Linking Individual to Collective Behavior in Complex Adaptive Networks

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A central problem in Physics is to understand how collective behavior results from a given fundamental two- or N-body fundamental interaction. Similarly, in a society, a central problem is to understand the link between individual behavior and emergent collective phenomena. Here we address this problem by letting individuals engage in pair-wise interactions by means of a well-defined social dilemma (a prisoner's dilemma of cooperation). These individuals are embedded in a social network that is both complex and adaptive. Adaptation here allows individuals to manifest preferences and resolve conflicts of interest, reshaping the networks accordingly. Exact Monte-Carlo simulations reveal the inadequacy of any of the tools developed to date to predict the co-evolutionary dynamics of the population at large. Here we develop an adaptive-network-sensitive mean-field observable that is capable of predicting the collective, population-wide dynamics, given prior knowledge of the fundamental rules that govern the interaction between 2 individuals in a social network. Our results show that adaptive social networks act to change the game at a global level, from a 2-person game to a N-person game exhibiting a radically different co-evolutionary dynamics, associated with a concomitant fundamental transformation of the Nature of the associated Nash equilibria.

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