Markus Eckhardt (Universität Oldenburg)

Emergent Coordination of Cooperation Patterns

Cooperation is widespread in social and biological systems and can vary greatly in amount: impalas exchanged between two and 42 grooming bouts per encounter (Hart & Hart, 1992). Cooperation benefits participants but costs time and energy.Early mathematical studies treated cooperation as a yes-or-no choice between fixed partners (Axelrod & Hamilton, 1981). Later models allowed contributions of any amount (Killingback & Doebeli, 2002; Doebeli et al., 2004). Do, Rudolf and Gross (2010) allowed simulated individuals, called agents, to contribute different amounts to different partners and form or end relationships.

This study changes how agents decide and adds exploiters. Partners receive the same benefit from their combined effort, even if only one contributes. Each agent pays for its total effort, and each additional contribution costs more. An agent's outcome is its benefits minus these costs. At each turn, most agents recalculate how much to contribute based on what benefits them most, rather than changing their effort gradually as in Do et al.'s model. Exploiters try to keep at least two partners but cut their contribution when the combined effort rises above a preset level. This tests what self-interested decisions can produce. It is not a claim about human nature.Across 700 simulations without exploiters, four patterns appeared as effort grew more costly: networks with many connections, a brief transition in which mutual contributions depended on random starting conditions, networks with few, mostly one-sided relationships and small, disconnected groups whose members contributed to one another. Although agents pursued only their own benefit, cooperation survived within small groups after the wider network broke apart.

Further experiments tested one, two, five, and ten exploiters. For every tested cost and exploiter count, the average outcome across agents and random starting conditions was lower than in otherwise identical simulations without exploiters. At every setting, exploiters did better than others on average and gained relative to simulations without exploiters, while the others lost. At low effort costs, losses were about 1%, 2%, 5%, and 10% for one, two, five, and ten exploiters, respectively. As their number rose, individual exploiters did not consistently gain more, but everyone else lost more. Persistent exploitation therefore benefited exploiters while harming the group as a whole.