Cooperation in Growing Communities

Rowan Martin-Hughes

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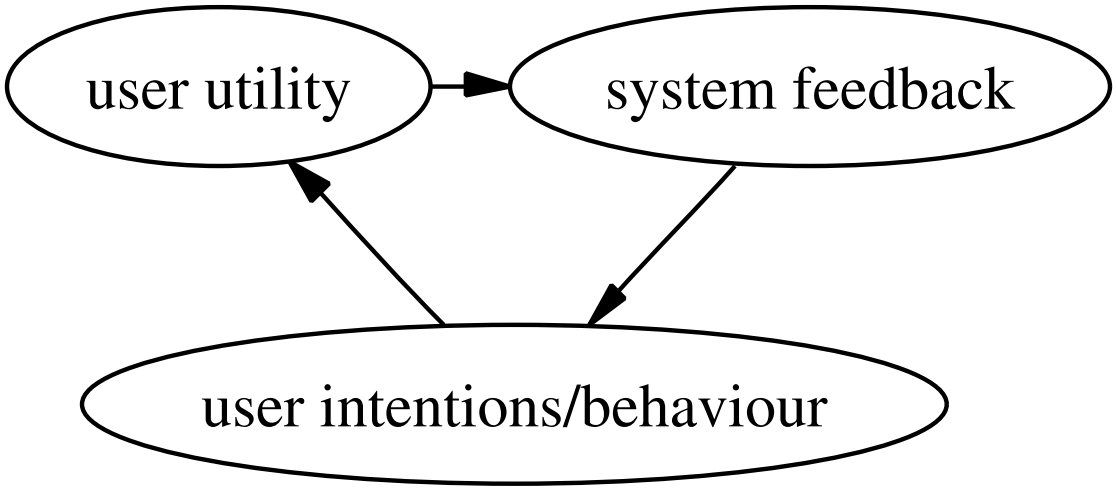
Introduction

- How does behaviour in a system change over time as we move from small communities to larger ones?
- Networks of interest
  - eBay
  - Message Boards
  - Generic Social Networks

How do we view trust?



- We view agents as not having an intrinsic behaviour
- Then trust makes sense as an emergent property of following this cycle over time

The basis of interaction

The Transaction Game

Table: Payoffs to Agent 1

Agent 1/Opponent	Cooperates	Defects
Cooperates	$-\texttt{cost1} + \texttt{payoutfrom2}$	$-\texttt{cost1}$
Defects	$\texttt{payoutfrom2}$	0

- Each agent essentially has the opportunity to give something to the other

Metric

- Average utility gained per transaction
  - Equates to the amount of cooperation in the system
  - Objectively: if one party is cheated this is only transferal of utility
  - Subjectively: a frequently cheated user is inclined to leave the system

Ways to modify the game

- Reduce available options
  - Buyers pay first?
- Increase payoff for cooperation
  - Users have reason to care about their opponent
- Decrease payoff for defection
  - Immediate punishment
  - Punishment through reputation

Lomborg's Study

- Iterated Prisoner's Dilemma games
- Agents playing reactive strategies

Examples

Table: The opposing actions (least recent to most recent) which each point in an agent's strategy corresponds to.

	1	2	3	4	5	6	7
Opponent history	initial	D	C	DD	DC	CD	CC
Response							

e.g. Strategy {C,DC,DCDC} is tit-for-tat with a history of two

Agent Characteristics

- With a sufficient history length complex strategies are feasible
- Innovation
  - Agents sometimes modify their strategies
- Imitation (learning)
  - Agents sometimes imitate a better performing strategy
- Noise resistance

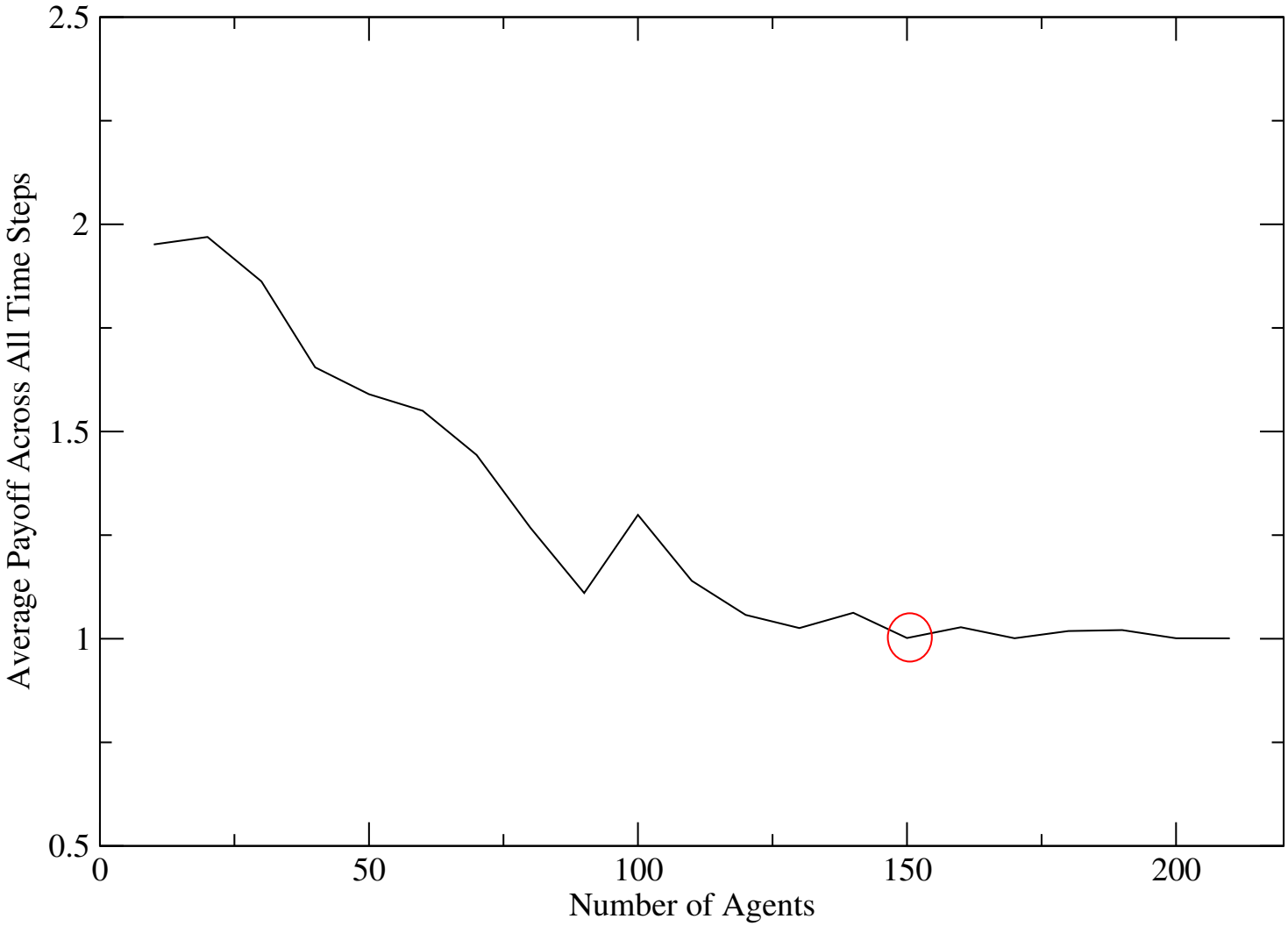
Analysis over time

- The most stable cooperative populations consisted of two broad categories of agent
  - Nucleus - very cooperative strategies
  - Shield - aggresively punishes past defectors
- Vulnerable mainly to complacency
- Similar to real personality distributions?

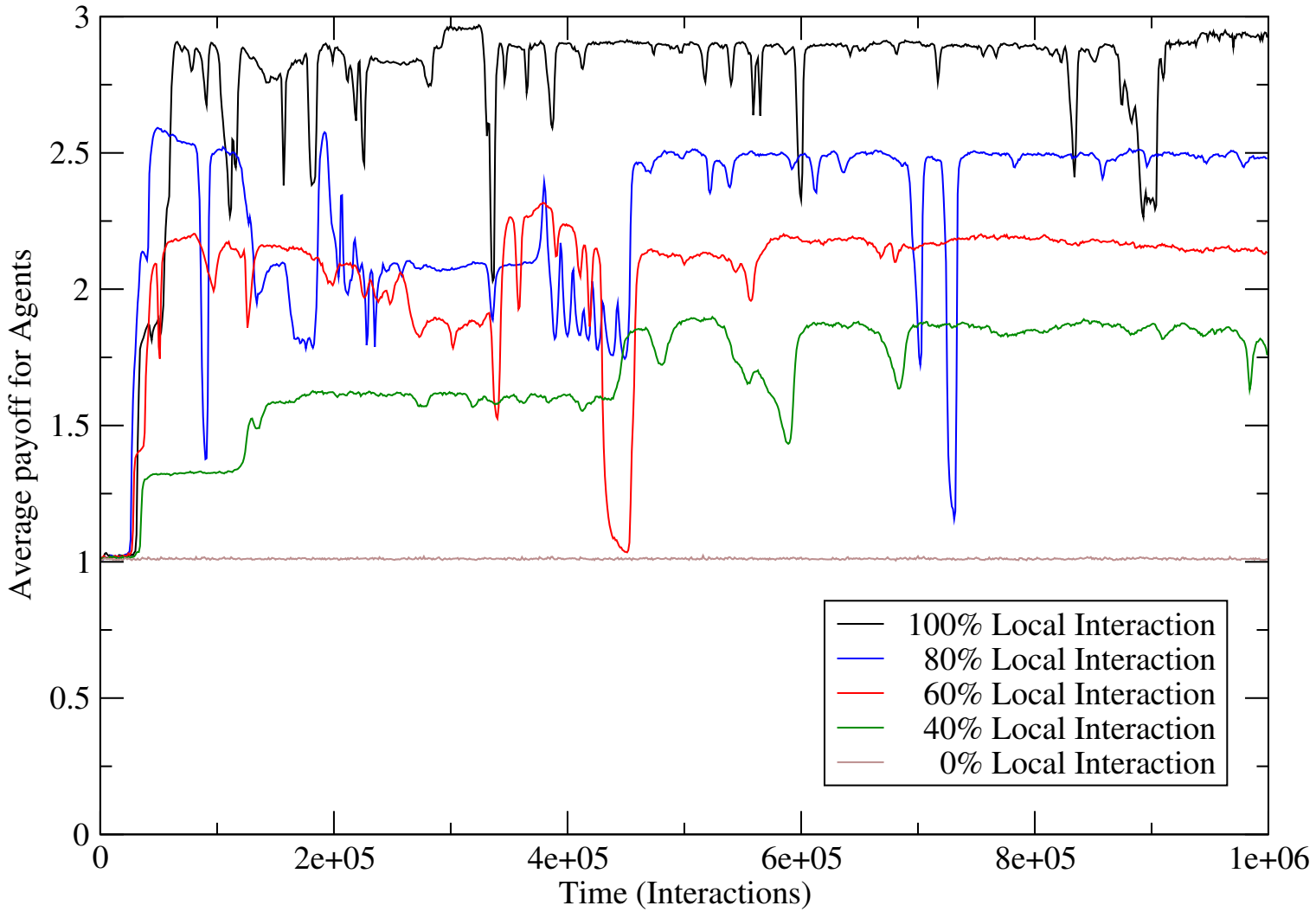
Limitations

- Lomborg had each agent playing many iterations at once against other agents at each time step
- We want to consider what happens when agents interact infrequently with each other agent

Limitations



How much local interaction do we need?



Are any strategies dominant?

- Take {D,DD,DDDD,CDDDDDDD} for instance...
- With credible threats, the Folk Theorem essentially says:
  - Any strategy has a counter-strategy
  - No stable equilibrium exists

Discussion of assumptions

Prisoner's Dilemma

Table: Default Payoffs

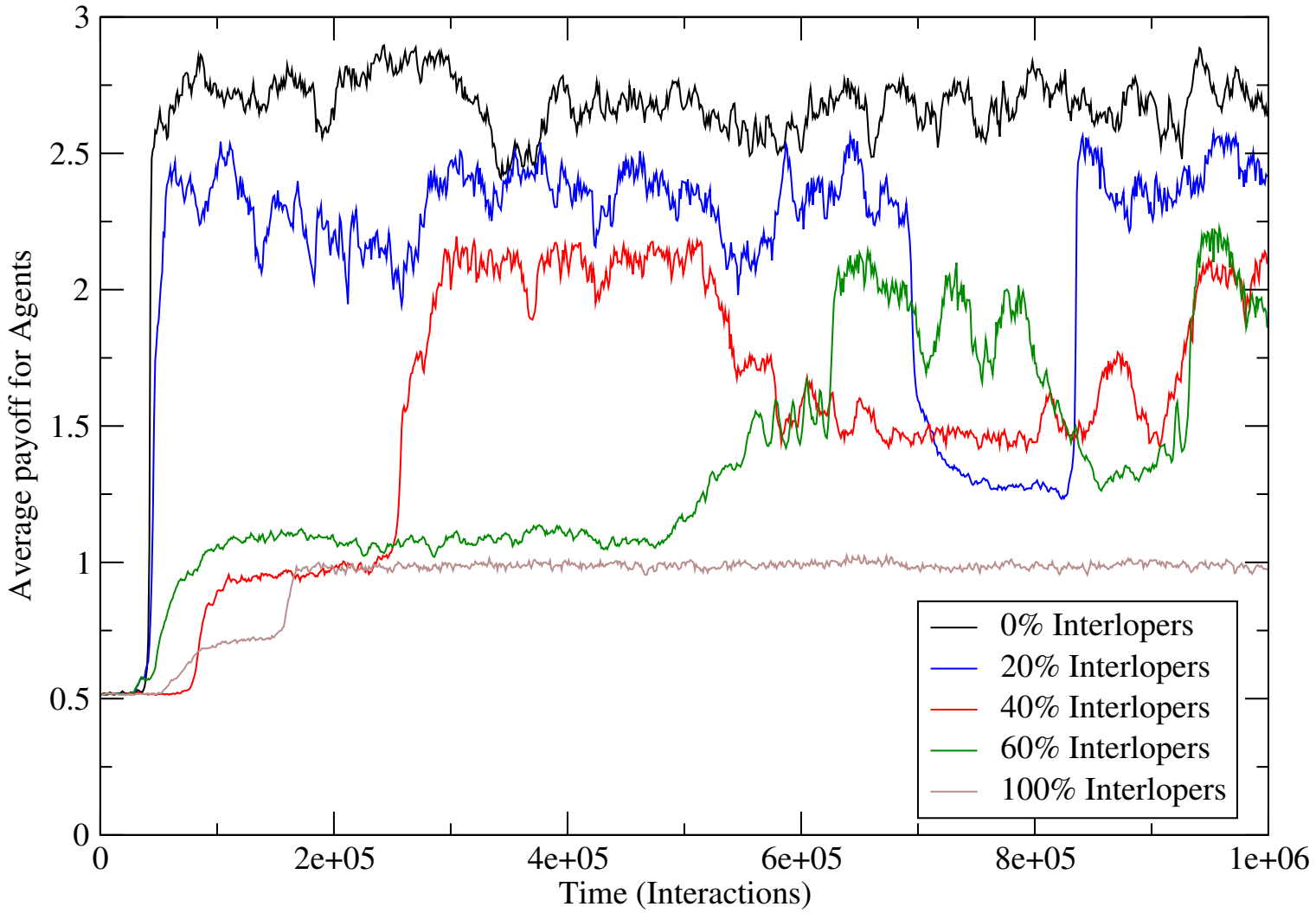
Agent/Opponent	Cooperates	Defects
Cooperates	3/3	0/5
Defects	5/0	1/1

- If we change these payoffs we change the outcome
- What if some proportion of agents are only there to cheat?

Reputation Systems

- Instead of assuming a degree of local interaction, consider a reputation system
- Abstractly able to punish defectors by reducing their payoff in the round after they defect
- Not enough punishment for cooperation to be strictly dominant, is it enough for cooperation to evolve with varying levels of interlopers?

What if some agents are only there to cheat?



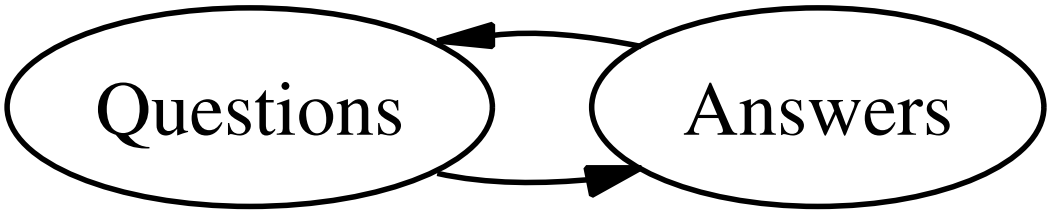
Comparison with fixed mixed-strategy playing

- If all agents were to play a fixed mixed-strategy then we can calculate the optimum such strategy
- With a high percentage of interlopers we approach this
- With a low percentage of interlopers we frequently exceed this

What can we do with this?

- Does not prevent defection
- Does show the factors which encourage evolution away from defection
- Valuable for situations which do not require absolute cooperation
- ...but which are prone to disintegration as they grow and the level of noisy defection becomes too high

Questions?



How much history should agents keep?