Emergence of Cooperation in Group Interactions: Avoidance vs. Restriction

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Abstract

Public goods, like food sharing and social health systems, may prosper when prior agreements to contribute are feasible and all participants commit to do so. Yet, free-riders may exploit such agreements (Han et al., 2013), requiring then committers to decide whether to enact the public good when others do not commit. So deciding removes all benefits from free-riders but also from those who are willing to establish the beneficial resource. Here we discuss our work published in (Han et al., 2014), wherein we show, within the framework of the one-shot Public Goods Game (PGG) and using methods of Evolutionary Game Theory (Sigmund, 2010), that implementing extra measures, delimiting benefits to free-riders, often leads to more favorable societal outcomes, especially in larger groups and highly beneficial public goods situations, even if so doing is costlier.

PGG is the standard framework for studying emergence of cooperation in group interaction settings (Sigmund, 2010). In a PGG, players meet in groups of a fixed size, and all players can choose whether to cooperate and contribute to the public good or to defect without contributing to it. The total contribution is multiplied by a constant factor and is then equally distributed among all. Hence, contributors always gain less than free-riders (non-contributors), leading to the destruction of cooperation, as predicted by evolutionary dynamics (Sigmund, 2010). In this scenario, arranging a prior commitment or agreement is an essential ingredient to encourage cooperative behavior, as abundantly observed both in the natural world (Nesse, 2001) and lab experiments (Cherry and McEvoy, 2013). Prior agreements help clarify the intentions and preferences of other players (Han et al., 2012). Hence, refusing to establish an agreement may be considered as intending or preferring not to cooperate (non-committers).

In our work (Han et al., 2014), we extend the PGG to examine commitment-based strategies in group interactions. Namely, prior to playing the PGG, commitment proposing players ask their co-players to commit to contribute to the PGG, paying a personal proposer's cost to establish that agreement. If all the requested co-players accept the commitment, the proposers assume that everyone will contribute. Those individuals that commit, yet later do not contribute, must compensate the proposers at a cost (Han et al., 2013).

As commitment proposers may encounter non-committers, they require strategies that can deal with this type of individuals. The simplest strategy is to not participate in the creation of the common good. Yet, this avoidance strategy, AVOID, also removes the benefits for those that wished to establish the public good. Alternatively, one can establish boundaries on the common good so that only those that have committed to make it work have (better) access or that the benefit non-contributors can acquire is reduced. This strategy is referred to as RESTRICT. We compare, both analytically and using numerical simulations, these two commitment-based strategies when facing various types of free-riders, from those who do not commit, to those who commit but later defect, to those who commit and contribute only when not having to share the cost of commitment arrangement.

Our results lead to two main conclusions: (i) both strategies can promote the emergence of cooperation in the one-shot PGG whenever the cost of arranging commitment is justified with respect to the benefit of cooperation, thus generalizing results from pairwise interactions (Han et al., 2013); (ii) RESTRICT, rather than AVOID, leads to more favorable societal outcomes, in terms of contribution level, especially when the group size and/or the benefit of the PGG increase, even if the cost of restricting becomes quite excessive.

As commitments have been widely studied in AI and Computer Science, e.g. to ensure cooperation in self-organized and distributed (large) multi-agent systems (Han et al., 2012), our results provided important insights into the design of such systems whenever dealing with group interactions. Artificial Life systems appear a good venue for testing similar strategies in a diversity of settings.

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