Rationality meets the tribe:

Some models of cultural group selection

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Models?

- Abstract models / artificial societies
- Agent based modeling
- Thought experiments
- Not empirically verified / or applied
- Relax assumptions of traditional game theory / rational action approach
- Copying (replication) and limited innovation (mutation) => cultural evolution?
- “Emergent” macro outcomes
- Focus on social dilemma / public goods type scenarios

Assumptions

- Agents interact producing individual payoffs (e.g. Prisoner's Dilemma game)
- Agent action determined by a trait (e.g. cooperate or defect)
- Agents select interaction partners based on further trait defining an "in-group"
- Traits can be copied and mutated
- Agents tend to copy traits that produce higher individual payoffs
- Evolutionary game theory

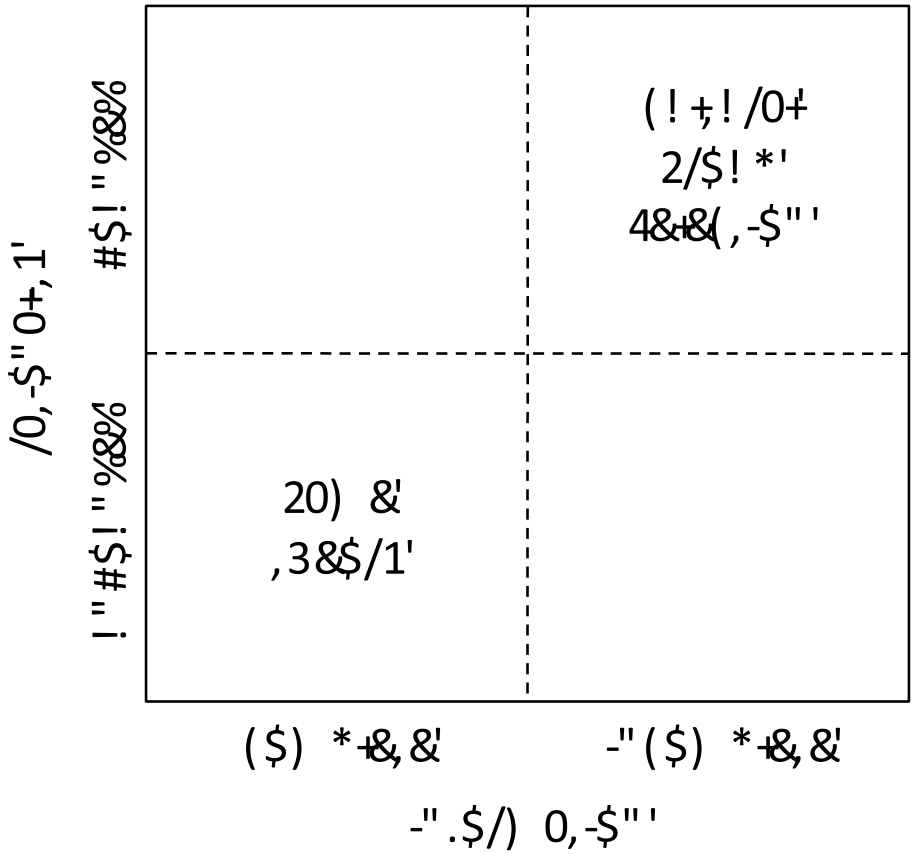


Figure 1. Traditionally, game theory models have focused on agents with unbounded rationality and complete information. The cultural group selection models presented here focus on highly bounded rationality and incomplete information.

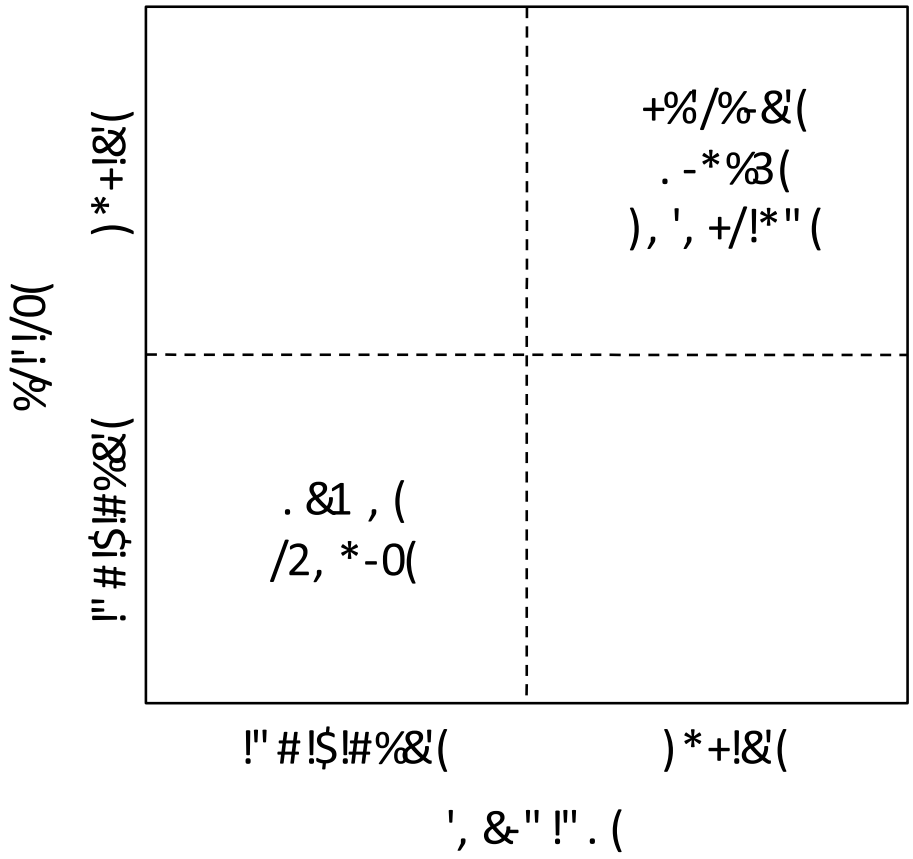


Figure 2. Cultural group selection models also differ from the traditional game theory approach in their focus on social learning and (often emergent) social utility over individual utility.

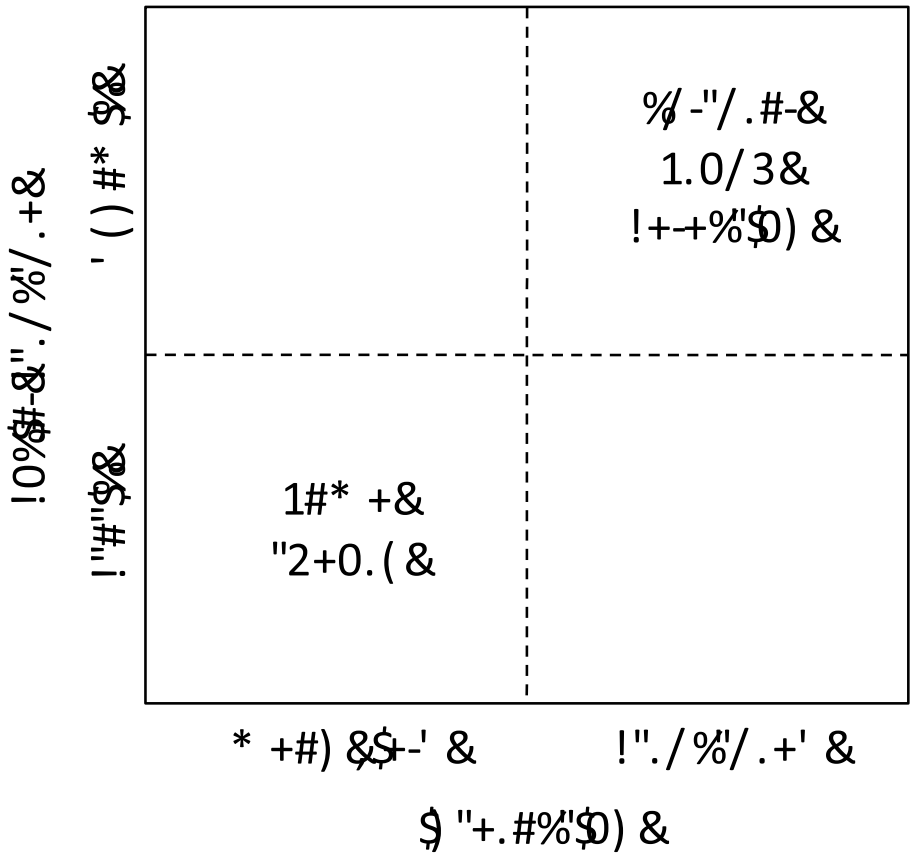


Figure 3. The cultural group selection models represent interactions within dynamic social structures whereas game theory has tended towards static "mean field" structures.

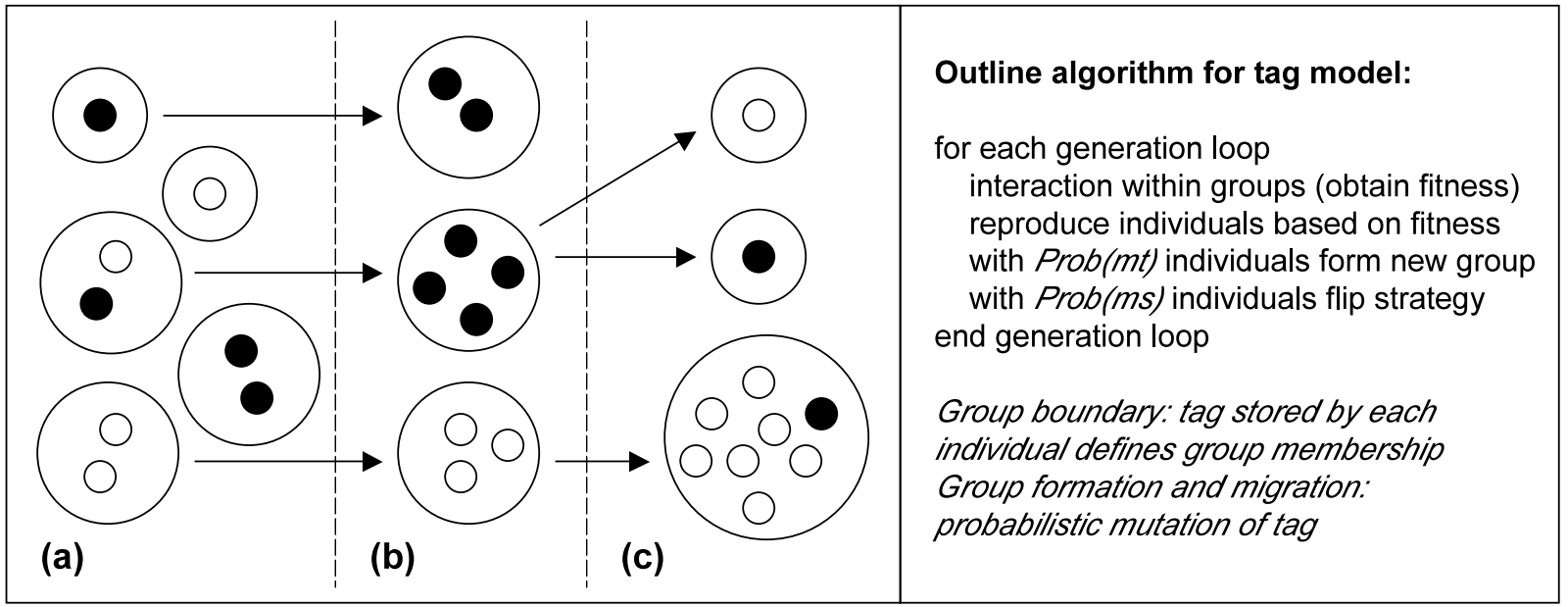
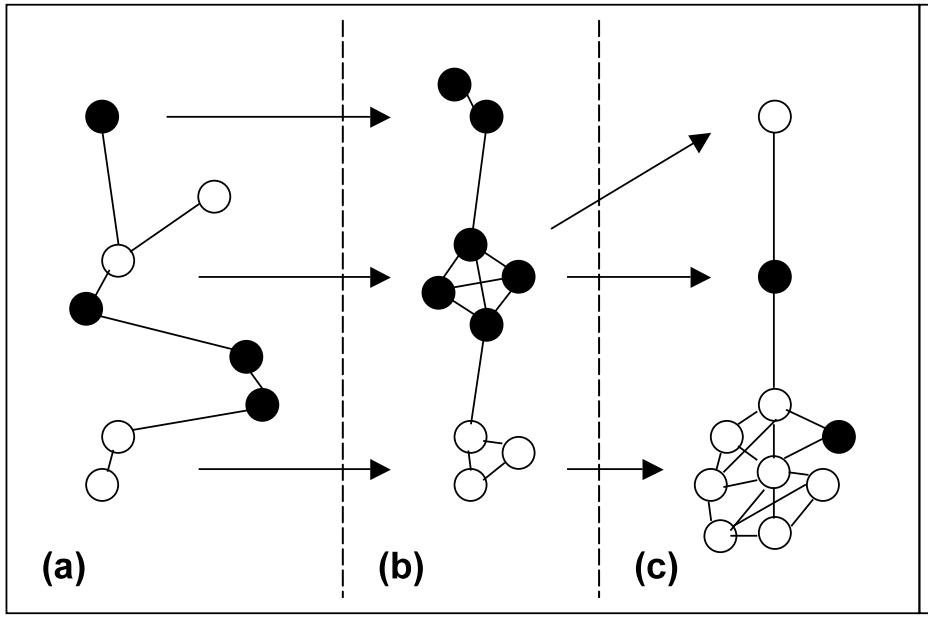


Figure 4. Schematic of the evolution of groups in the tag model. Three generations (a-c) are shown. White individuals are pro-social, black are selfish. Individuals sharing the same tag are shown clustered and bounded by large circles. Arrows indicate group linage. Migration between groups is not shown.

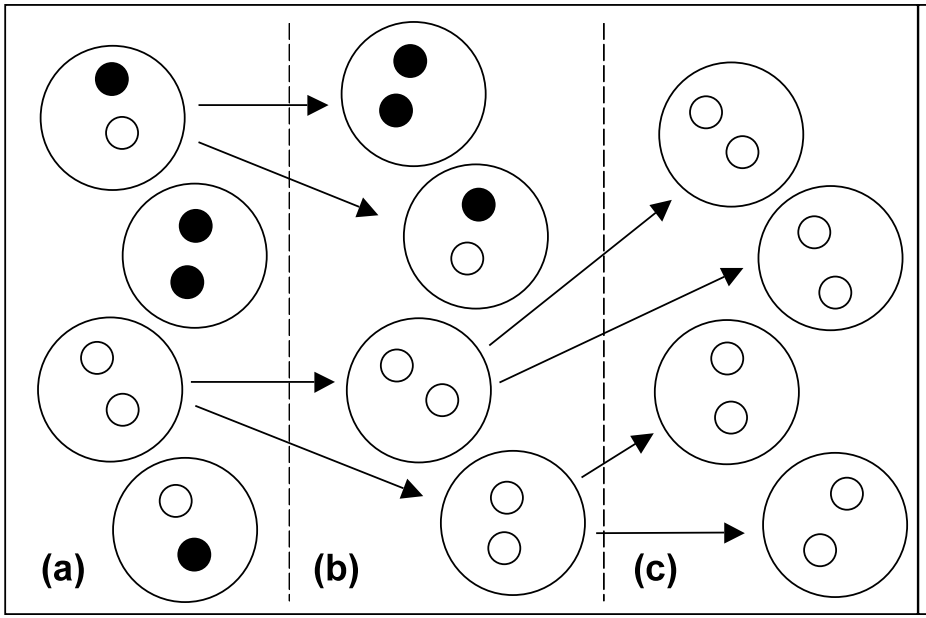


Outline algorithm for network model:

for each generation loop
interaction within groups (obtain fitness)
reproduce individuals based on fitness
with *Prob(t) copy new links*
with *Prob(ms)* individuals flip strategy
end generation loop

Group boundary: individuals directly linked in the network
Group formation and migration:copying of links probabilistically

Figure 5. Schematic of the evolution of groups (cliques) in the network-rewiring model. Three generations (a-c) are shown. White individuals are pro-social, black are selfish. Arrows indicate group linage. Notice the similarity to the tag model in figure 4.



Outline algorithm for split model:

for each generation loop
interaction within groups (obtain fitness)
reproduce individuals based on fitness
with *Prob(q) split any group > m in size*
eliminate random group
end generation loop

Group boundary: individuals exogenously given group membership
Group formation and migration: splitting of group when size > m.

Figure 6. Schematic of the evolution of groups in the group-splitting model. Three generations (a-c) are shown. White individuals are pro-social, black are selfish. Individuals sharing the same group are shown clustered and bounded by large circles. Arrows indicate group linage. Migration between groups is not shown.

What are tags

- Tags are observable labels, markings or social cues
- Agents can observe tags
- Tags evolve like any other trait (or gene)
- Agents may discriminate based on tags
- John Holland (1992) => tags powerful “symmetry breaking” function in “social-like” processes
- In GA-type interpretation, tags = parts of the genotype reflected directly in the phenotype

Tag Models

- Tags may be bit strings signifying some observable cultural cues
- Tags may be a single real number
- Any distinguishing detectable cue
- Most show cooperation / altruism between selfish, greedy (boundedly rational) agents

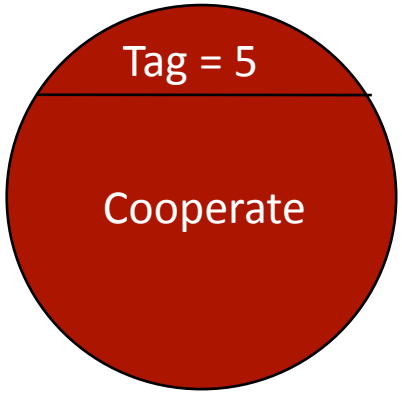
Tags in the literature

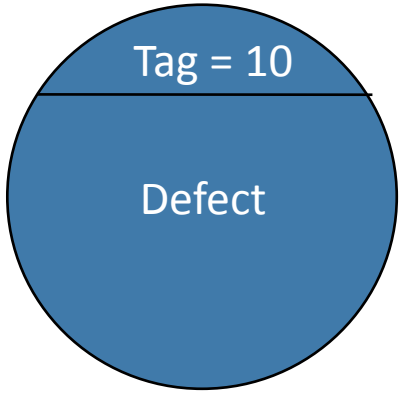
Year	*Author(s)*	*Tag Type*	*Model*	*Interp.*	*Task*	*Ref*
1993	Holland	general / real no.	none	socio. / bio	IPD	SFI WP
1997	Riolo	real number	bio.	bio.	IPD	SFI WP
2000	Hales	binary string	socio.	socio.	PD	MABS2000
2001	Riolo et al	real number	socio.	socio.	giving game	Nature
2002	Hales	real number	socio.	socio.	special-isation	MABS2002
2003	Hales & Edmonds	binary string	agents	agents	help giving	AAMAS2003
2003	Hales & Edmonds	various	agents	agents	various	ESOA2003
2004	Hales	network links	p2p	p2p	PD	ESOA2004
2004	Hales	network links	p2p	p2p	file-sharing	IEEE p2p2004

Generic evolutionary algorithm

Initialise all agents with randomly selected strategies
LOOP some number of generations
    LOOP for each agent (a) in the population
        Select a game partner (b) from the population
        select a random partner with matching tag
        Agent (a) and (b) invoke their strategies
                receiving the appropriate payoff
    END LOOP
    Reproduce agents in proportion to their average payoff
            with some small probability of mutation (M)
END LOOP

Agents – a tag and a PD strategy

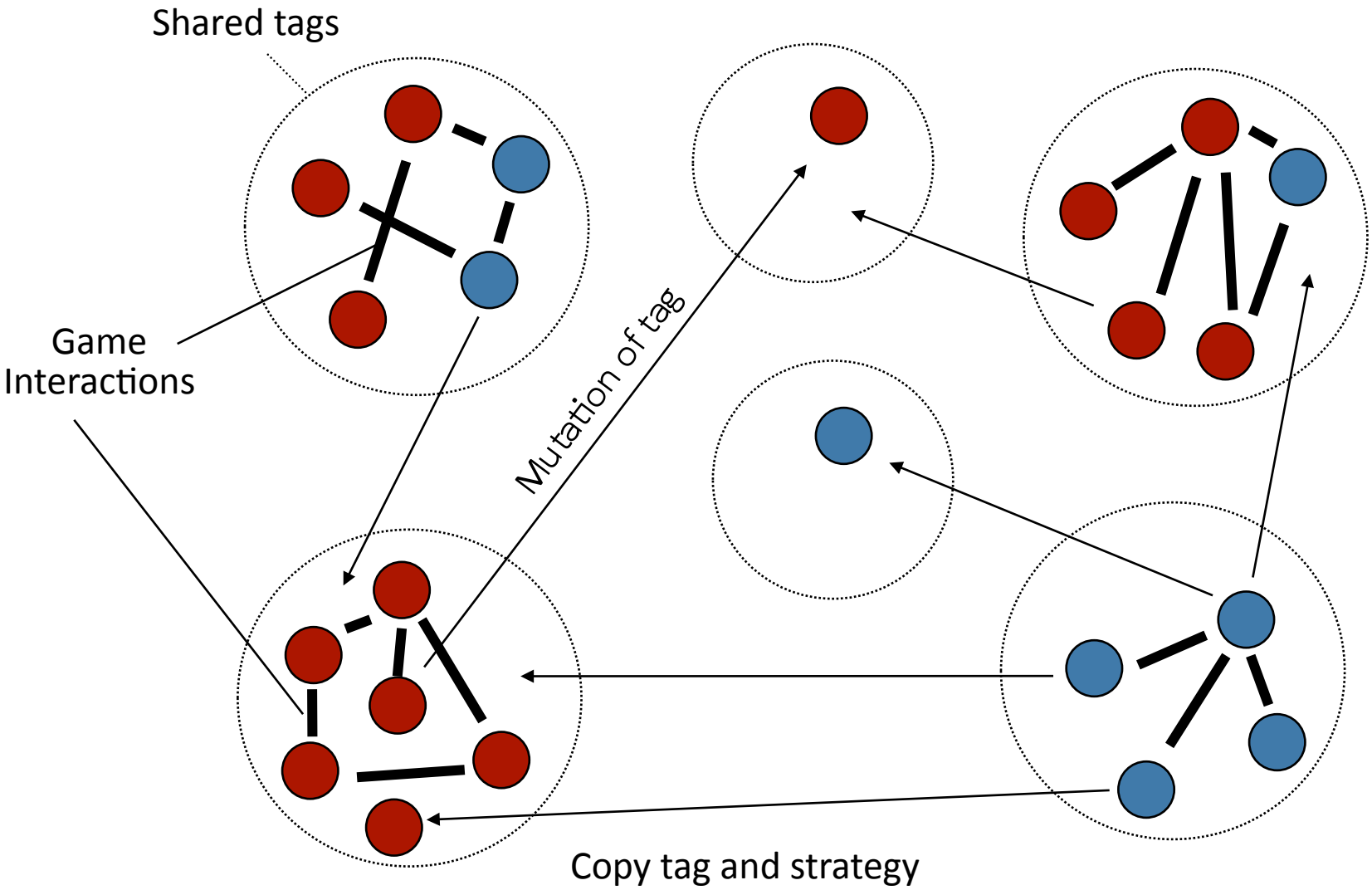




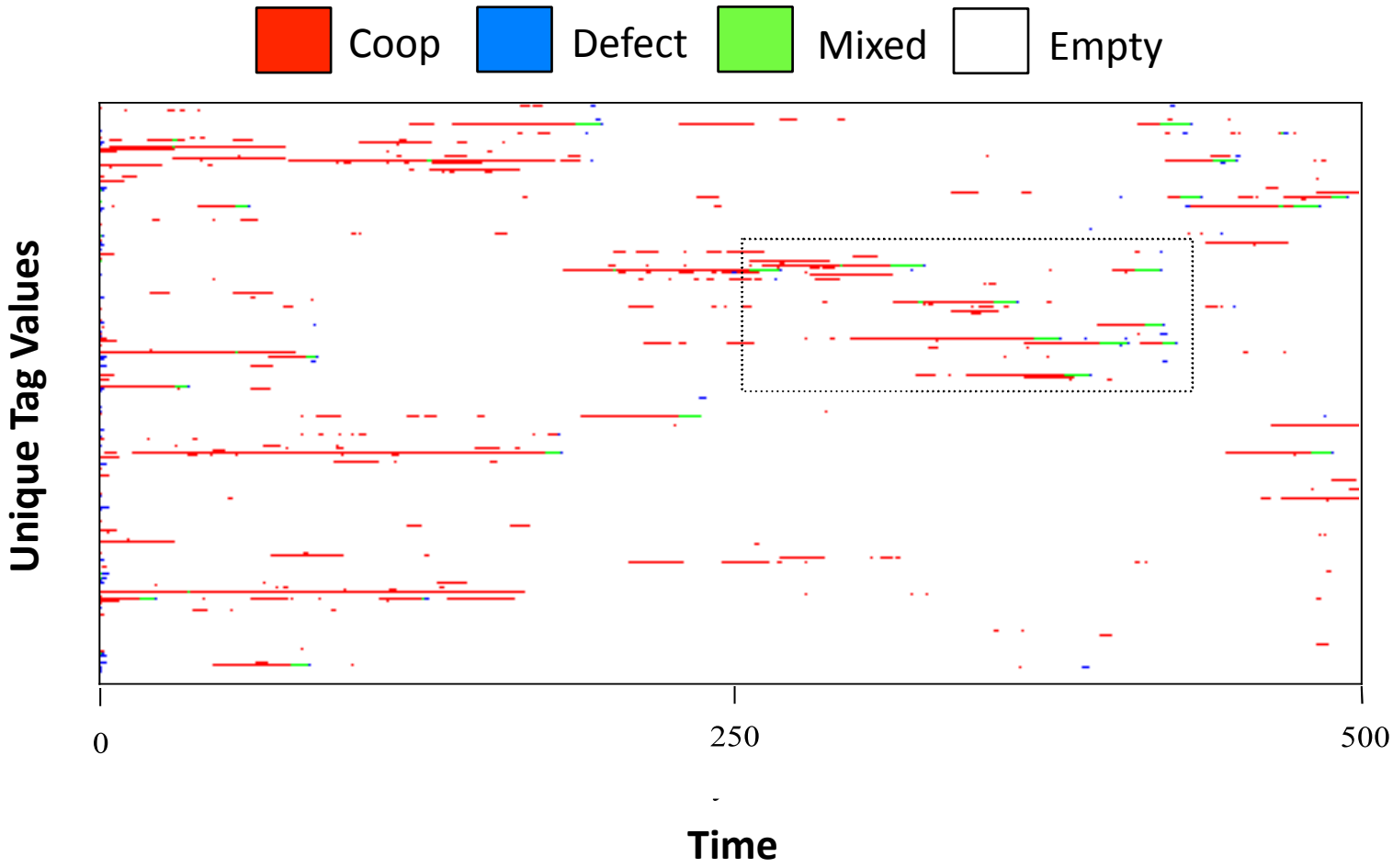
Tag = (say) Some Integer

Game interaction between those with same tag (if possible)

How tags work



Visualising the process



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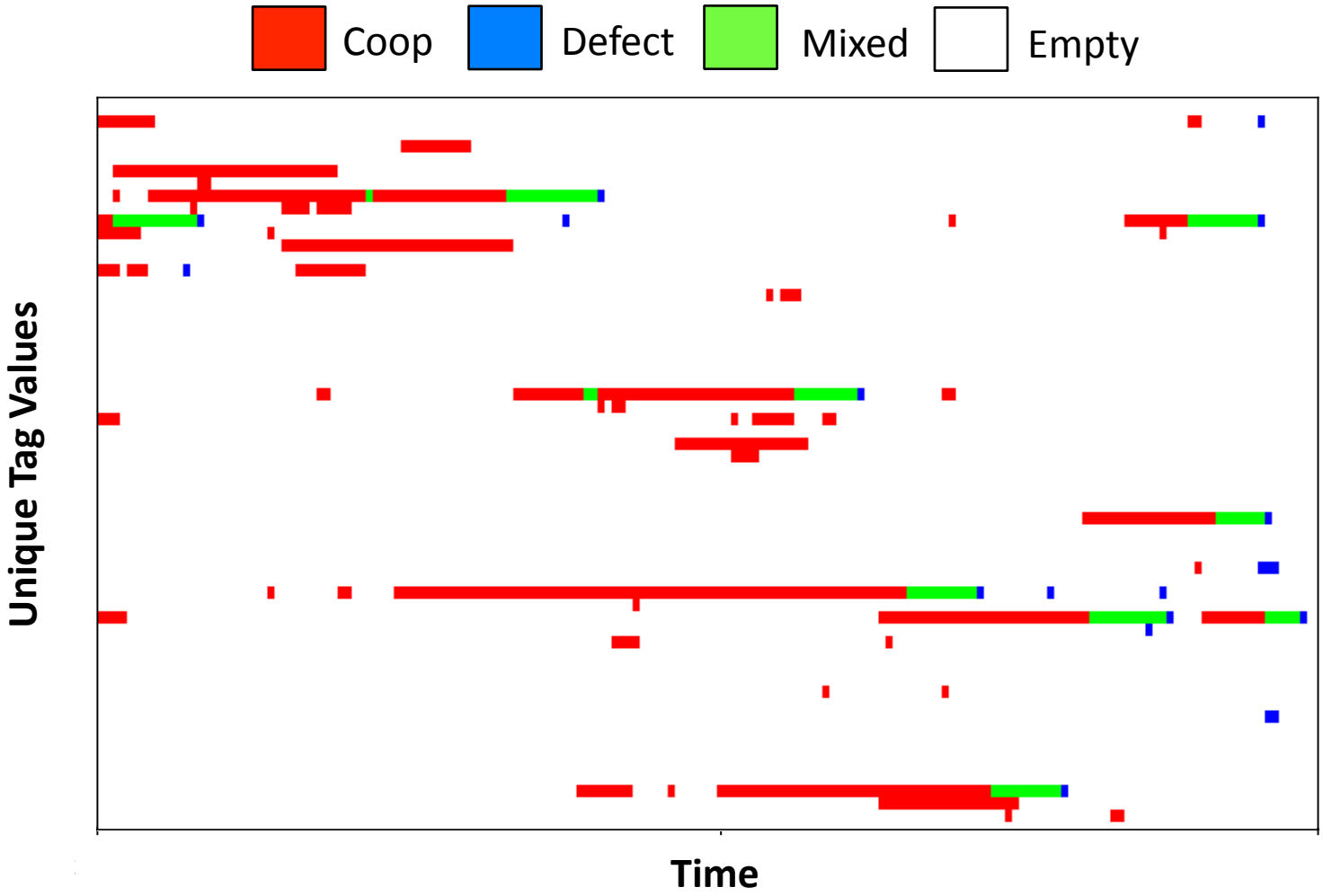
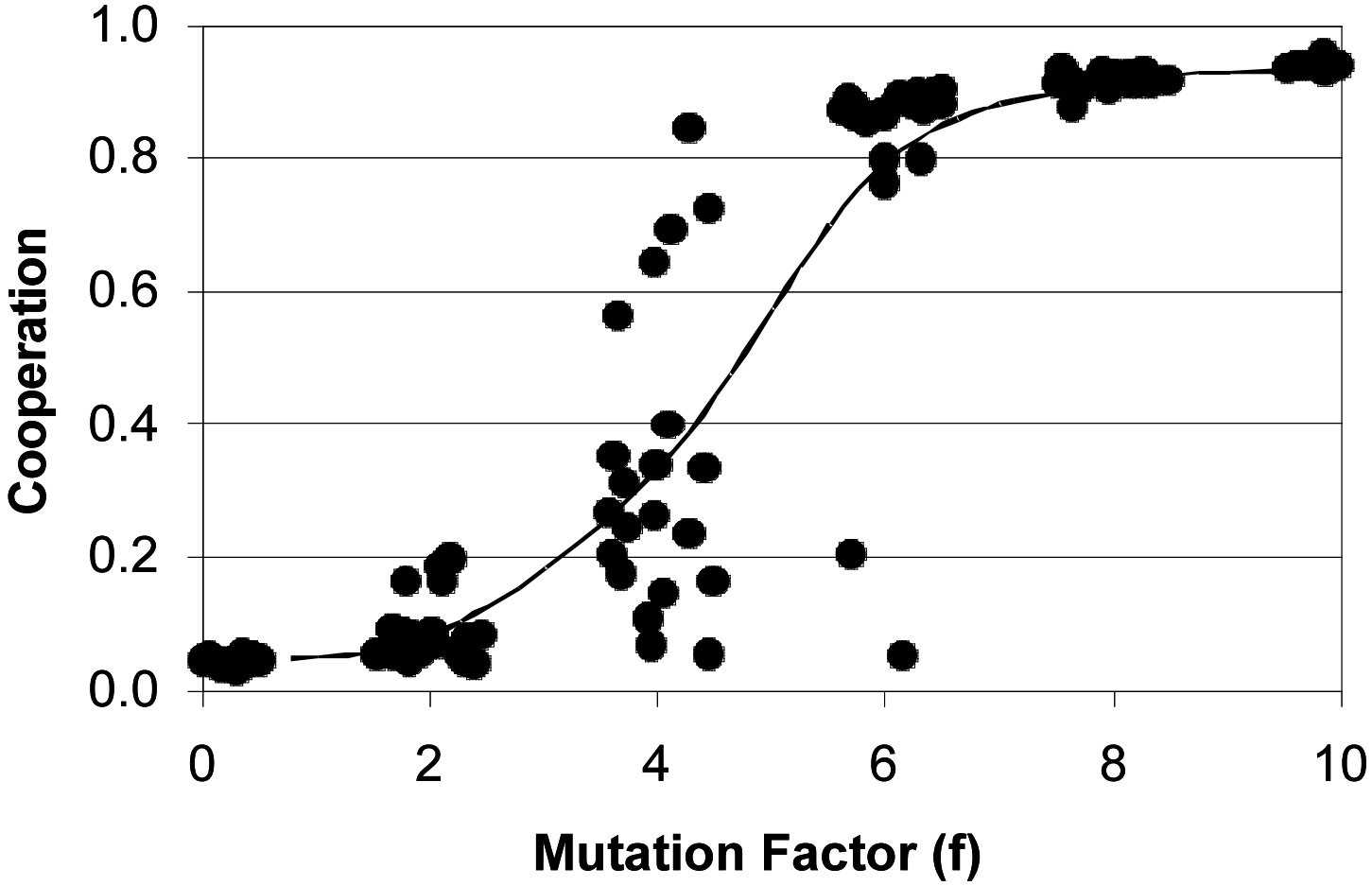


Change your tags fast…

- Groups have to be formed more quickly than they invaded and killed
- New groups are formed by mutation on the tag
- Old groups are killed by mutation on the strategy
- So if tag mutation > strategy mutation this should promote cooperation?
- Test it by looking at the existing models and implementing a new one

Tag / strategy mutation rate



Network rewiring movie

Summary

- Simple copying heuristics based on individual utility with social structure => “as if” a motivating force higher than self-interest towards to in-group
- Agents “vote with their feet” by moving to better groups via copying
- History of system important to understand behaviour at any given point in time

Any Use?

- Can such processes be observed in real systems? How could they be measured?
- Models assume the rapid ability to create new groups and free movement between groups – is this valid in real systems?
- Online communities? Ephemeral groups? Twitter tags?
- Can such models be adapted from the abstract to particular scenarios? Vary assumptions?