Complex social systems:
prospects and problems

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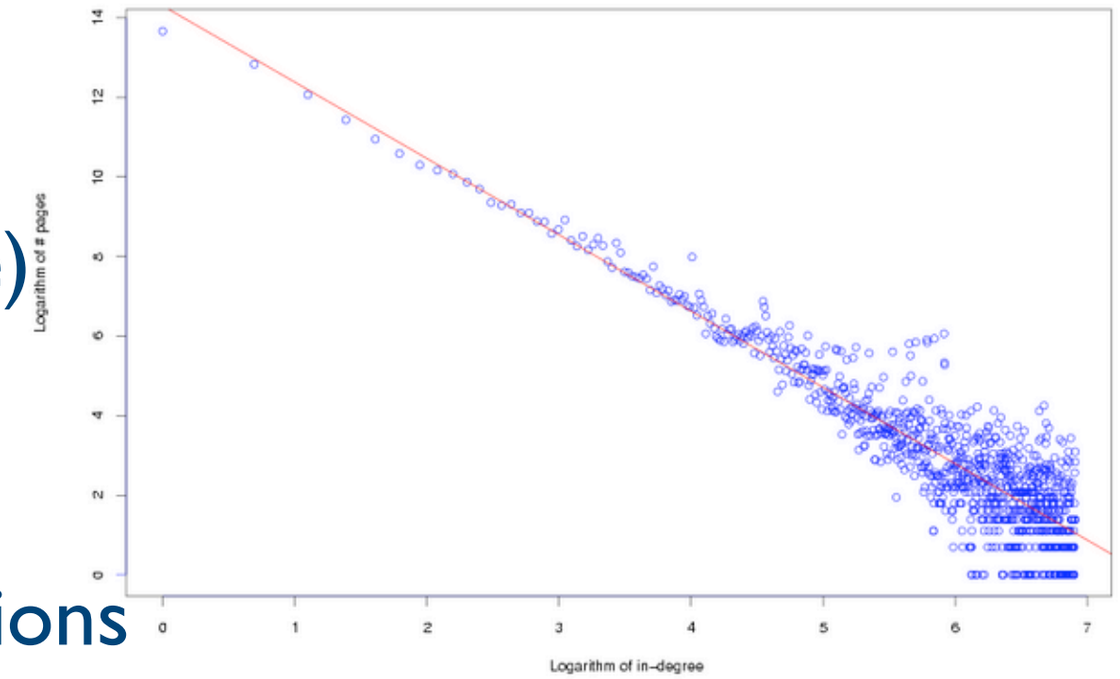
Overview

- Social systems are complex...
  - non-linear
  - multi-level
  - emergent
  - open systems
- but are *not* the same as complex physical systems
  - second-order emergence
  - social construction
- The implications for social scientists
- The implications for natural scientists
- Some challenges and prospects

Social Systems are non-linear

- for example, power law relationships (= Pareto distribution, =Yule distribution, Matthew effect) are everywhere, once you start looking!
  - ✦ distribution of wealth (Pareto)
  - ✦ word frequency (Zipf)
  - ✦ citations (Simon, de Solla price)
  - ✦ web site popularity
  - ✦ size of human settlements
  - ✦ rail traffic through railway stations



- but be cautious: most of the empirical distributions are not exactly Pareto distributed – most often there is a 'problem' at the top and bottom ends

Firm sizes

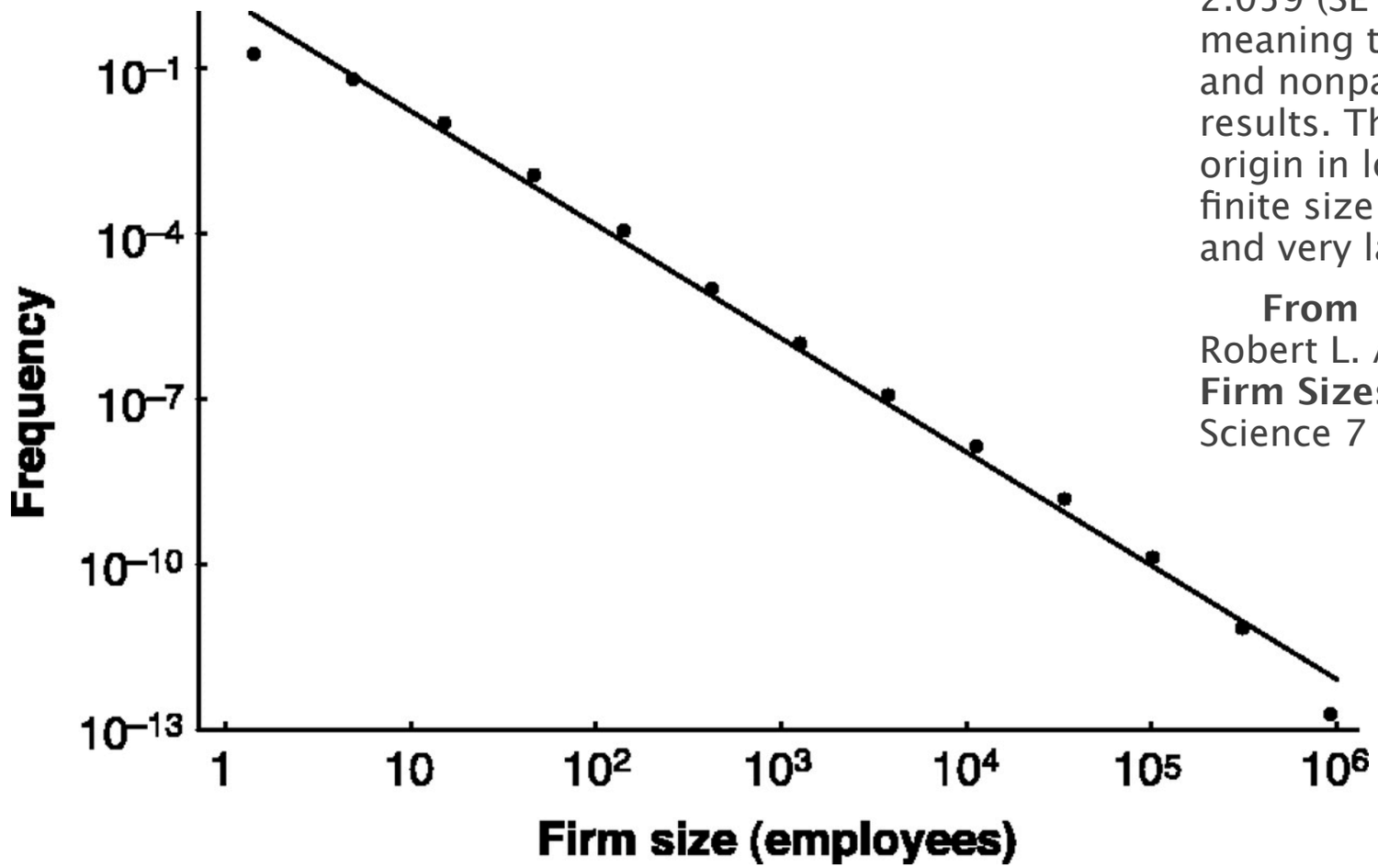
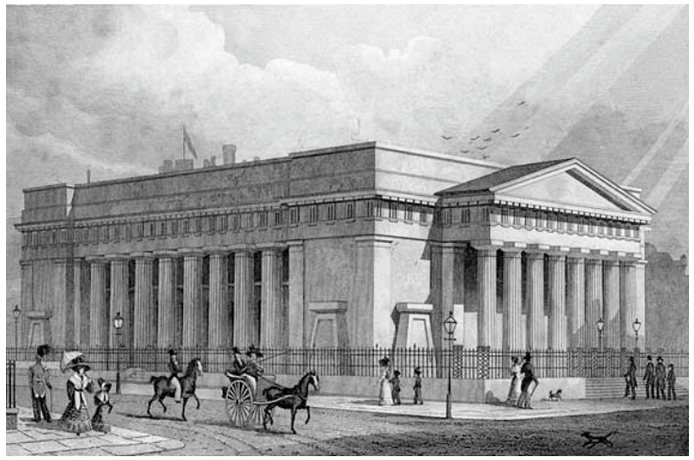
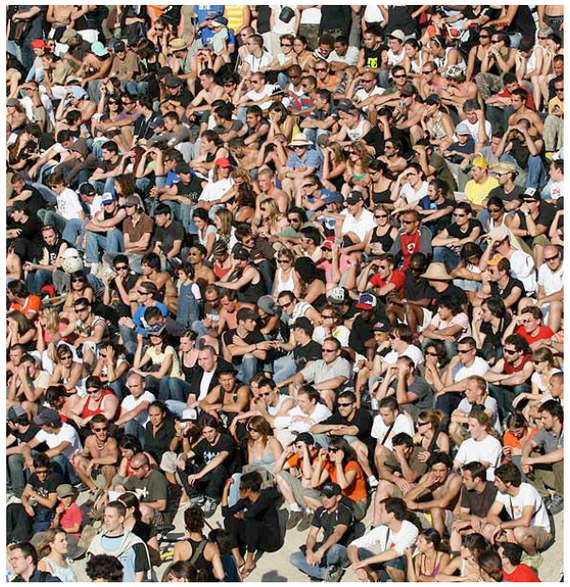


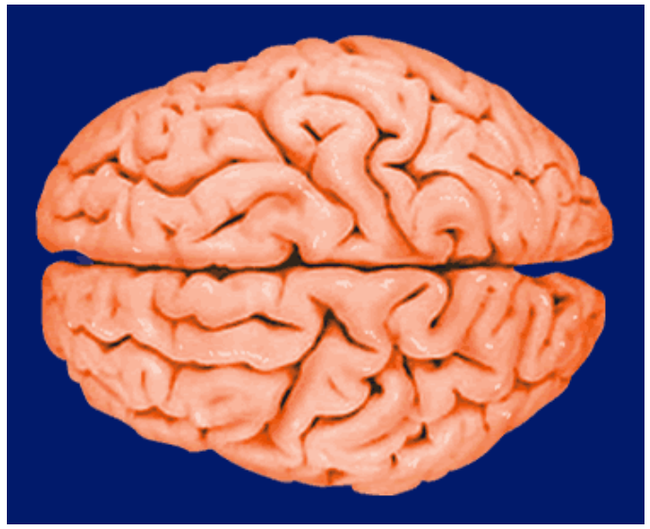
Figure 1. Histogram of U.S. firm sizes, by employees. Data are for 1997 from the U.S. Census Bureau, tabulated in bins having width increasing in powers of three (30). The solid line is the OLS regression line through the data, and it has a slope of 2.059 (SE = 0.054; adjusted $R^2 = 0.992$), meaning that = 1.059; maximum likelihood and nonparametric methods yield similar results. The data are slightly concave to the origin in log–log coordinates, reflecting finite size cutoffs at the limits of very small and very large firms.

From
Robert L. Axtell. **Zipf Distribution of U.S. Firm Sizes**
Science 7 September 2001: 1818–1820.

Multi-level







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Emergent

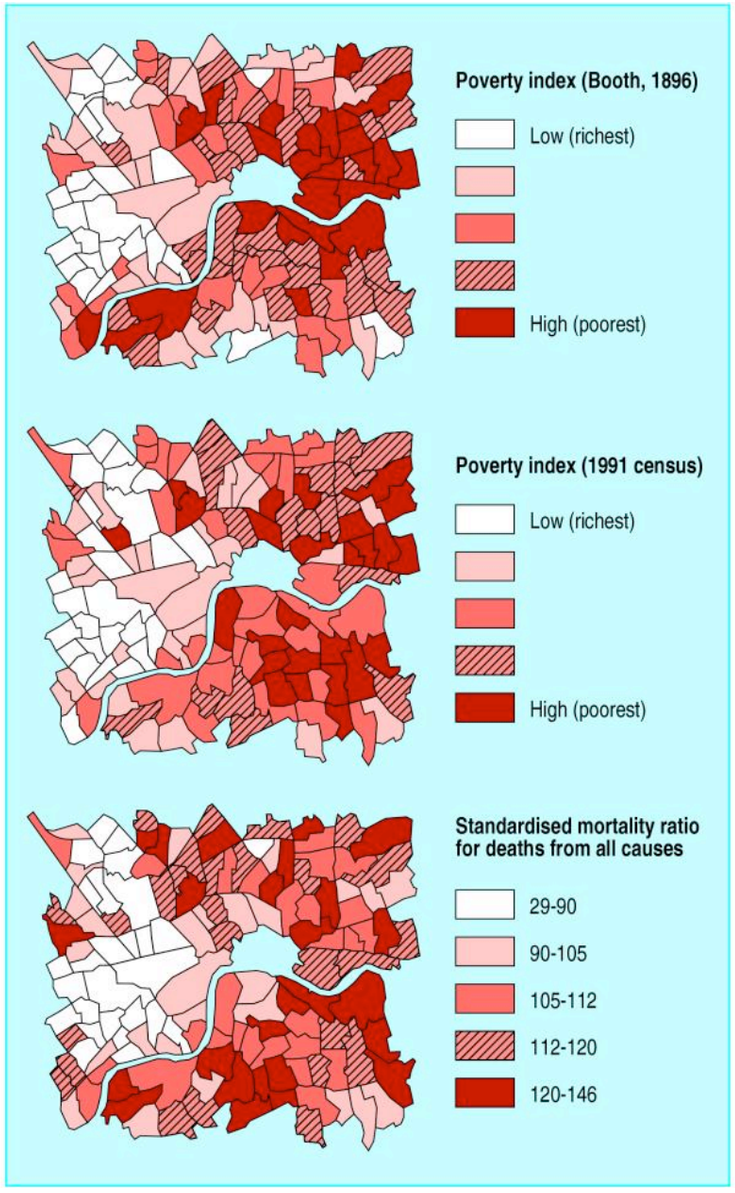
Path dependent

Central London:

Poverty 1896
(deep red = poorest)

Poverty 1991
(deep red = poorest)

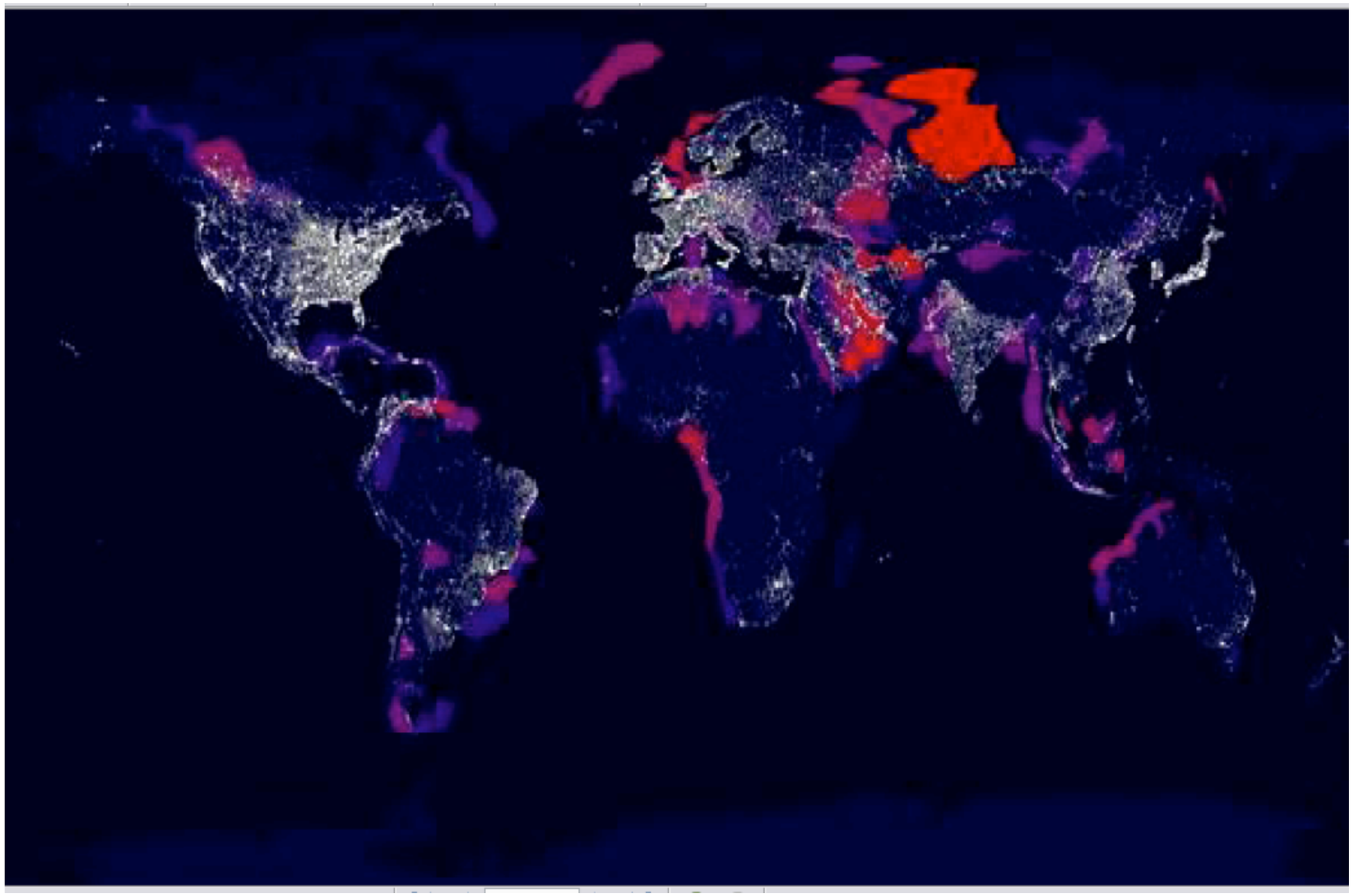
Standardised mortality ratio, 1991
(~ lifespan)



Danny Dorling, Richard Mitchell, Mary Shaw, Scott Orford, George Davey Smith (2000) The Ghost of Christmas Past: health effects of poverty in London in 1896 and 1991 *BMJ*. December 23; 321(7276): 1547–1551.

Open systems

World energy supply and demand, from http://www.rice.edu/energy/publications/docs/PEC_Medlock_10_25_04.pdf



But…

- But while these are also features of many biological and even some physical systems, social systems have their own characteristics
  - these mainly arise from the fact that people can think and talk!
    - categories are constructed
    - analyses are reflexive
    - second-order emergence
- Consequently, methods of analysis imported from the natural sciences should be applied with caution in the social sciences

Social construction

- e.g. labelling theory
  - the labels applied to individuals influences their behaviour, often towards making their behaviour more like that implied by the label
- e.g. the reflexive nature of social indicators
  - the police collect statistics on crime by locality
  - some areas seem to have more criminality than others
  - hence these areas are policed more heavily than lower crime areas
  - hence the amount of detected crime in these areas remains high
  - then social scientists point this out

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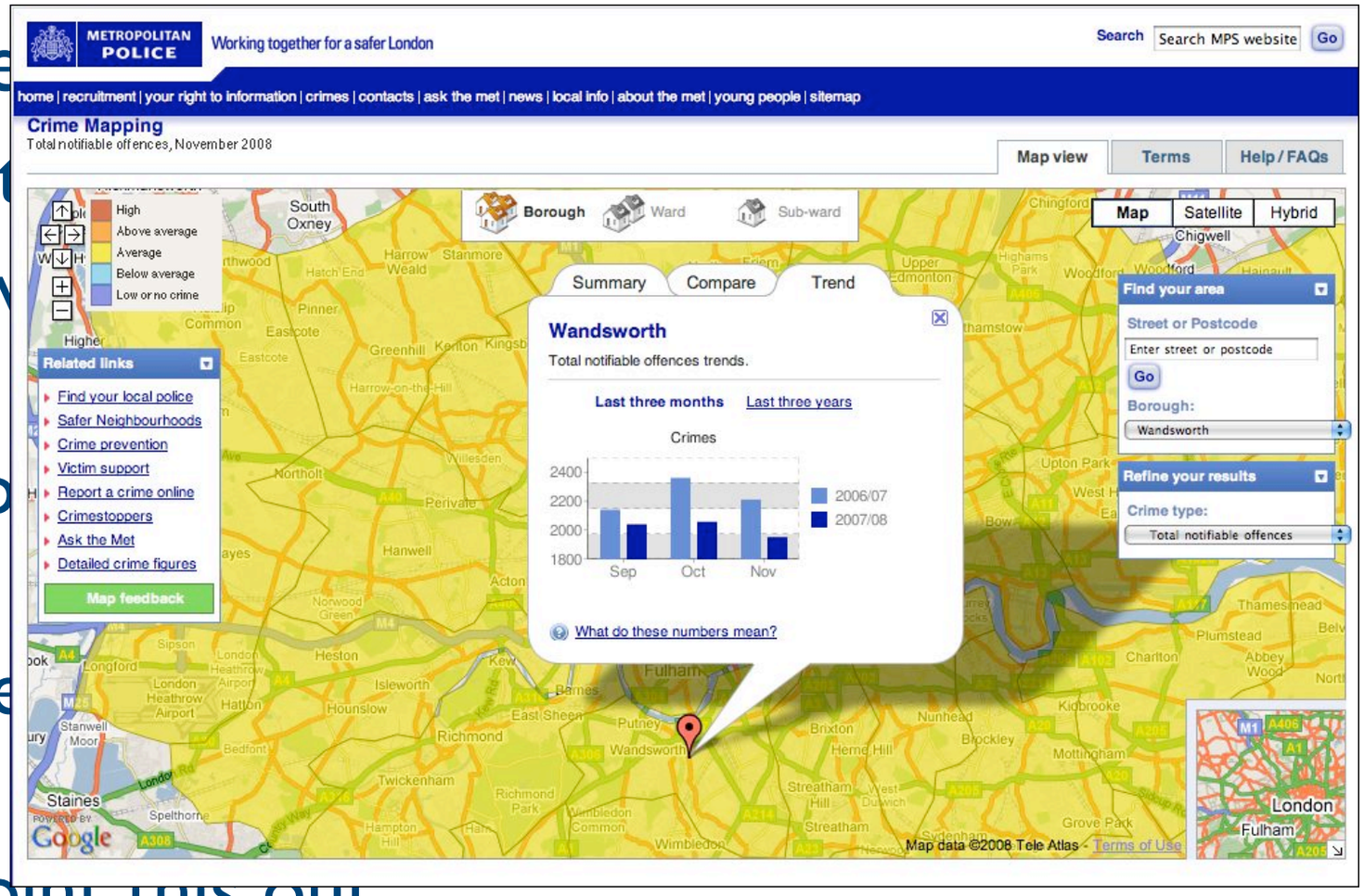

Second order emergence

- Interaction at the individual ('micro') level yields new patterns at the global ('macro') level
- These patterns remain even though the individuals come and go
- The patterns are recognised by people, who name them and respond to them
  - So the macro feeds back onto the micro: second-order emergence

Schelling residential segregation model, but with desired locations influenced by the predominant ethnicity of the neighbourhood/cluster

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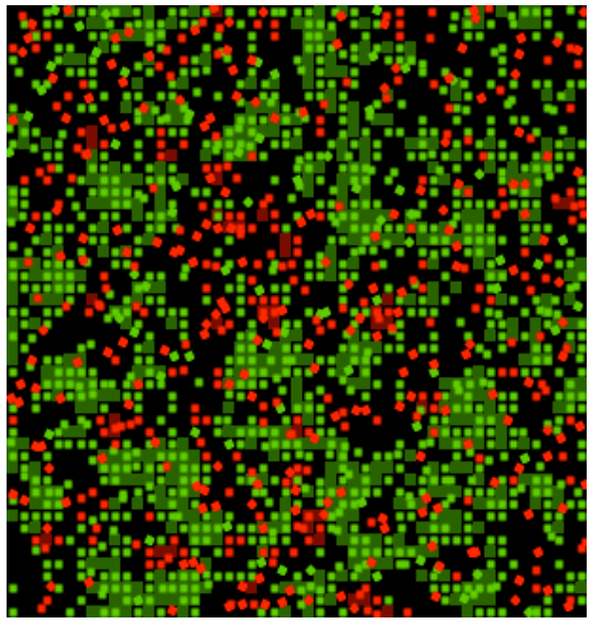

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Second-order emergence

- Individual action leads to emergent social structures
  - Social structure = rules, norms and regularities
- These structures are the matrix in which action takes place
- This action maintains and changes the structures

State opening of Parliament of Trinidad and Tobago

Coleman's theory

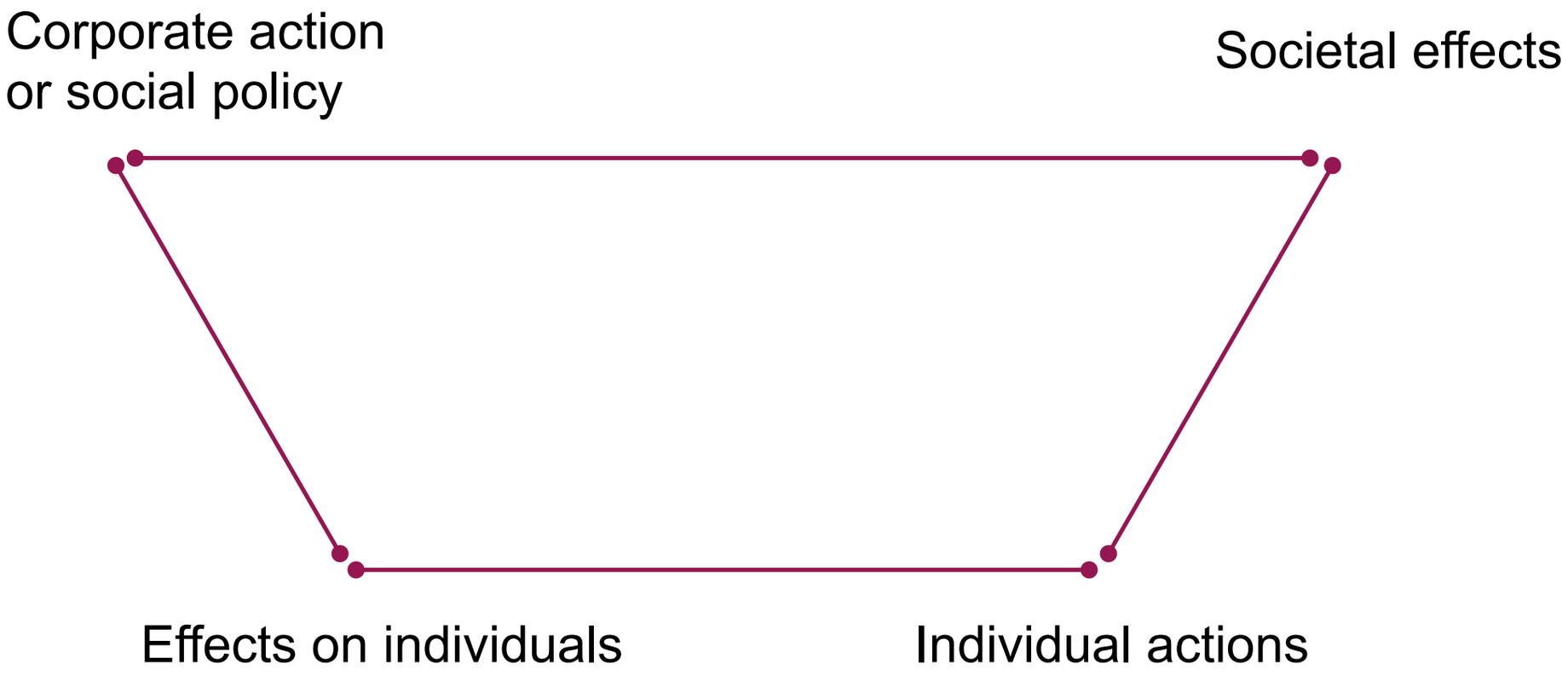

Figure 23.6 in James Coleman (1990) *Foundations of Social Theory*. Harvard University Press.

Implications for social scientists

- provides a way of thinking about the 'micro-macro link' which dissolves some of the historical puzzles

Durkheim versus Weber

- Methodological individualism
  - e.g. Max Weber (1864 - 1920)
  - He argued that individual actions and beliefs (e.g the Protestant Ethic) led to the mergence of social institutions (e.g. capitalism)

- Methodological collectivism
  - e.g. Emile Durkheim (1858 - 1917)
  - He argued that social facts had an independent existence greater and more objective than the actions of the individuals that composed society and could only be explained by other social facts

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  - *cf* correlational analyses of one-shot surveys

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- encourages a greater focus on geography and network links
  - taking into account spatial and network interaction
  - *cf* structural equation/econometric modelling

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- demands greater attention to identifying 'mechanisms'
  - *cf* cause and effect induced from correlations

Implications for natural scientists

- tempting to consider humans as just particles
  - and doing so (more-or-less) works in some restricted situations
    - e.g. traffic and pedestrian modelling
- risks ignoring or misunderstanding existing social science
  - e.g. the 'discovery' of preferential attachment network structures
    - Evelyn Fox Keller (2005) Revisiting "scale-free" networks. BioEssays 27: 1060-1068
- modelling for its own sake, without much regard for social scientific data
    - e.g. some of the literature on 'opinion dynamics'
- fitting power laws to distributions of social indicators is too easy
  - even if the fit is good, it doesn't tell us much about the underlying social processes that generated it
- physics is based on a paradigm that says there are a few universal laws that apply to everything.
  - This may not be true for social science (or it may be true, we don't know!)

Challenges

- Prediction
  - what can we predict, in principle?
  - what can we predict, in practice?
  - how can predictions be made believable?
- Scale
  - simple versus complicated models
  - are there qualitative differences between the behaviour of models with 10 and millions of agents?
  - how can very large models be implemented?
- Reflexivity
  - how can we represent and understand the consequences of the reflexivity that there is in human societies?

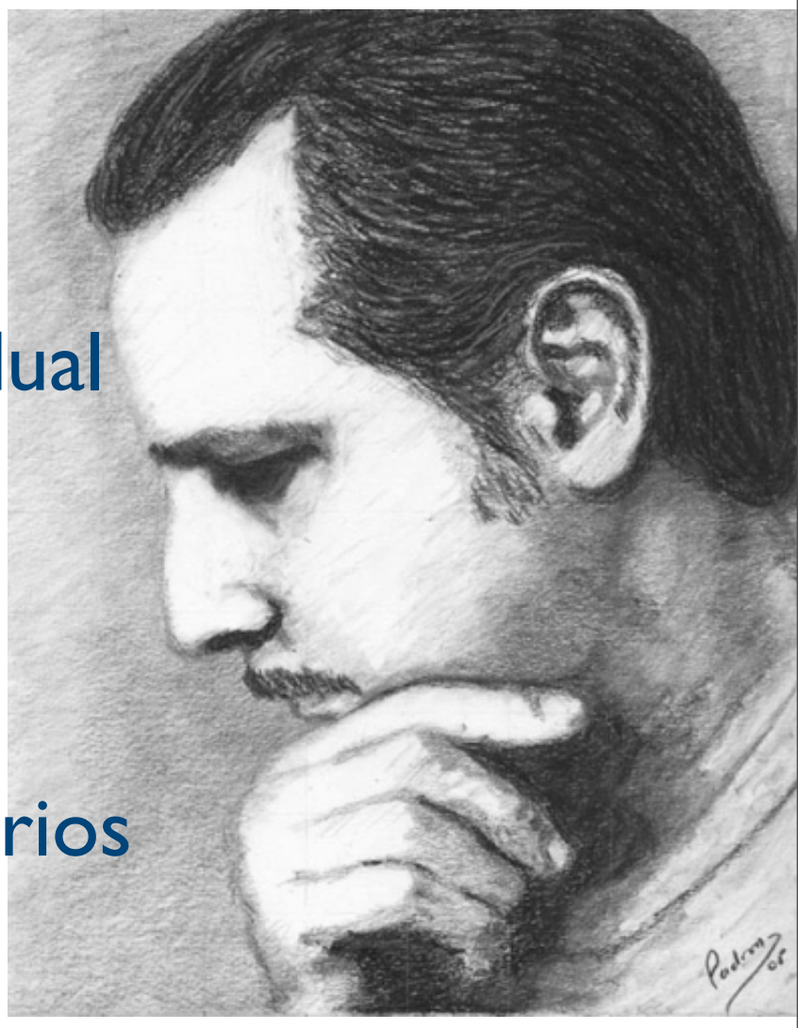
The limits of prediction

- What, in principle and in practice, can we predict?
  - NO
    - the FTSE index next year
    - the weather in a month's time
  - YES
    - it will not be 40 degrees Celsius, in Paris in January 2010

- How can predictions be made believable?
  - If the model predicts a situation already anticipated, the model is of little practical value
  - If the model predicts a situation not already anticipated, perhaps the model is wrong.
- Prediction challenge: formalise what we can and cannot expect to predict

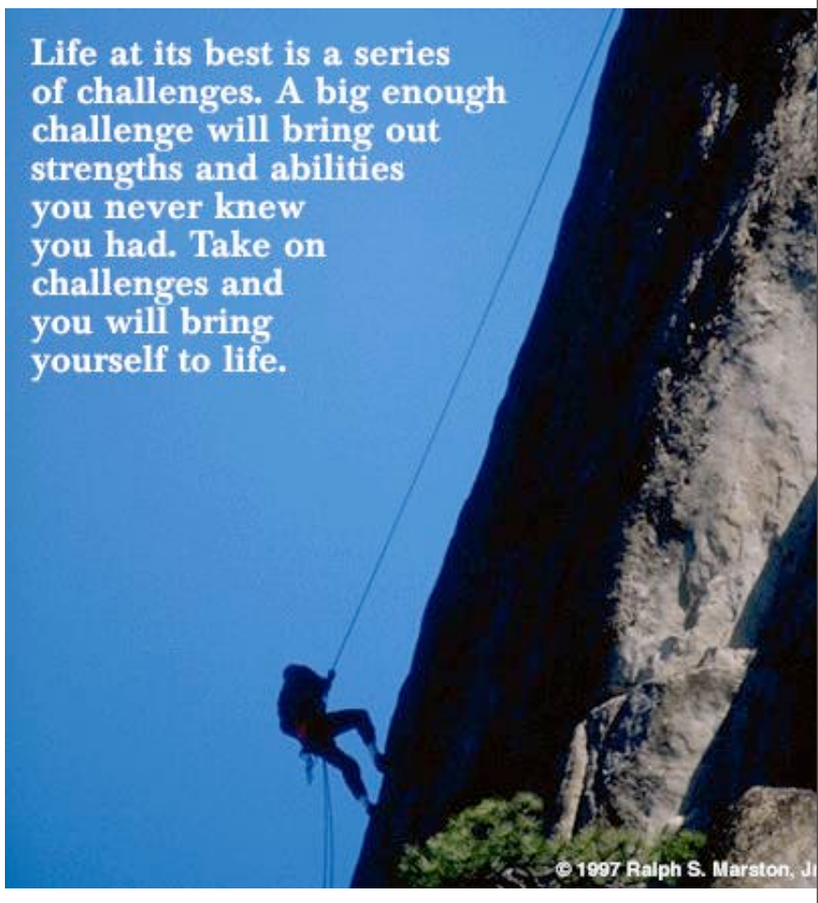
Scale

- Tools for thinking
  - relatively simple models
  - few parameters
  - usually highly abstract
  - emergence of social regularities from individual action is the focus
- Tools for doing
  - relatively complicated
  - fitted to specific domains, localities or scenarios
  - many parameters
- Scale challenge: when do we need big models with millions of agents?



Reflexivity

- Reflexivity challenge: how do we model social construction, reflexivity and emergence?
  - ✦ thus making models of *social* systems



Prospects

- Areas of social science where there are active and productive developments using complexity ideas and methods:
  - Economics
  - Geography
  - Politics and sociology
  - Anthropology
  - ...

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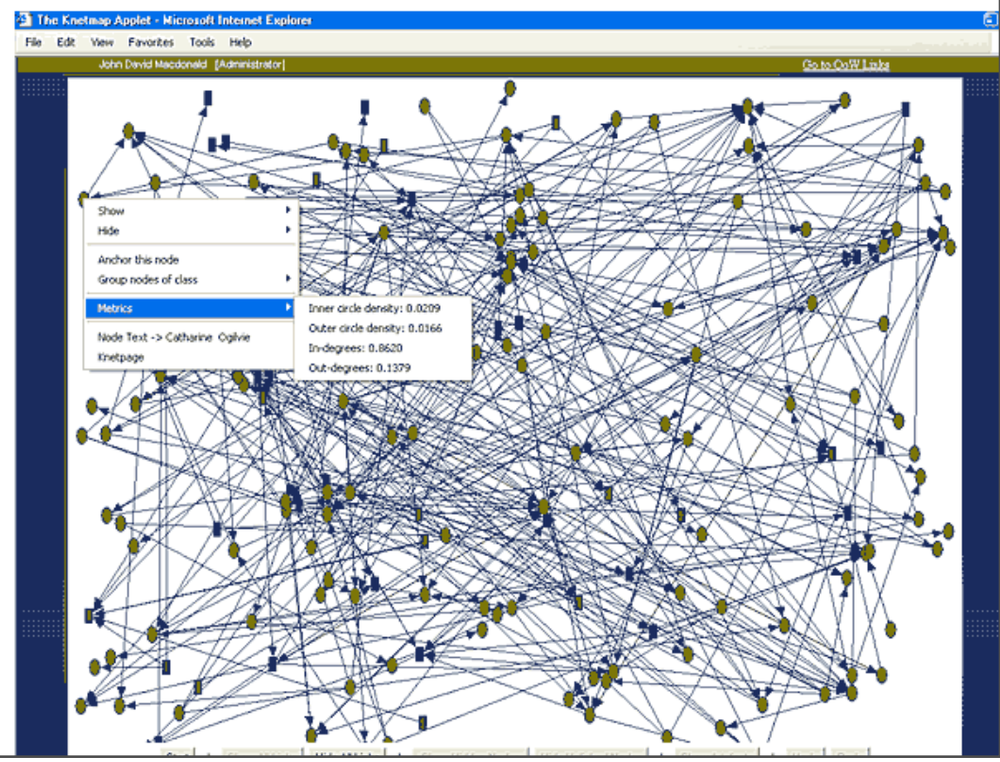
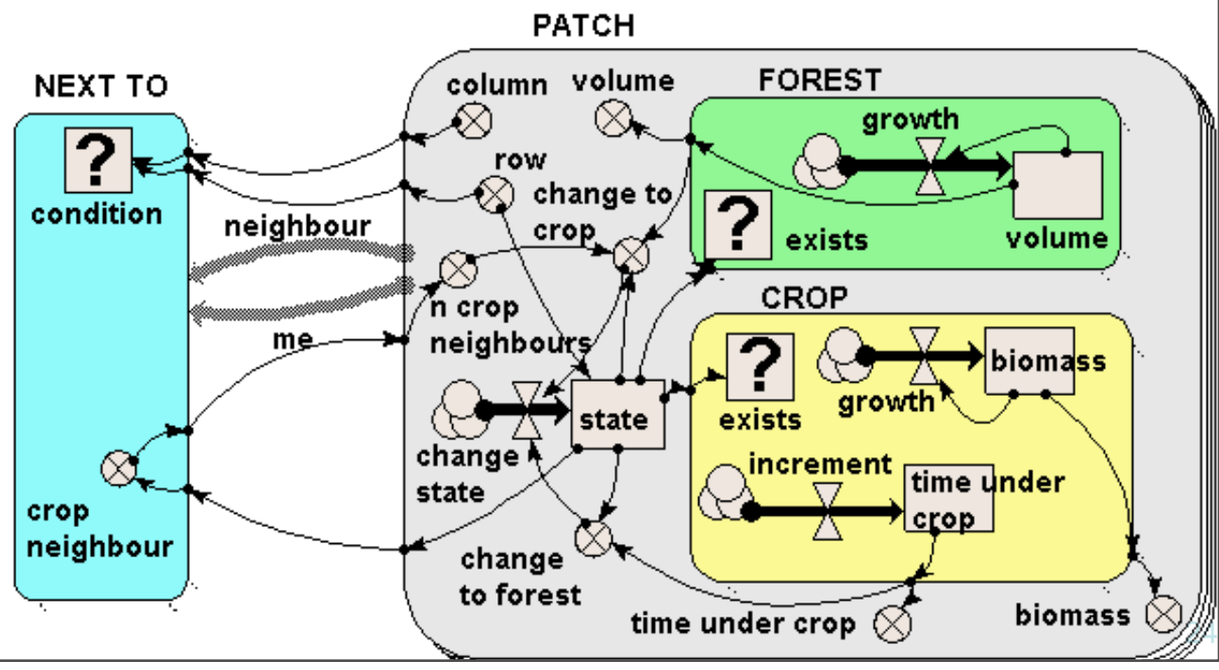
Economics

- Markets
  - artificial stock exchange
  - housing market
  - labour markets
- Firm behaviour
  - innovation networks
  - strategic decision making
- Game theory
  - social dilemmas
  - experimental economics



Geography

- land use
- industrial clusters
- epidemics and their control
- traffic and pedestrian modelling
- location analysis



Politics and sociology

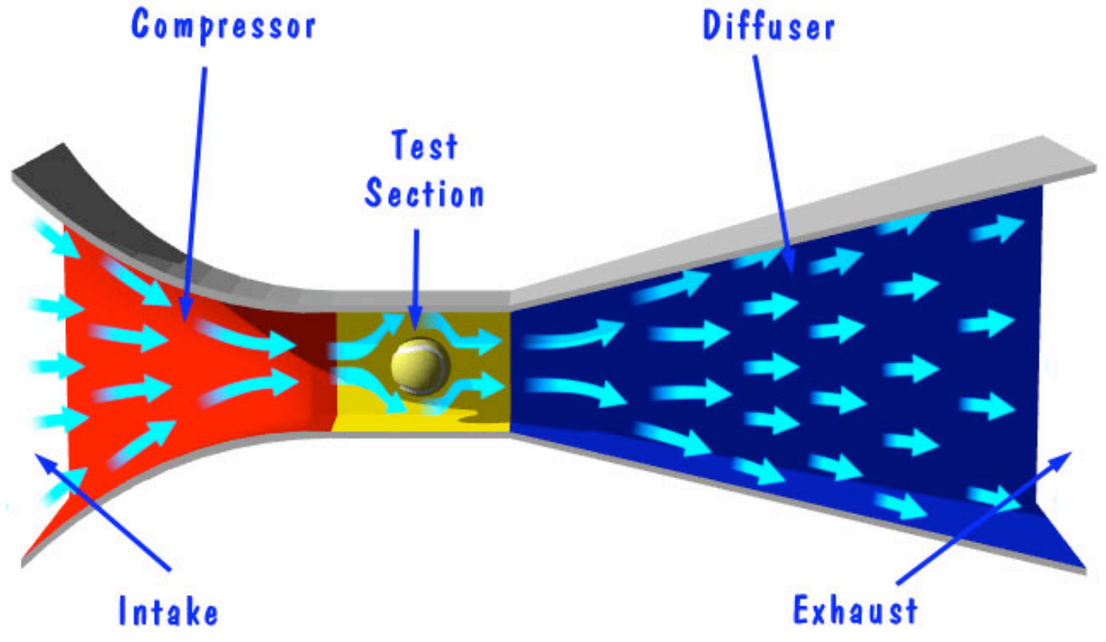
- opinion dynamics
- trust and reputation
- policy modelling
- new social movements
- voting behaviour

Anthropology

- evolution of language
- the causes of violence in simpler societies
- evolution of co-operation, altruism and social groups
- the development and effects of social norms

And…

- The policy wind-tunnel
  - most social policy are implemented without prior testing
  - the new-ish 'evidence-based policy' movement relies on ex post facto evaluation of effectiveness -after damage has been done
  - we need to experiment with policies before implementation
  - and to experiment with policy
  - using a virtual society
    - the policy wind tunnel



Conclusion

- "I would be grateful, therefore, if you could prepare a presentation of **up to 30 minutes' duration**, which will leave us ample time for questions from the audience. This scene-setting talk should aim to give a broad view of relevant research achievements and open challenges in complexity science from your own social sciences perspective. "

if I have talked fast enough, there will now be time for your…

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Questions

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