Robustness of cooperative behaviours in reputation-based evolving populations

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The uprising and maintenance of cooperation in human societies, despite its inconvenience at the individual level, is a very important topic in game theory, complex systems physics, sociology and politics, debated not only for strictly scientific reasons, but also in order to have hints of how societies can enhance cooperation among its members.

Among others, one of the proposed mechanisms is the indirect reciprocity, originally suggested by Alexander[1], stating that individuals help recipients in order to receive help in their turn not necessarily by the same recipients they cooperated with in the past, but by someone else in their community. A somehow realistic way to implement indirect reciprocity in experiments and simulations is reputation. Nowak and Sigmund[2] conceived a smart model to simulate the effect of reputation on the evolution and enhancement of cooperation in a totally connected population playing a Prisoner's Dilemma Game. Here, each agent is characterized by a public reputation, which is a variable increasing each time she cooperates and decreasing when she defects. At the same time, an individual i chooses to cooperate only when opponent's reputation has at least a minumum value, k_i, which is in general different for each individual and depends on her past experience. Afterwards, Suzuki and Akiyama[3] generalized Nowak and Sigmund's results applying the same mechanism to a particular Public Goods Game, finding similar results: reputation can evolve and spread through the whole system; this effect is much stronger when agents play the PGG in samll groups; in medium-sized communities cooperative species can coexist in a stable manner with defecting species.

In this work, we have furtherly generalized the model, verifying its behaviour with different values of the parameters of the game (cost, synergy, total population size, *etc.*), and also testing it on networks, above all on bipartite graphs. We show that when the effects of reputation on cooperation are positive, they are enough stable if some parameters or topology of the model are changed, and we also have begun to think to possible experimental platforms in order to validate the simulative outcomes[4].

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[2] Nowak M. A. and Sigmund K., *Nature*, **393**, 573 (1998).
[3] Suzuki S. and Akiyama E., *Proceedings of the Royal Society*, **272**, 1373 (2005).
[4] Vilone D., Giardini F. and Paolucci M., in preparation (2014).