Localised Reputation in the Prisoner's Dilemma

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Abstract. Under what conditions can cooperation emerge and be sustained? Previous studies abstract cooperation and defection using the spatial Prisoner's Dilemma (PD) game. We study a local reputation mechanism in which agents can remember defectors, abstain from interacting with them, and warn nearby agents. Simulations find that local reputation is effective in sustaining cooperation and punishing defection. Further, we find that the size of agent memory and amount of gossip are not significant factors, provided the locality range of gossip is greater than the agent movement speed.

1 Motivation and Experimental Design

Reputation systems strongly boost cooperation in spatial exchange games such as spatial PD [2, 6]. Similarly, allowing game participants to pass information, either directly [4] or indirectly [1], increases the rate of cooperation.

We aim to explore the limits of local reputation—built up via gossip—in promoting and sustaining cooperation. Agent's behaviour is defined by the finite state diagram shown in Figure 1. We expand over prior work [5] by giving agents a (limited size) memory to keep track of defectors and to allow them to share this information by gossiping with other agents in a certain range.

2 Results and Discussion

We allow agents to remember the 5 most recent defectors and to ask nearby agents in a Moore neighbourhood of radius 1, 2, and 3 if they remember an

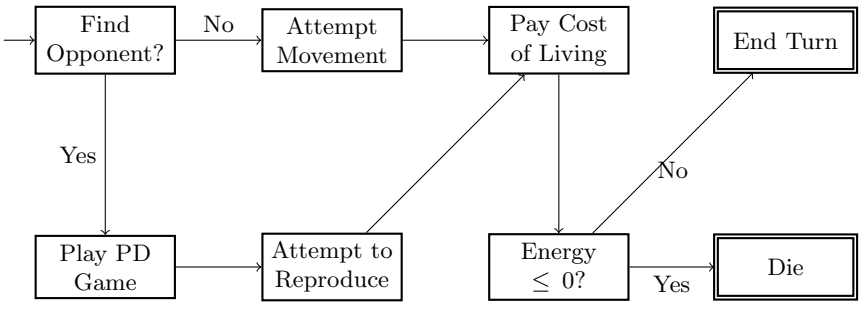

Fig. 1. Agent behaviour diagram: showing the decision flow of an agent's single turn

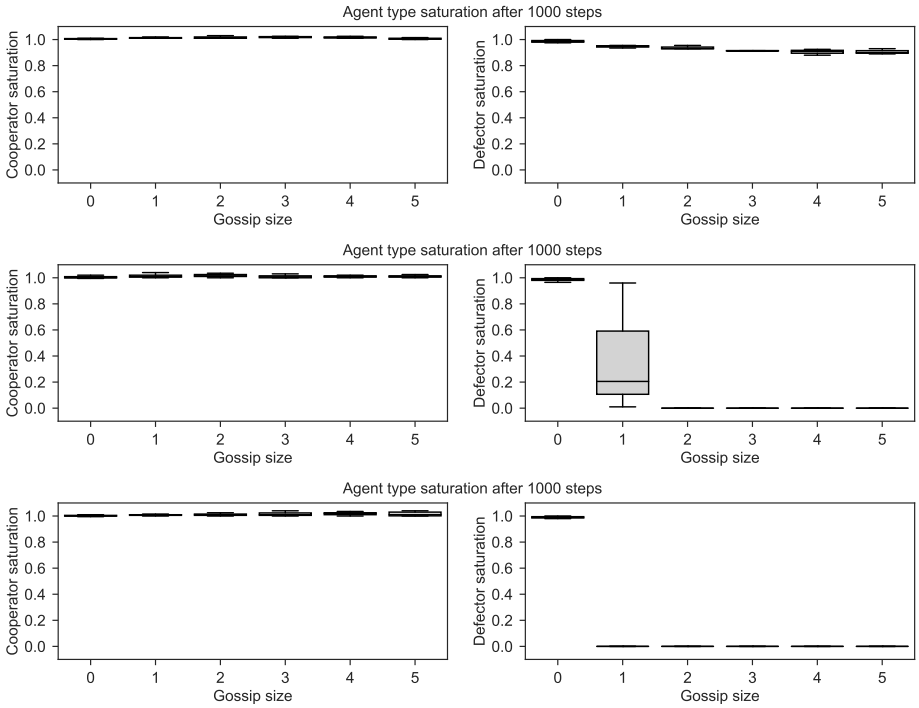

Fig. 2. Agent type saturation for various gossip sizes after 1000 steps, gossip radii 1, 2, and 3, respectively top to bottom; std. dev. of 30 simulation runs, outliers removed

agent defecting in a certain number of past encounters—varying between 0 and 5 (including both bounds). We run the simulation for 1000 steps and plot the agent type saturations in Figure 2.

The introduction of gossip is a strong deterrent of defection and quickly leads to cooperator–only populations. The size of the memory and the size of the gossip are not significant factors, only speeding up the convergence slightly.

Our simulation results find that the most important factor in predicting cooperator success is the range at which gossip can be exchanged; the amount of information included in the gossip has negligible effect. If the gossip can move faster than agents, cooperators will flourish. Otherwise, defectors can reach full population saturation.

Several directions can build on our results. Notably, we assumed all information is transferred with 100% fidelity. However, not all strategies that perform well in noiseless environments can do so under the presence of noise [3]. The gossip mechanism could turn out to be disadvantageous if the agent behaviour was unpredictable enough, since it would deter more cooperator–cooperator interactions.

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