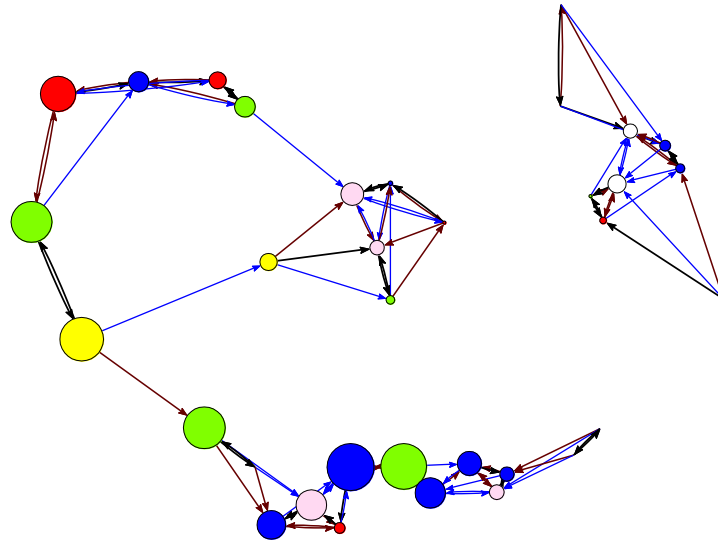


# Beyond Small Worlds



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# Archaeology and physics: an odd couple?

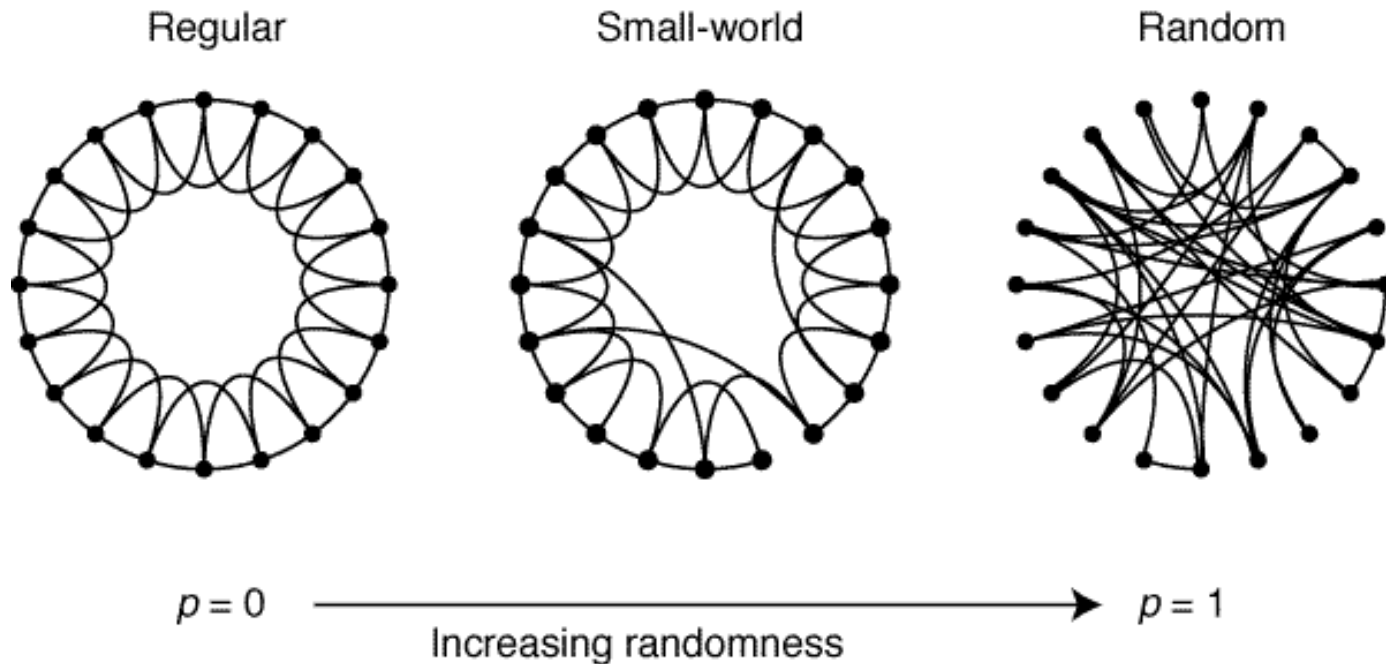


- Co-directors
  - David Lane (economics)
  - Sander van der Leeuw (archaeology)
  - Geoff West (theoretical physics)
- ISCOM principally focussed on contemporary issues
- But broader aims: to include history and prehistory
- Archaeological data imperfect; oddly advantageous

# Boom in network studies - small worlds

Intuitive understanding; but mathematically elusive

Watts and Strogatz - Clustering and short path lengths



**Both local cliques and global connectivity: crossing scales**

# Articulating scales: micro – macro

Mark Granovetter 1973 'The Strength of Weak Ties'

Sociology failing to relate micro-level interactions to macro-level patterns in any convincing way

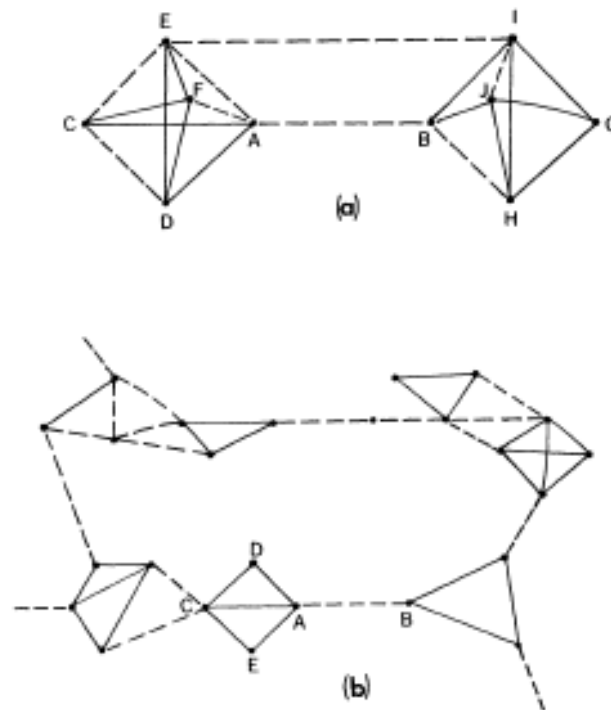


FIG. 2.—Local bridges. *a*, Degree 3; *b*, Degree 13. — = strong tie; - - - = weak tie.

Watts and Strogatz etc. picking up on Granovetter (and Milgram)

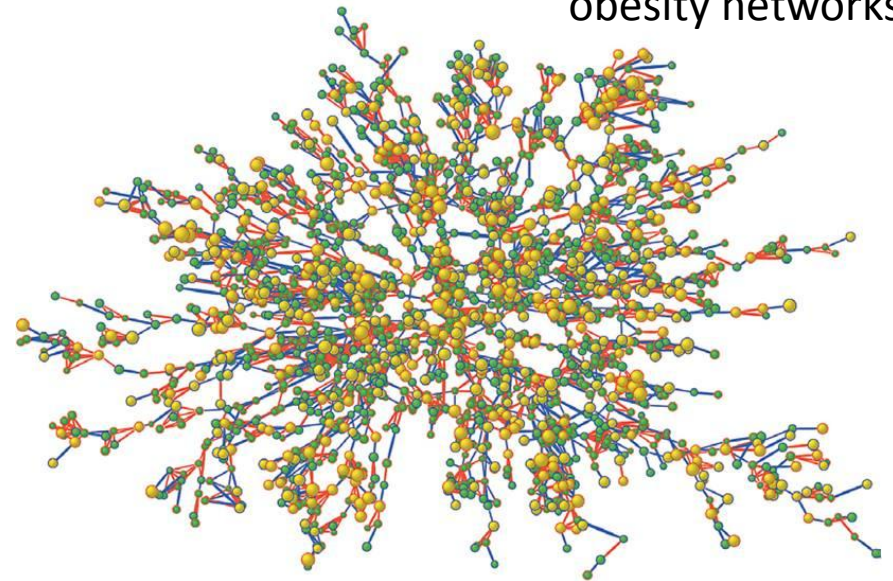
And advancing formal side considerably

Certainly crossing scales in ways many other studies do not

Christakis and Fowler  
obesity networks

BUT tending to be socially unrealistic

1. Random rewiring
2. Searchability
3. Lattice substrate



Symptomatic of a broader problem...

Structure  $\longleftrightarrow$  Function

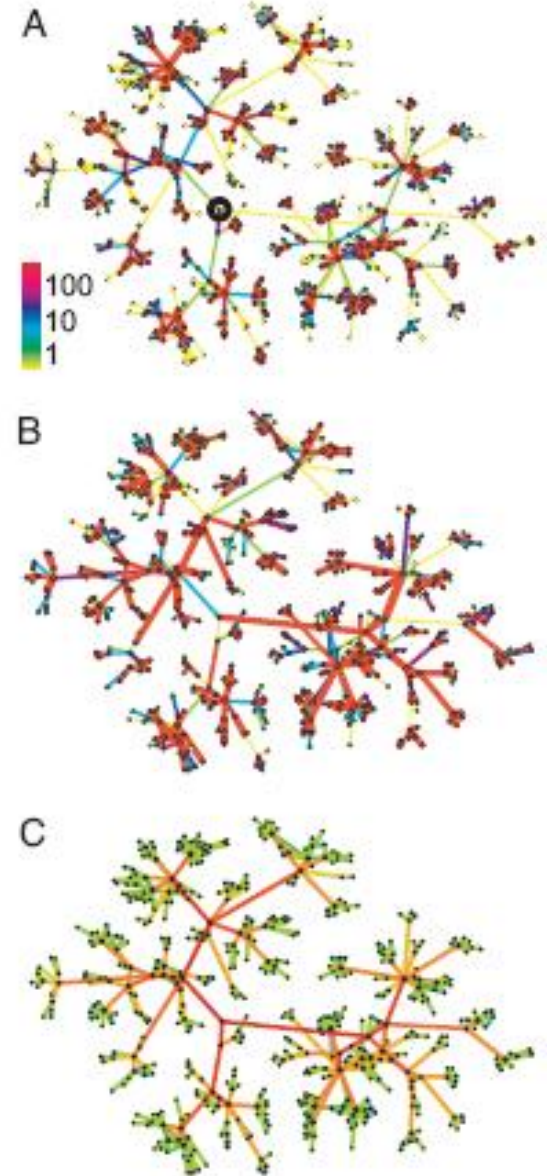
Watts, Newman etc: function follows structure

Granovetter: global function creates global structure

Onnela et al: local function creates global structure

*Is network function cause or effect?*

*Surely networks are for something...*



SO... a first step in making our physics more social:  
Optimisation: balancing benefit and cost

We may not know exactly what networks are for

But presumably they bring some **benefit**

Local clusters yes; but 'global' connectivity?

Thus need to consider that they bring **cost** too

Creating a (long-distance) link is not cost-free

One problem with W-S model is that links appear cost-free

Little sense of either cost or benefit associated with links



Hence we propose an optimisation model  
Benefits of global links = access to resources  
Costs of global links = travel



**'Minoanisation'**  
c 1700 BC

The effect is to connect function to structure:  
optimisation means function causes structure  
But how to put into practice?

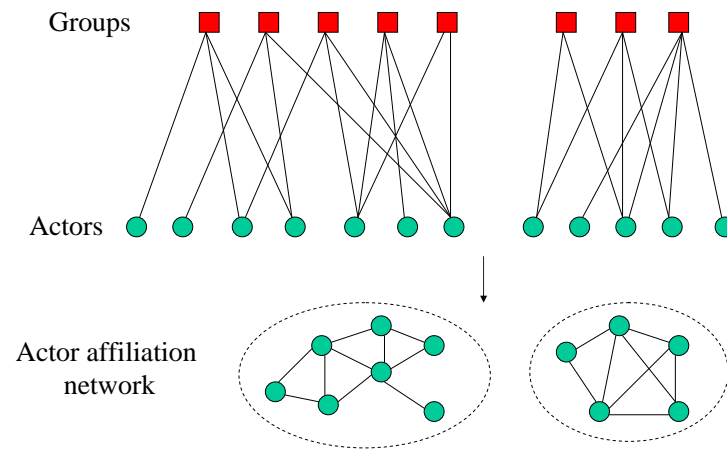


Optimisation one step towards social reality

One further step: beyond fixed lattice substrates

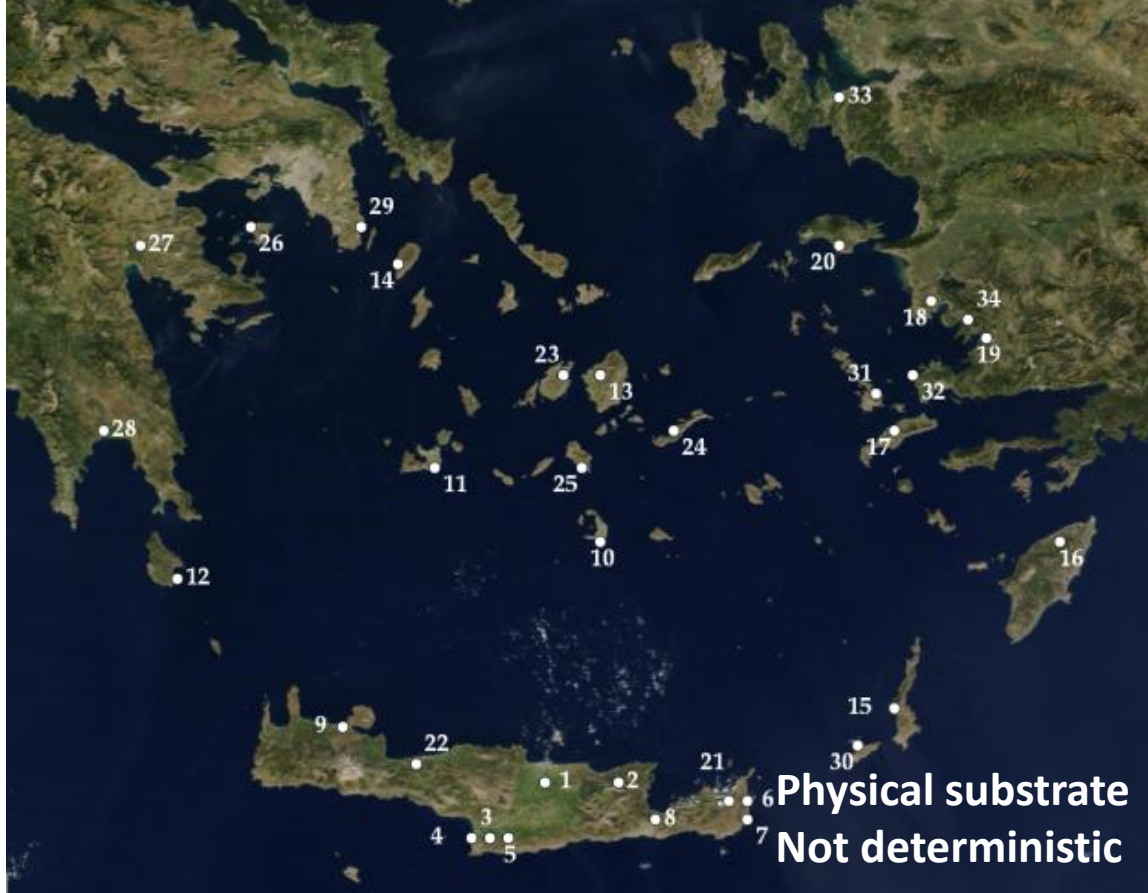
Common dichotomy: physical / social space

Watts falls into trap with his 'affiliation networks'



We combine the two in a sociogeographical approach

Physical yes, substrate yes; but it is dynamic



- Hence general aim is to produce dynamic networks
- Driven by function: networks bring benefits (& costs)
- We alter balance of benefit/cost in the model
- Then see how networks emerge in different conditions
- Different networks may or may not see articulation of scales
- **‘Small world’ just one possibility among many**