- Primarily about ABM
- Many scientific challenges
 - How much detail in agents?

Manifesto of computational social science

[R. Conte](#) , [N. Gilbert](#), [G. Bonelli](#), [C. Cioffi-Revilla](#), [G. Deffuant](#), [J. Kertesz](#), [V. Loreto](#), [S. Moat](#), [J. -P. Nadal](#), [A. Sanchez](#), [A. Nowak](#), [A. Flache](#), [M. San Miguel](#) & [D. Helbing](#)

The European Physical Journal Special Topics **214**, 325–346 (2012) | [Cite this article](#)

11k Accesses | 217 Citations | 29 Altmetric | [Metrics](#)

Abstract

The increasing integration of technology into our lives has created unprecedented volumes of data on society's everyday behaviour. Such data opens up exciting new opportunities to work towards a quantitative understanding of our complex social systems, within the realms of a new discipline known as Computational Social Science. Against a background of financial crises, riots and international epidemics, the urgent need for a greater comprehension of the complexity of our interconnected global society and an ability to apply such insights in policy decisions is clear. This manifesto outlines the objectives of this new scientific direction, considering the challenges involved in it, and the extensive impact on science, technology and society that the success of this endeavour is likely to bring about.

Much in common...

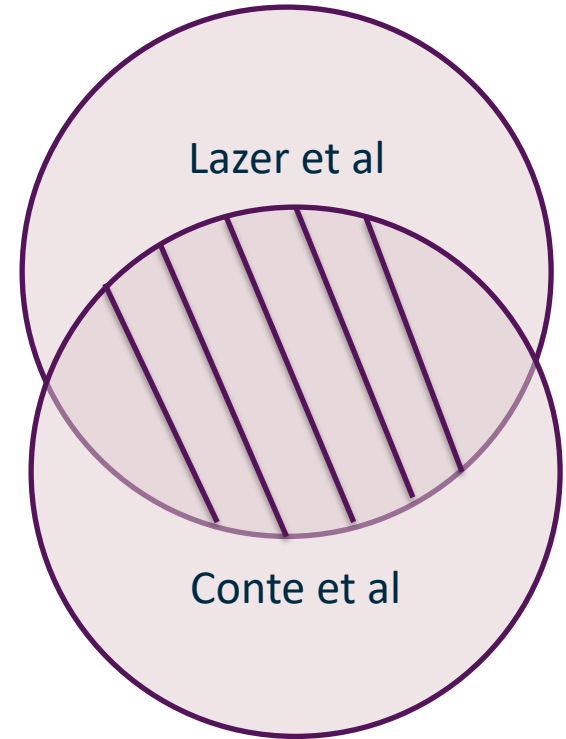
Potential of big data for social science

- Digital traces of individual and group behaviour
- Enormous scale of the available data
- Similar data sources

Opportunity to apply quantitative methods to understand society

- Data science provides methods

Interdisciplinary: social science and data science

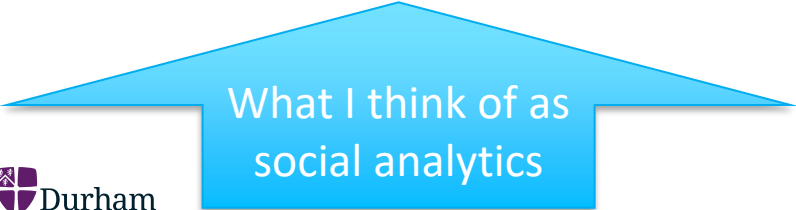


... but fundamentally different

Lazer et al: Applying data science methods to social data

- Data driven analysis of patterns of behaviour

... leverages the capacity to collect and analyze data at a scale that may reveal patterns of individual and group behaviors



What I think of as
social analytics

Conte et al: using computational methods to do social science

- Explicit integration of analysis with theory and complexity

... unprecedented volumes of data ... opens up exciting new opportunities to work towards a quantitative understanding of our complex social systems



This module

Is someone analysing Facebook friend data doing social science?



If yes, why?

About social interactions and behaviour

Can research phenomena such as diffusion, conformity, opinion change, characteristics of groups of interest

If no, why not?

No meaning defined by friendship

Social science connects to some theory

Analysis is primarily descriptive

Ultimately, depends on the research question: what is the purpose of the analysis?

CSS is quantitative, but different from statistics

2010 ESRC review of UK sociology found

- Weak training in quantitative methods compared to US tradition
- Statistics core to social science

Byrne's commentary

- Agree more quantitative needed
- Review equated that to statistics
- Methods must deal with complexity
 - Statistical methods do not

UK Sociology and Quantitative Methods: Are We as Weak as They Think? Or Are They Barking up the Wrong Tree?

David Byrne
Durham University, UK

Abstract

This piece responds to the *Benchmarking Review of UK Sociology's* assertion that the discipline has a deficit in quantitative methods and that the solution involves a recognition that: '... statistical methods form the core of social science.' It argues that whilst a quantitative programme is essential and we can agree that there are problems in relation to the quantitative competencies of sociologists at all levels in the UK, a turn to conventional statistical methods is not the way to go. The argument is developed first in relation to epistemic critiques of those methods by Pawson and Goldthorpe and then by the outlining of an alternative founded in a synthesis of complexity and systematic comparison. The key issue is that we need a quantitative programme which actually corresponds to social reality and that is not to be found in statistical methods which reify variables and consider causality in linear terms.

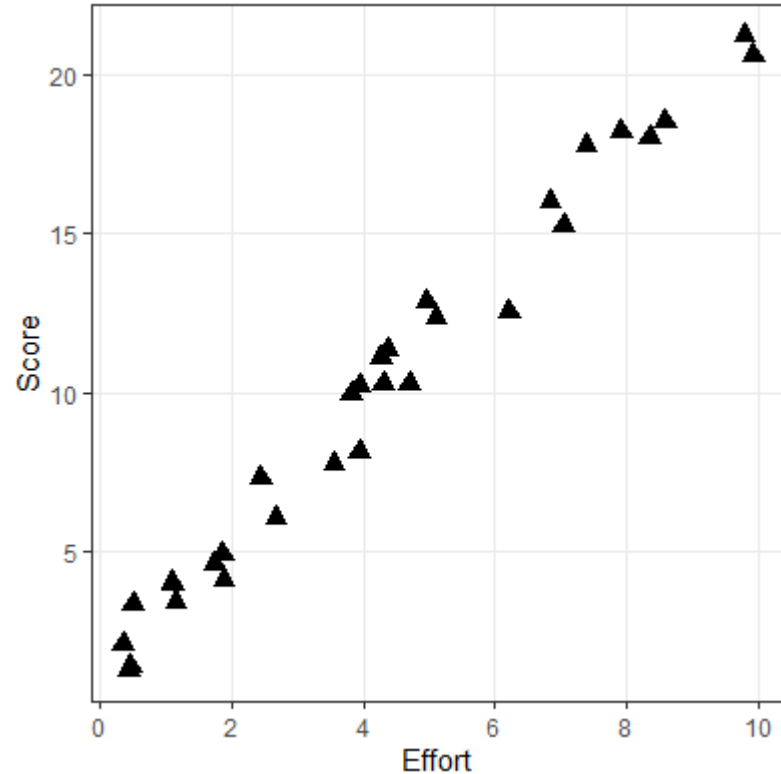
Sociology
46(1) 13–24
© The Author(s) 2012
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DOI: 10.1177/0038038511419178
soc.sagepub.com


Explanation with linear statistical modelling

How would you summarise the attributes of these cases?

- People who put in only a small amount of effort achieve a low score, and those who put in a large effort achieve a high score
- Each additional amount of effort is associated with the same increase in score

Linear: constant increase regardless of effort

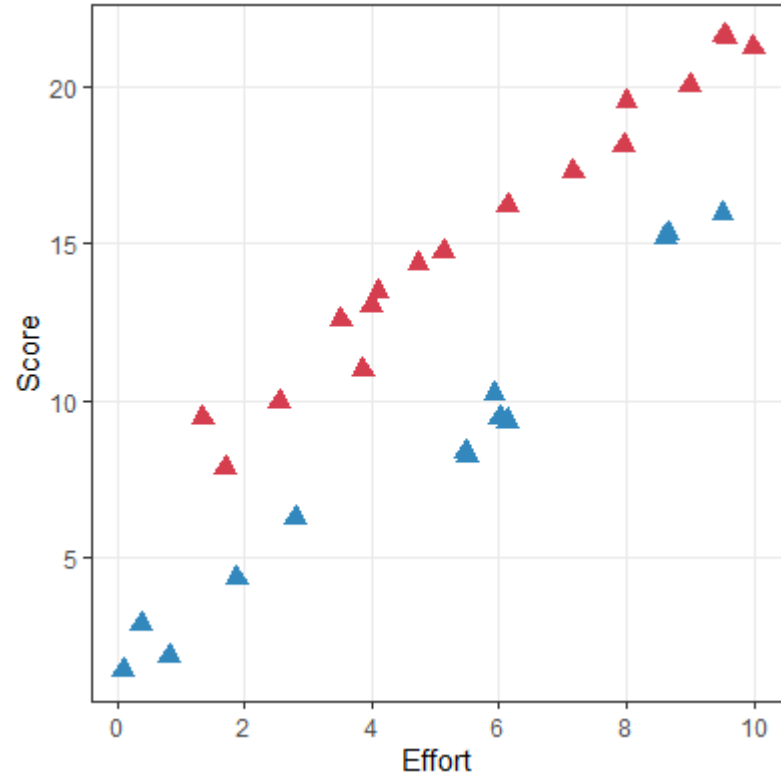


Explanation with multiple relevant attributes

How would you summarise the attributes of these cases?

- As before, score related to effort
- Additional factor indicated by colour
 - Those marked as red have consistently higher scores for same effort

Additive and independent: additional score for red is constant regardless of effort

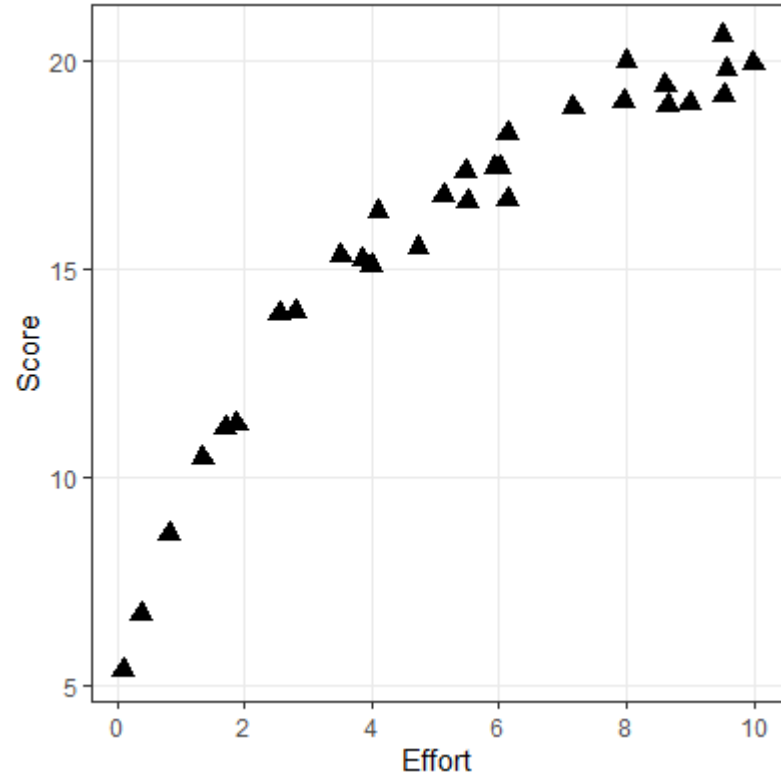


Explanation with nonlinear statistical modelling

How would you summarise the attributes of these cases?

- Score increases with effort
- After a certain amount of effort, each additional amount of effort has smaller impact

More complicated mathematical relationships are possible, but all have a single equation to set out how the value of one attribute is estimated by some combination of the values of all others



Difference in type of explanation most evident for QCA

Cases that are irrelevant in the logical structure of QCA would reduce the explanatory power of statistical model

Example: (from lecture) of hypothetical austerity protests

- Subset of cases with severe austerity
- Rapid price rise sufficient to protest
- Protests without rapid price rise undermine statistical explanation

Rapid price rises	Protests	
	Yes	No
T	23	0
F	6	7

Explanation in complex realism

In Complex Realism effects are

- Complex: involve interactions between multiple factors
- Emergent: cannot be reduced to individual factors or elements
- Contingent: function differently depending on context

Cannot be described by some mathematical relationship between values of attributes




Dealing with complexity

THE VISUAL REPRESENTATION OF COMPLEXITY

★ Definitions, Examples & Learning Points ★

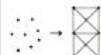
Sustainability practitioners have long relied on images to display relationships in complex systems. The development of such images and associated definitions, however, has been slow and inconsistent. Learning, reflection and evaluation as they contribute to shared understanding of systemic processes. This research addresses the need for images that are easily understood across different fields and sectors for researchers, policy makers, design practitioners and evaluators using varying degrees of familiarity with the complexity sciences. The research identifies, defines and discusses in lay language of complex systems and contributes to an emerging visual language of complexity. Utilising the over 300 images, definitions and learning points developed through this research project, the set delivers an online self-reflexive tool. New definitions address themes raised and draw links, many thanks to RSDX organizers and all who contributed images and links to this online tool.

1. Feedback




When a sub-system of a process influences the input either directly or indirectly. These are scenarios in complex systems.

2. Emergence




When a system or process exhibits a new property or behavior that is not present in the individual components.

3. Self-organization



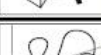
When a system or process exhibits a new property or behavior that is not present in the individual components.

4. Levers and hubs




When a system or process exhibits a new property or behavior that is not present in the individual components.

5. Non-linearity




When a system or process exhibits a new property or behavior that is not present in the individual components.

6. Domains of stability




When a system or process exhibits a new property or behavior that is not present in the individual components.

7. Adaptation




When a system or process exhibits a new property or behavior that is not present in the individual components.

8. Path dependency




When a system or process exhibits a new property or behavior that is not present in the individual components.

9. Tipping points




When a system or process exhibits a new property or behavior that is not present in the individual components.

10. Change over time




When a system or process exhibits a new property or behavior that is not present in the individual components.

11. Open system




When a system or process exhibits a new property or behavior that is not present in the individual components.

12. Unpredictability




When a system or process exhibits a new property or behavior that is not present in the individual components.

13. Unknowns




When a system or process exhibits a new property or behavior that is not present in the individual components.

14. Distributed control




When a system or process exhibits a new property or behavior that is not present in the individual components.

15. Nested systems




When a system or process exhibits a new property or behavior that is not present in the individual components.

16. Multiple scales and levels



When a system or process exhibits a new property or behavior that is not present in the individual components.





How do the four methods deal with complexity?

Identify 2 or 3 complex realism aspects for each method

- Clustering (case based)
- QCA (configurational)
- Network analysis
- Simulation

Note

- Also consider interactions
- Characteristics are dynamic, but methods also static

Small groups

THE VISUAL REPRESENTATION OF COMPLEXITY
★ Definitions, Examples & Learning Points ★

Sustainability practitioners have long relied on images to display relationships in complex adaptive systems on various scales and across different domains. These images facilitate communication, learning, collaboration and evaluation as they contribute to shared understanding of systems processes. This research addresses the need for images that are widely understood across different fields and sectors for researchers, policy makers, design practitioners, and evaluators with varying degrees of familiarity with the complexity sciences. The research identifies, defines and illustrates a key feature of complex systems and contributes to an evolving visual language of complexity. Ultimately the work supports learning as a basis for informed decision-making at CECAN Centre for the Evaluation of Complexity Across the Nexus. Across the Nexus and other communities engaged with the analysis of complex problems.

A research process was designed to identify seven key characteristics of complexity and to inform the development of new images and descriptions. In order to gather ideas from academics, sustainability practitioners and managers with expertise in the complexity sciences, systems thinking and design, I collected 150 surveys at The Environment, Economy, Democracy: Flamingo Together F2020 (Relating Systems, Thinking and Design) conference in Oslo December 2020 and ran two participatory workshops in London (November and December 2020). The images, definitions, examples and learning points were developed with the research process. The text below was written with Alan Peck, Peter Barbrook-Johnson, Martin Babel and Claire Hill. Many thanks to F2020 organisers and all who contributed images and ideas to the survey and workshops.

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1. Feedback
When a result or output of a process influences the input either directly or indirectly, there is a feedback loop. Feedback loops can be positive or negative. Positive feedback loops amplify the initial input, while negative feedback loops dampen it. Feedback loops are essential for systems to maintain stability and to adapt to change.

2. Emergence
New, unexpected system-level properties can arise from the interactions of components. These properties are said to be emergent if they cannot easily be deduced, explained, or predicted from the properties of the individual components.

3. Self-organisation
Regulation or higher-level patterns can arise from the local interaction of autonomous, lower-level components.

4. Levers and hubs
Some nodes for complex systems have a disproportionate influence because of the structure of their connections. These nodes are said to be levers or hubs. They can be used to influence the system as a whole.

5. Non-linearity
A system is non-linear when the effect of inputs on outcomes are not proportional. The behaviour of a system may exhibit exponential changes, or changes in direction (e.g., increases in some measure becoming decreasing), single small or consistent changes in inputs.

6. Domains of stability
Complex systems may have multiple states which can change in the same system. Systems gravitate towards such states, remaining there unless significantly perturbed. If change in a system passes a threshold, it may slide rapidly into another stable state, making change very difficult to reverse.

7. Adaptation
Components or actors within the system are capable of learning or evolving, changing how the system behaves in response to their interactions. They are said to be adaptive. In social systems people may communicate, interpret and behave intelligently to anticipate future situations. In biological systems, species will evolve in response to change.

8. Path dependency
Current and future states, actions or decisions depend on the sequence of states, actions, or decisions that preceded them - namely their historical temporal path.

9. Tipping points
The point beyond which system outcomes change dramatically. Change may take place slowly initially, but suddenly reverse in state. A threshold has been passed which system behaviour suddenly changes.

10. Change over time
Complex systems evolve over time. Their behaviour may change more slowly, but also more rapidly, than the behaviour of their components. This may be due to the system's internal dynamics, or to external influences.

11. Open system
An open system is a system that has external interactions. These can take the form of information, energy, or material resources into or out of the system boundary. In the social sciences an open system is a person, the economic market, energy, people, capital and other.

12. Unpredictability
A complex system is a system whose behaviour is unpredictable. The number and nature of its components, interactions, and external influences are too complex to be predicted.

13. Unknowns
Because of their complex causal structure and openness, there are many factors which influence a system which are not fully understood or are not known. The inevitable existence of such unknowns means we often see unexpected indirect effects of our interventions.

14. Distributed control
Control of a system is distributed amongst many actors. No one actor has total control. Each actor may only have access to local information.

15. Nested systems
Complex systems are often nested hierarchies of complex systems (so-called 'systems of systems').

16. Multiple scales and levels
Because of their complex causal structure and openness, there are many factors which influence a system which are not fully understood or are not known. The inevitable existence of such unknowns means we often see unexpected indirect effects of our interventions.

Clustering: Key Idea

Find patterns in cases based on their whole set of attributes

Also referred to as case-based complexity

Workshop case study: Criminology

- Patterns of arrests in USA States

Area Code	Income	Employment	Health						
	People in income deprivation (%)	Working-age people in employment deprivation (%)	GP-recorded chronic condition (rate per 100)	Limiting long-term illness (rate per 100)	Premature death (rate per 100,000)	GP-recorded mental health condition (rate per 100)	Cancer incidence (rate per 100,000)	Low birth weight (live single births less than 2.5kg) (%)	Children aged 4-5 who are obese (%)
	16	10	14.3	22.7	382.4	23.2	611.9	5.5	11.8
Isle of Anglesey	15	10	13.4	20.8	359.6	23.0	601.1	5.5	12.7
Gwynedd	13	8	12.9	19.5	348.9	20.3	604.0	5.0	13.0
Conwy	15	10	12.9	20.6	375.6	23.7	593.6	5.1	11.4
Denbighshire	17	11	14.7	21.8	397.4	28.4	639.3	6.1	12.2
Flintshire	12	8	14.1	19.7	358.1	23.1	647.8	5.4	11.2
Wrexham	15	9	14.3	21.5	393.7	24.3	637.3	6.4	12.4
Powys	11	7	12.8	18.8	309.1	19.0	579.8	4.7	10.5
Ceredigion	12	8	12.7	20.0	322.4	19.9	545.5	4.8	10.5
Pembrokeshire	15	10	13.1	20.5	345.8	22.1	606.1	5.2	12.5
Carmarthenshire	15	11	13.9	23.7	365.5	20.0	602.6	5.4	12.8

Case →

Clustering: Steps

Normalise data

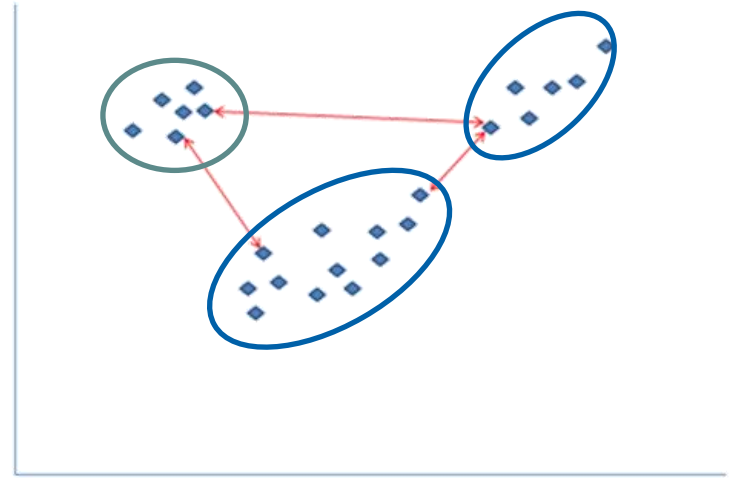
Choose appropriate distance measure

Use a clustering algorithm

- Group close cases into a cluster
- Maximise separation between clusters

Assess whether the clusters are meaningful

- Visualise
- Interpret



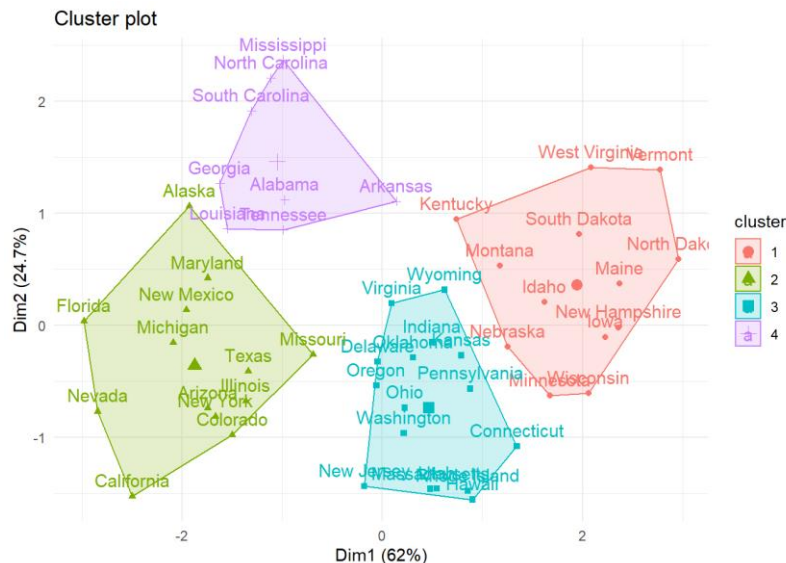
Clustering: Challenges

Only relevant for scale data attributes

- Relies on mapping attributes to coordinates in spatial dimensions

Easy to obtain spurious results

- Algorithms work whether or not structure exists



Clustering: Complexity

Emergence: cases treated as complete entities

- Close on all dimensions, not just some

Self-organisation

- Structure is revealed by the method

Multiple scales and levels

- Small clusters may occur within broader clusters

QCA: Key Idea

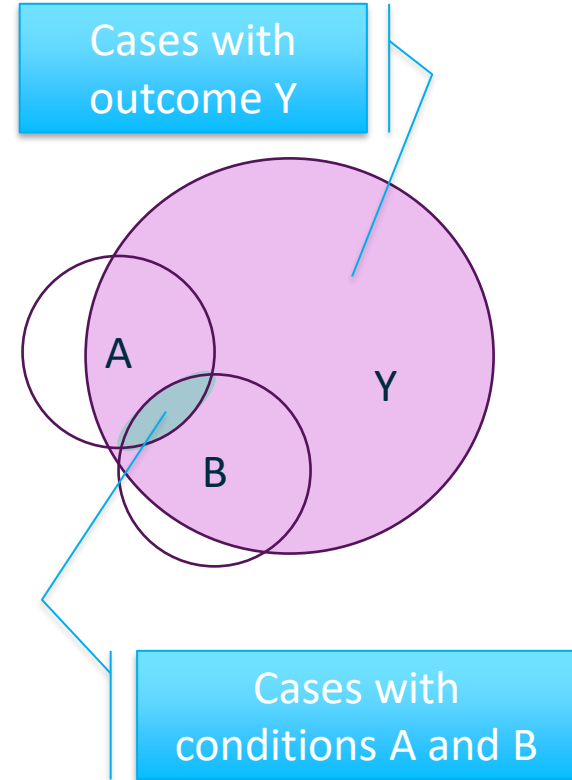
Structured method for case based comparative research

- Select attributes that appear to be relevant
- Compare attribute patterns where the phenomenon occurs and where it doesn't

Also referred to as configurational complexity

Workshop case study: Political Science

- Explain survival/breakdown of democracy



QCA: Steps

Identify social phenomenon and potential contributing conditions

Select moderate number of cases

Calibrate attribute values

Construct truth table

- Resolve contradictions

Simplify truth table

- May include configurations without cases

Assess quality of solution

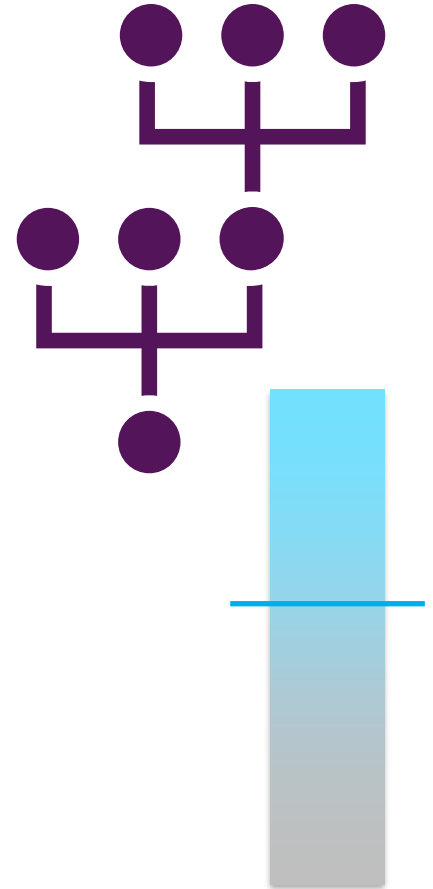
Conditions		Cases by outcome	
A	B	Y	Y
T	T	≥1	0
T	F	any	≥1
F	T	any	≥1
F	F	any	any

QCA: Challenges

Diverse cases are essential

- The logic of comparing sets of truth values relies on many combinations available from the dataset
- Too many remainders limit the opportunity to identify recipes

Operationalising attributes (crisp or fuzzy) relies on judgement and iteration



QCA: Complexity

Emergence: cases treated as composite of their attributes

Non-linearity: Recipes use logical operators

Levers and hubs: Causal recipe is lever for outcome

Recipes respect diversity and heterogeneity of the cases and their contexts

- Adaptation?

Recipes have a close relationship with theory

- Realist perspective, something exists to influence observations

Networks: Key Idea

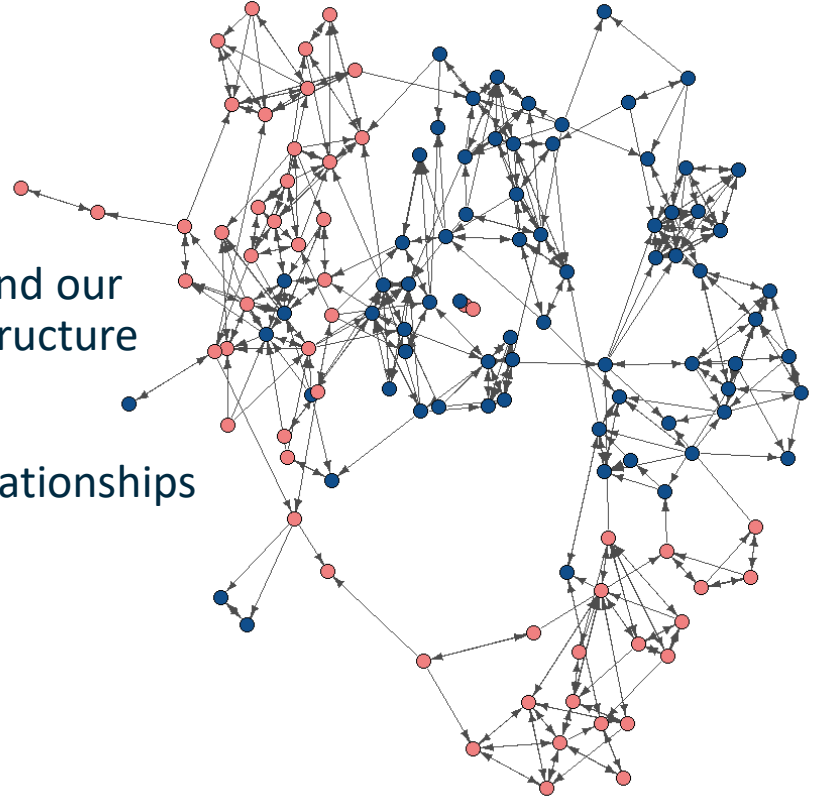
Relationship between cases is focus of analysis

Network analysis provides a set of tools to extend our intuition of the patterns that construct social structure

- Visualise to highlight patterns and structure
- Develop theories about the way in which relationships influence social phenomena and processes
- Empirically test such theories

Workshop case study: Sociology

- Diffusion of family planning practices



Networks: Steps

Many different methods with different steps

Collect information about cases and the relationships

- Construct network

Understand the network

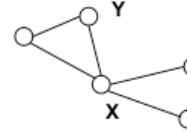
- Visualise with attributes and layout
- Calculate centrality and other properties
- Consider communities



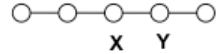
indegree



outdegree



betweenness



closeness

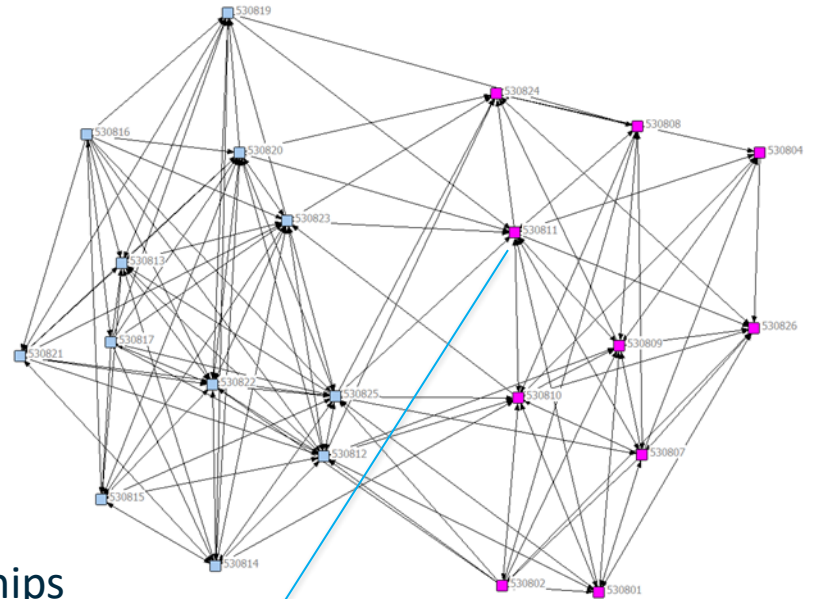
Networks: Challenges

Terminology

- Two (or three) traditions
- Entire discipline, not just one method

Sensitive to data quality issues

- Missing cases/attribute data
- Misattribution of information and relationships
- Retrospection error: recalling interactions



Imagine if this node (and its edges) is missing

Network: Complexity

Specifically maps interactions as relationships

Levers and hubs: Influence arises from network position

Non-linearity and tipping points

- Dynamics over networks (eg epidemics)

Path dependency: Which edges are involved in a relationship, not just how many

Multiple scales and levels: Analyse at node, community, whole of network

Simulation (ABM): Key Idea

Modelling some social process

- Justified stories are plausible coherent explanations of a dynamic phenomenon

Agent-centric thinking

- I, the agent, have certain characteristics and beliefs of my own as well as information about the world around me, and therefore will decide on some action

Workshop case study: Social Psychology

- Conformity and segregation

$$P(\text{deterrence}) = 1 - (1 - d)^G$$

d is deterrence per guardian
 G is number of guardians



Simulation: Steps

Relevant entities

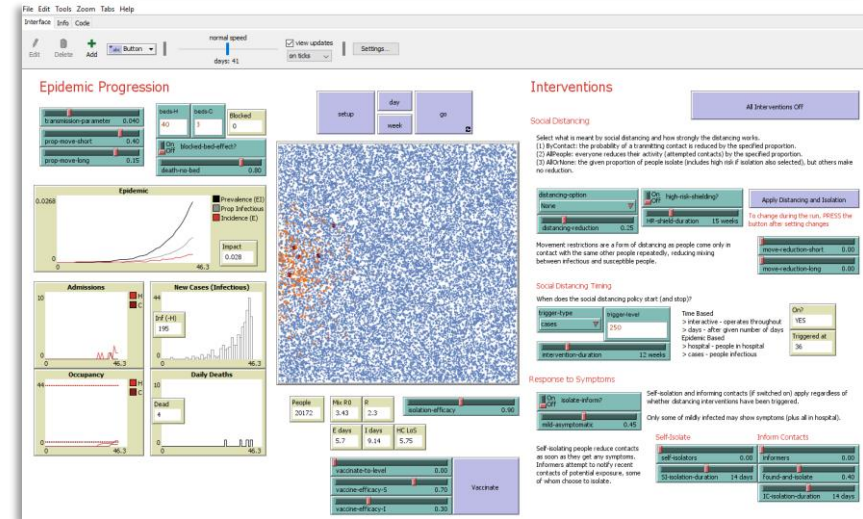
- Agents, Environment, Attributes

Develop rules

- How do agents behave?
- Influences on that behaviour and effect of decision

Build model, testing iteratively

Run scenarios (experiments)



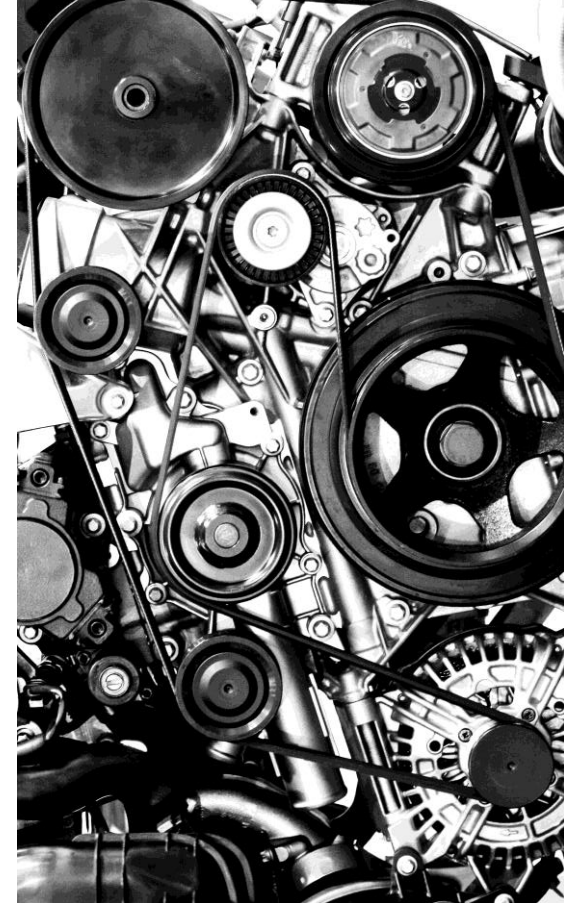
Simulation: Challenges

Process or mechanism orientation

- Different type of thinking about theory and data
- Data not available about mechanism, only outcomes

Balance between simplicity and detail

Programming skills



Simulation: Complexity

Agents interact with each other (social environment) and with their physical environment

- Choice of action affected by environment and selected action has impact on the environment

Dynamic interactions

- Feedback / Tipping Points / Path Dependency
- Change over time / Non-linearity

Distributed control: definition of agent

Theory and method work together

Computational Social Science is truly interdisciplinary

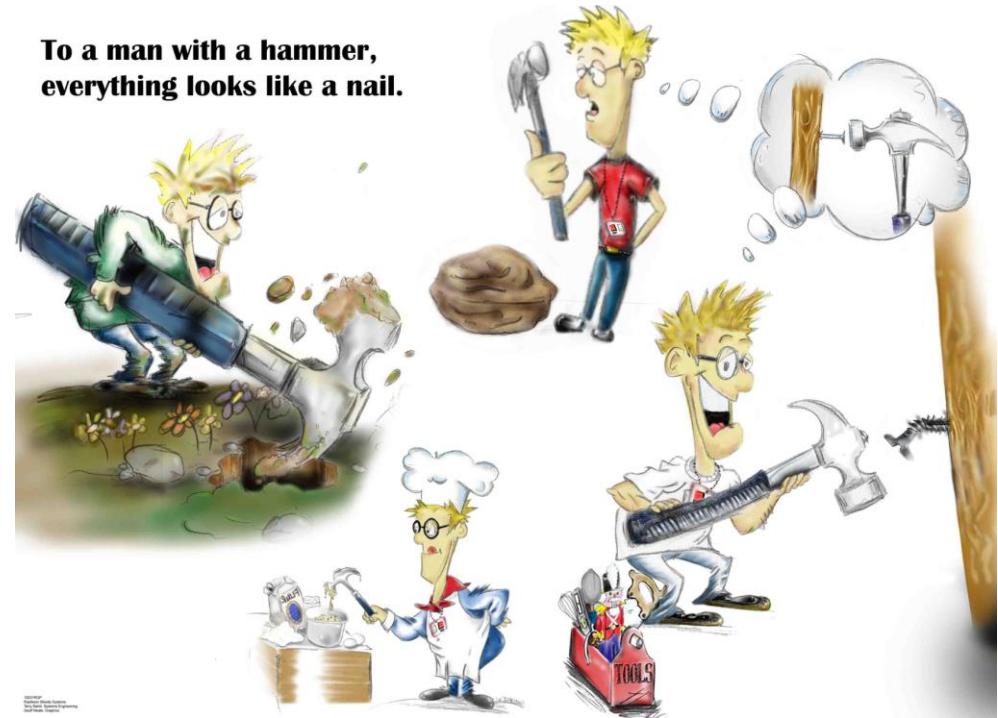
- Mathematical/computer scientists have analytical skills and training to develop methods and work with data
- Social scientists bring ideas, applications and interpretation
- Theory organises the ideas and interpretation

As much as it bears similarities to previous work, however, what is new about the current generation of network-related research is a rapidly emerging and highly interdisciplinary synthesis of new analytical techniques, enormously greater computing power, and an unprecedented volume of empirical data. Sociologists have much to gain from this progress, and also much to contribute. Most of the work discussed in this review is taking place in the mathematical sciences, particularly in physics. That is hardly surprising, as physics and mathematics typically lead the way methodologically, whereas biological and social sciences follow with applications. But in this particular case, the flow of ideas has been bidirectional, with many of the core ideas—not just applications—having come from sociology. Physicists may be marvelous technicians, but they are mediocre sociologists. Thus, if the science of networks is to live up to its early promise, then the other disciplines—sociology in particular—must offer guidance in, for example, the interpretation of empirical and theoretical findings, particularly in the context of policy applications, and also in suggesting measures and models that are increasingly relevant to the important problems at hand.

Question first, then select the method

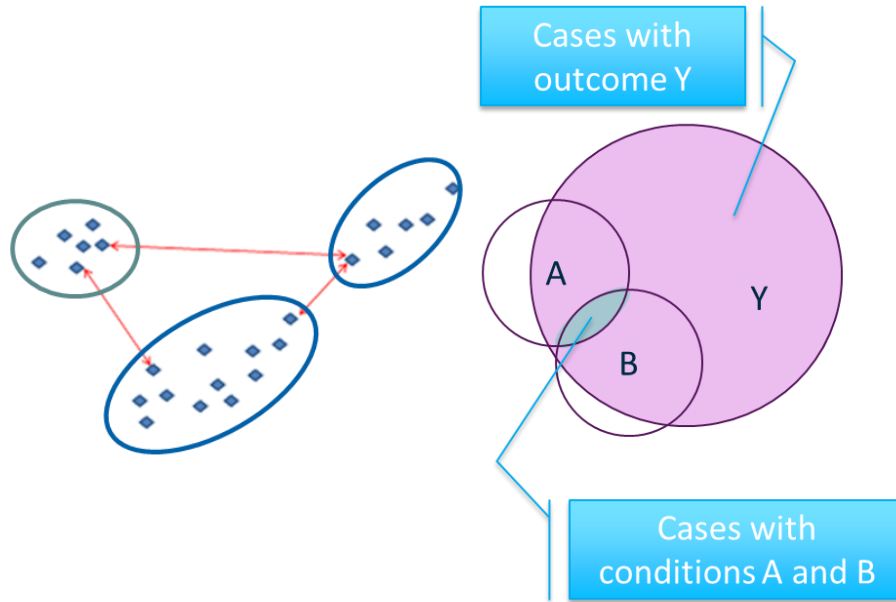
Each computational method responds to different aspects of complex systems

Choosing a method asserts something about the structure of the system being examined and the validity of specific types of questions

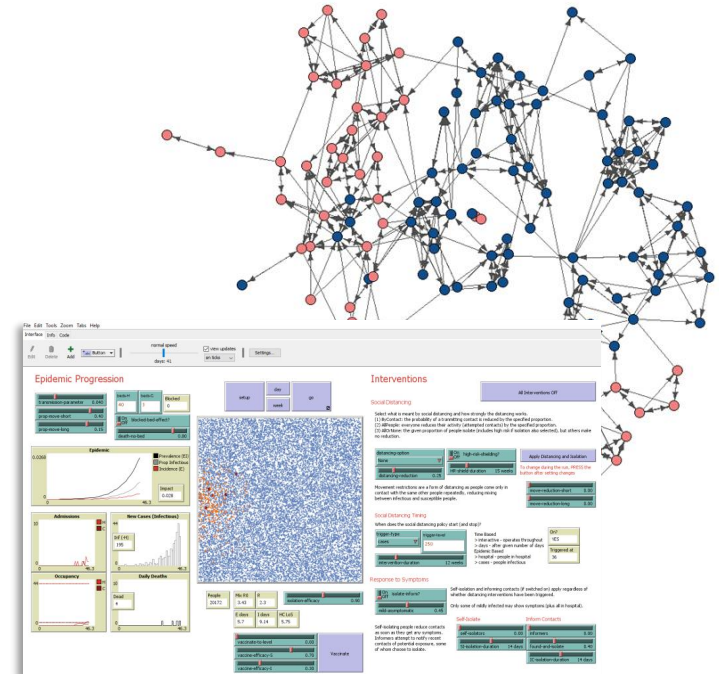


Where does the complexity lie (roughly)?

Internal: within cases



External: processes, relationships



Beyond the module



Assessment due 22 April at 13:00

Make sure research question and proposed method(s) match

The method(s) MUST deal with relevant aspects of complexity that you identify

1/ Compare two methods

- What methods could complement each other?

2/ Use one of the methods

- Choose question with relevant dataset / model
- Be guided by what is possible with your dataset or model

Remember the reader

- Explain how the method(s) you choose could be useful, not about answering a research question

Extensions and adjustments have forms

Come and talk to me if unsure

Your reflections

Something(s) you learned in this module that you think is important



Something(s) you learned in this module that you found interesting



The End

Thank you

- For being a great group to teach
- For taking on something a little different



Please complete the Module Evaluation Questionnaire when you are asked

- I don't find out what you think of the module unless lots of you fill it in

