Sharp Transitions in the Evolutionary Dynamics of Group Formation

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Abstract

We introduce a simple model, based on the Evolutionary Game Theory, for studying the dynamics of group formation. The latter constitutes a relevant phenomenon observed in different animal species, whose individuals tend to cluster together forming groups of different size.
Results of previous investigations suggest that this phenomenon might have similar reasons across different species, such as improving the individual safety (e.g. from predators), and increasing the probability to get food resources. Remarkably, the group size might strongly vary from species to species, and sometimes even within the same species. For instance shoals of fishes, herds of lions, and human groups (e.g. families), represent some examples of animal groups of different size and, considering human groups, one can find small tribes or even smaller groups, composed of very few members (e.g. 2).

In the proposed model, agents are represented as spin vectors, whose value of each entry can be s = +- 1, and they try to form homogeneous groups of different size, on varying a parameter named individual payoff. The latter represents the gain one agent would receive acting individually. In particular, agents have to chose if to form a group, receiving a group payoff, or if to play individually.

The phase diagram representing the equilibria of our population shows a sharp transition between the 'group phase' and the 'individual phase', in correspondence of a critical individual payoff. In addition, we found that forming homogeneous groups of small size was easier than forming big groups.
To conclude, we deem that the proposed model and related results constitute a support to the hypothesis that the phenomenon of group formation has evolutionary roots.

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