Linking Individual to Collective Behavior in Complex Adaptive Networks

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A long-standing and central problem in Physics is to understand how collective behavior results from a given two- or N- body fundamental interaction. Similarly, in a society, a central problem is to understand the link between individual social behavior and emergent collective phenomena (vaccination, epidemics, crowd behavior, diffusion of innovations, global governance, etc).
Here I 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 network 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. I will present and discuss in detail an adaptive-network-sensitive observable that is capable of predicting the collective, population-wide dynamics, given prior knowledge of the fundamental rules that govern the social interaction between 2 individuals in a social network. In this fundamental step towards linking individual behavior with population wide dynamics, I show that adaptive social networks act to change the "collective" game, 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.