Classification of interactions and behaviours in evolutionary games

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In evolutionary games players are located on the sites of a network and the interactions among the connected players are described by matrix games when the players choose one of their n options by following a dynamical rule. These players can represent atoms in physical systems, species in ecological models, or different behaviours in human societies. The systematic analysis of the matrix games threw light on the decomposition of matrices into four classes of elementary interactions. The symmetric part of elementary games with self- and cross-dependent payoffs represents interactions resembling an external effect without real player-player interactions, while the antisymmetric part is responsible for the emergence of social dilemmas causing serious troubles in human societies and biological systems. The effects of coordinations between the possible strategy pairs are similar to those studied by different versions of the Ising, Potts, and Ashkin-Teller models. The tools and results of statistical physics can be adopted for the investigation of potential games which are composed of the latter three elementary interactions and evolve into the Boltzmann distribution if a logit rule controls the evolution. The fourth type of interactions represents cyclic dominance and can be built up from rock-paper-scissors type elementary games. The presence of cyclic components prevents thermodynamic behaviour and results in self-organizing strategy distributions characteristic to living systems. The applicability of this frame will be demonstrated by examples representing several combinations of the elementary interactions.

References

[1] G. Szabó and G. Fáth, *Evolutionary games on graphs*, Phys. Rep. **446** (2007), 97–216.

[2] G. Szabó and I. Borsos, *Evolutionary potential games on lattices*, Phys. Rep. **624** (2016), 1–60.

[3] G. Szabó, K. S. Bodó, B. Allen, and M. A. Nowak, *Four classes of interactions for evolutionary games*, Phys. Rev. E **92** (2015), 022820.

[4] G. Szabó, K. S. Bodó, and K. A. Samani, *Separation of cyclic and starlike hierarchical dominance in evolutionary matrix games*, Phys. Rev. E **95** (2017), 012320.

[5] G. Szabó and B. Király, *Extension of a spatial evolutionary coordination game with neutral options*, Phys. Rev. E **93** (2016), 052108.

[6] B. Király and G. Szabó, *Evolutionary games with coordination and self-dependent interactions*, Phys. Rev. E **95** (2017), 012303.