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Agent-based approaches to modelling social systems

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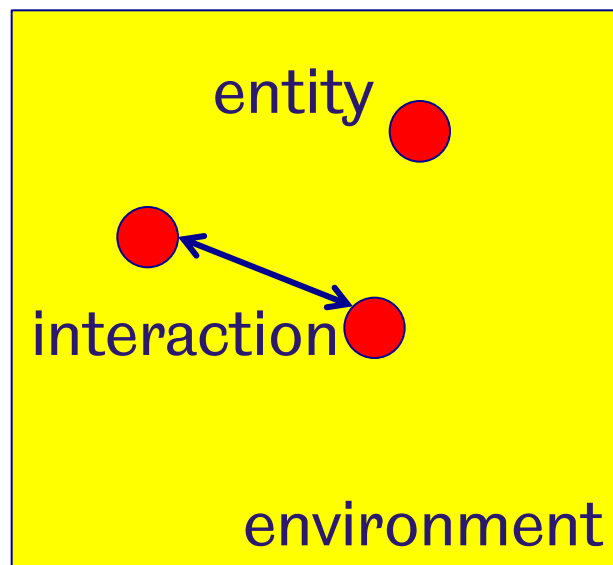
CWiPP workshop on quantitative analysis of growing up in poverty, 1 August 2013



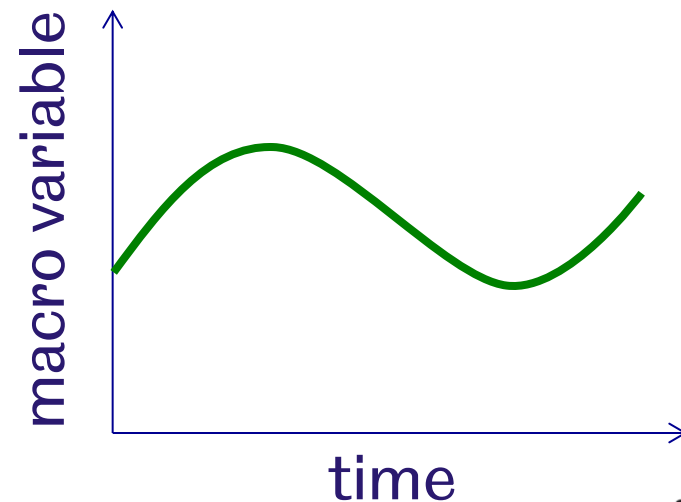
Overview

- What is an agent-based model (ABM)?
- How are agent-based models used in the social sciences?
- What are the strengths and limitations of agent-based modelling?

Agent-based models are a **bottom-up** approach for understanding and predicting social phenomena

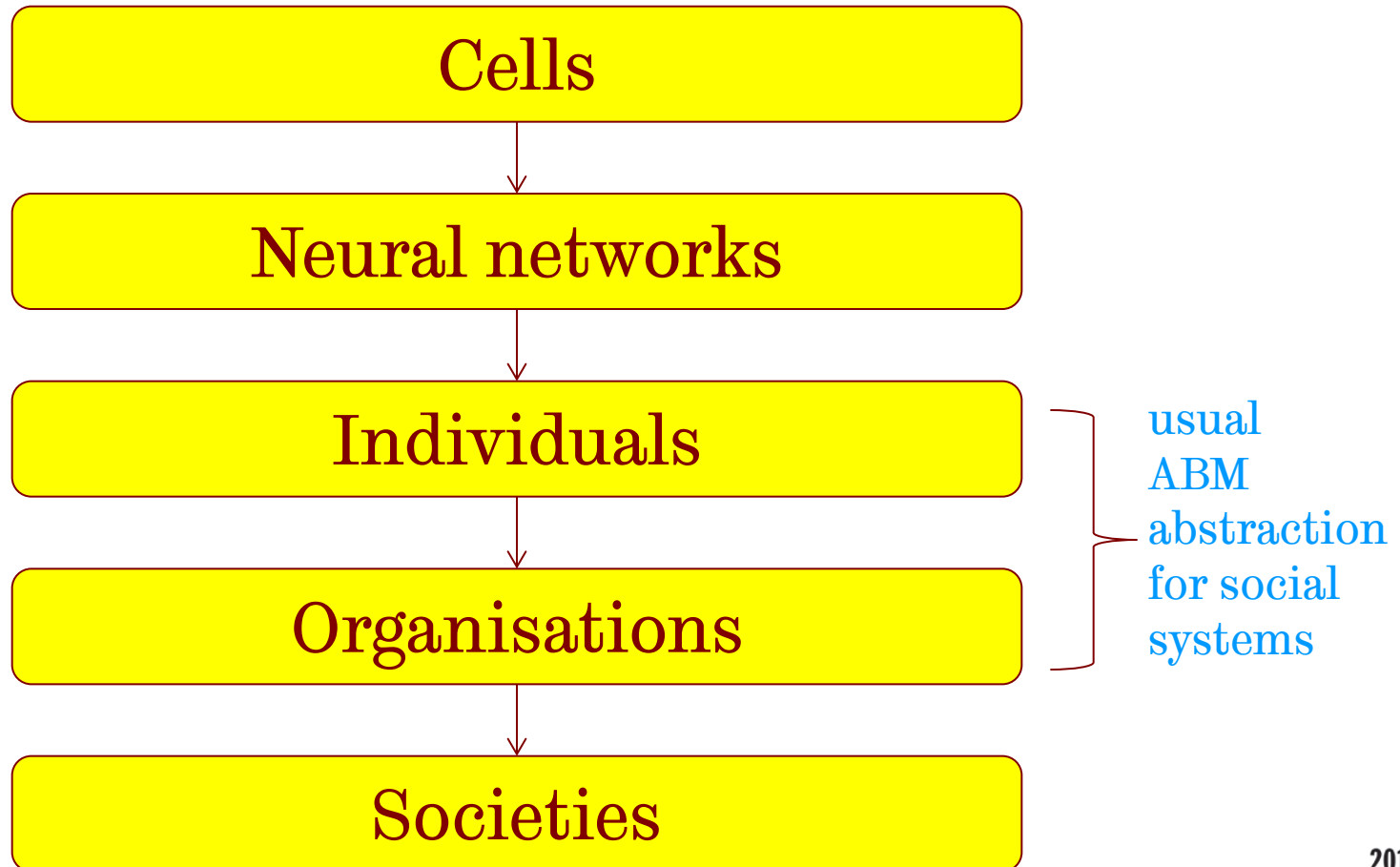


→
"emergence"





Abstraction: what has agency?





ABM in the social sciences (Gilbert 2008)

Abstract Models

Used in the development of general social theory, by forcing a complete description of social processes
e.g. process of segregation

Middle Range Models

Used to describe particular social phenomena in general terms
e.g. racial segregation in cities

Facsimile Models

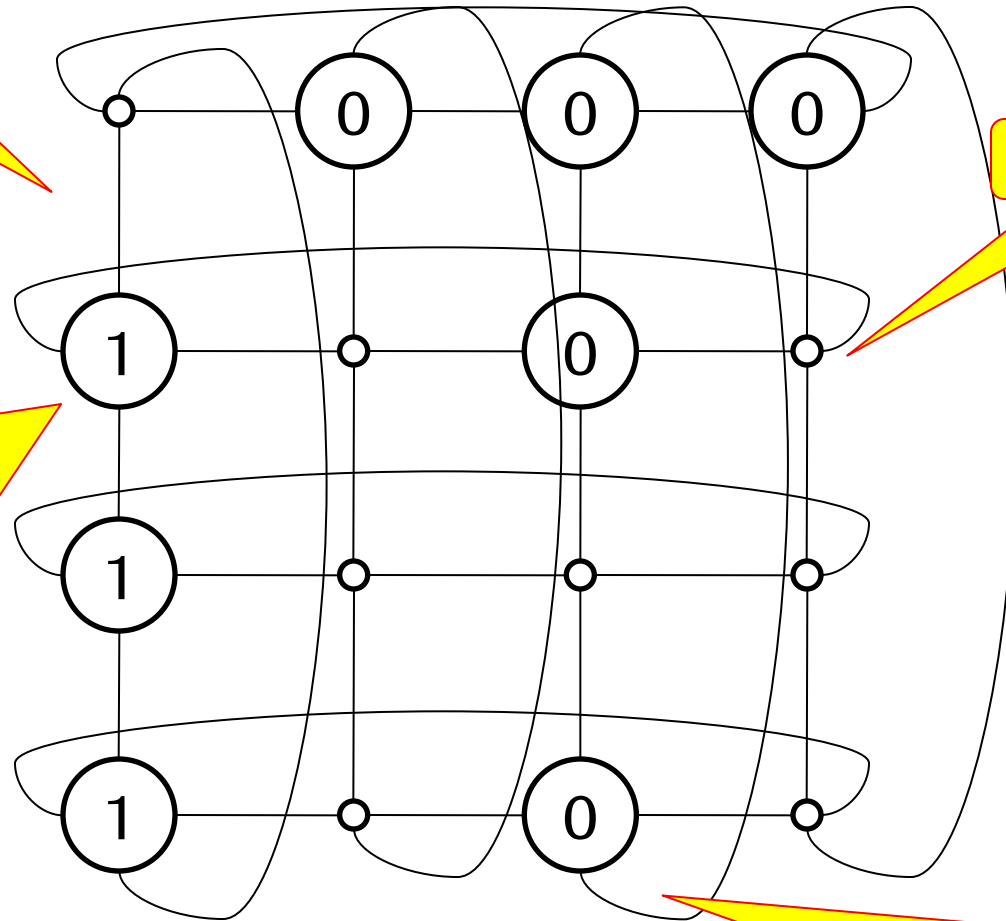
Used to reproduce specific phenomena, with a view to prediction
e.g. racial segregation in Chicago, 1940-50.



Middle Range Model

8 agents inhabiting a 4x4 grid network.

Rule:
if (different > same)
then **move**
else **stay**



Empty node.

Possible steady-state response: agents of type 0 and 1 have formed separate communities.



Where do the agent interaction dynamics come from?

- Very simple rules based on high-level abstractions of behaviour (e.g. segregation model)
- Rules based on sociology or social psychology theory (e.g. theory of planned behaviour)
- Elicitation of rules based on empirical observation in controlled conditions
- Non-prescription of rules, within some adaptive framework of bounded rationality...



Formulate agent interactions using game theory

- e.g. prisoners' dilemma:

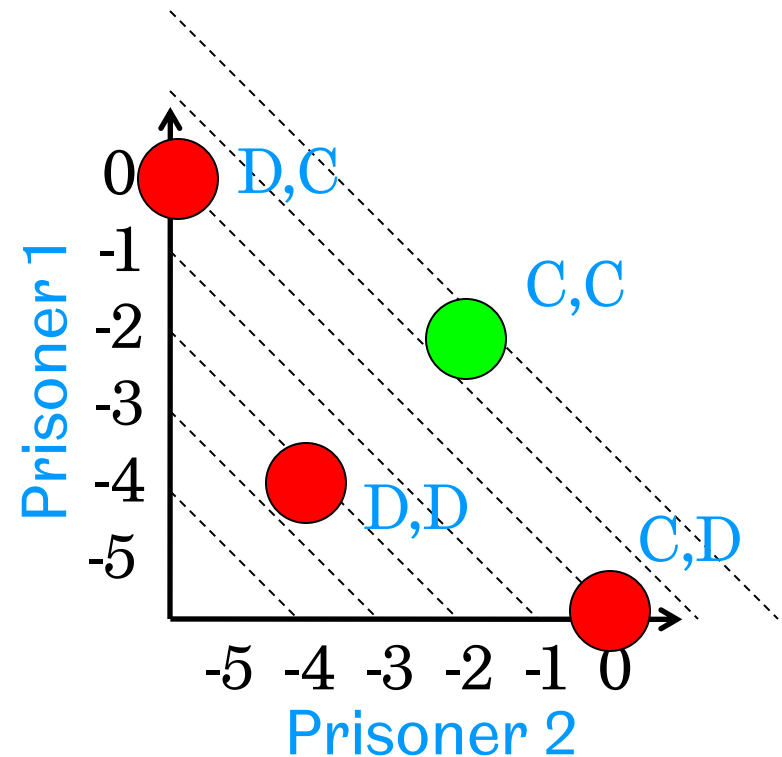
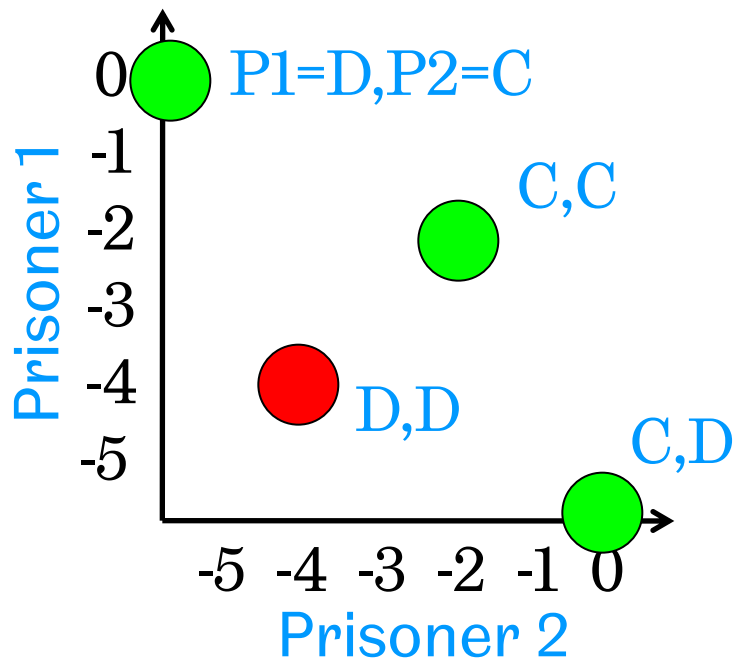
		Prisoner 2	
		Cooperate	Defect
Prisoner 1	Cooperate	-2, -2	-5, 0
	Defect	0, -5	-4, -4

Do not confess

Confess

What is 'socially' optimal?

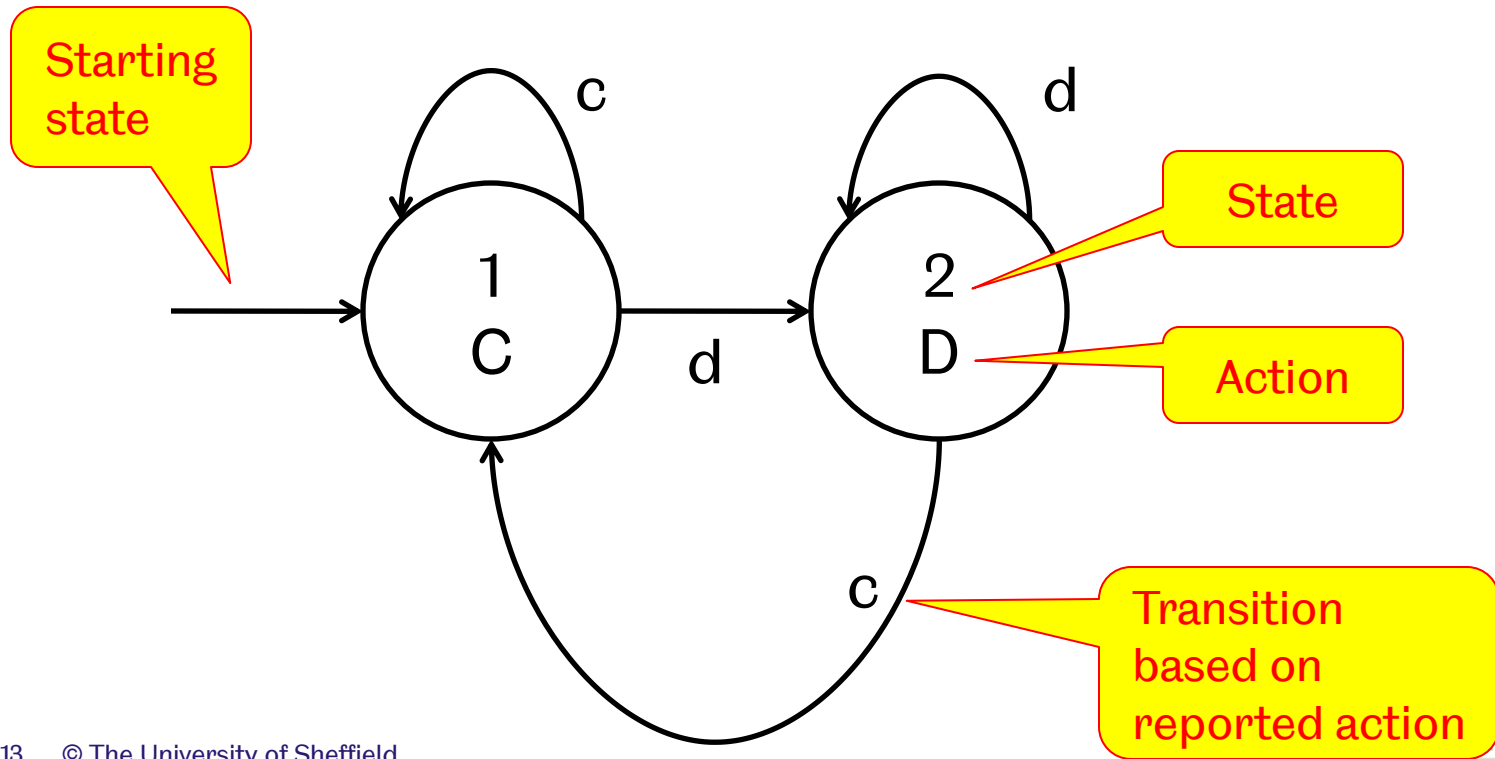
- *Social efficiency*
- *Social welfare*





Formulate bounded rationality as automata

- e.g. start by cooperating
- Then do to the other agent next time whatever they did to you this time.



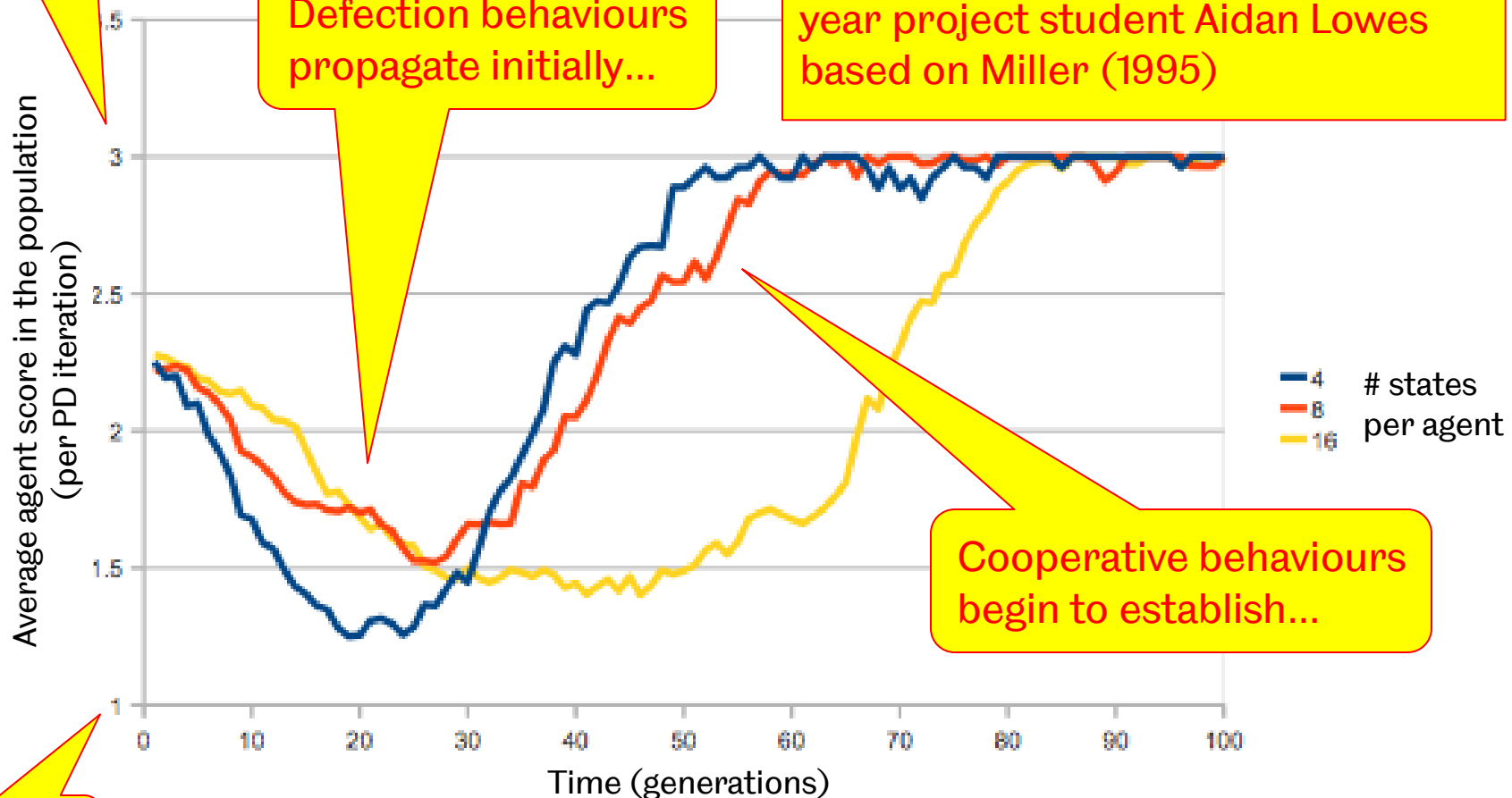


Cultural evolution of agent strategies

= mutual cooperation

Defection behaviours propagate initially...

Results obtained by ACSE MEng final year project student Aidan Lowes based on Miller (1995)



Cooperative behaviours begin to establish...

= mutual defection

Critical evaluation of ABM

Strengths

- Explicit representation of dynamic causal processes
- No strong linearity assumptions
- Able to handle heterogeneity
- Permits bounded rationality and mistake-making by agents.

Limitations

- Introduces many degrees of freedom, making validation challenging
- Still quite immature – may not be trusted by research users; lack of best practice
- Barriers to entry – requires programming skills, access to significant time and computing resources.



Further reading

