Heterogeneous resource allocation can change social hierarchy in public goods games.

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TRACK A: RESEARCH

Here we present a modification of the classical N-person prisoner's dilemma on networks where players are allowed to distribute their investments unevenly, allocating more resources to profitable games and less in unfavorable ones. In the classical N-person prisoner's dilemma on networks, individuals participating in *m* different groups divide equally their contribution *c* between all the groups they participate. In our setting, we allow players to decide how to distribute their capital according to what they earned in previous rounds. We employ a simple distribution function with a parameter α allowing a linear α =1.0 or non-linear α >1.0 allocation of the resources.

Results from numerical simulations show that when players are allowed to distribute their investments unevenly, an increase in the cooperation level is observed with a shift of the critical value of the synergy parameter r_c to lower values. However, we observed that the most important changes take place at the microscopic level.
An established result in public goods games is that the most connected nodes - the hubs - are responsible for the emergence of cooperation and for the production of the majority of the payoff. Our results depict a totally different landscape where players prefer to form small clusters in which everyone invest almost its entire capital in one game and markets centered on hubs only collect a small fraction of individuals' investments. This paradigm shift also has other interesting consequences.

One of the criticisms of the classical N-person prisoner's dilemma is that it fails to reproduce the wealth distribution observed in real economic systems - i.e. the Pareto principle - where the 80% of the wealth is produced by the 20% of the population. In our simulations we observed that with a non-linear allocation of resources (α = 4.0) the 80% of the payoff has been generated by the 20.4% of the individuals. Moreover, focusing on how individuals distribute *c* over their links we found that in most cases players choose one link for the majority of their contribution and divide the remaining part almost equally between the other links. This uneven distribution can have other important consequences on the dynamics of the games. In fact, we found that if the contribution of player *i* is significantly smaller than the average of the contributions in the game, the payoff obtained by the other players is smaller than what they would obtain if player *i* did not participate. These latter results impose a radical change in our idea of cooperation as they demonstrate that also in the classical formulation of Public Goods Games players can act as cooperators and defectors at the same time.

Finally, our work shed light on the large-scale organization of social and economical systems. In addiction, the present work gives a simple framework for the emergence of features present in real economic scenarios, like the Pareto law, from first principles.