Intermittent behaviour in the complex system base on a large game

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Evolutionary game theory has been studied intensely as a mathematical framework for understudying Darwinian evolution. Despite the fact that evolutionary dynamics, whether in biological ecosystems or, say in human environments like the economy, takes place in the form of co-evolving webs of interactions; game theory is usually studied in the limit of very few strategies. Here, we study replicator dynamics with extinctions and mutations in a large game with many strategies. We perform numerical simulations of a game, where each player can play one of a large number of strategies. The game is defined with a payoff matrix whose elements are random numbers which can be positive or negative, with majority being zero. At the beginning of the simulation we choose randomly a small number of strategies to be played. Reproduction of players is done according to the replicator equation in which a small amount of mutations is introduced. In this way new strategies can appear in the system. Additionally we introduce an extinction threshold; strategies with a frequency less than this threshold are removed from the system. The resulting behaviour shows complex intermittent time dependence similar to those of the Tangled Nature model. The dynamics has two types of phases: a quasi stable phase in which the number of active strategies is more or less constant and hectic phases during which creation and extinct of strategies happens at a high rate. We conclude that the complex behaviour of the Tangled Nature model, which is in good agreement with observations on ecosystems, also arises from the game theoretic basis of the replicator dynamics. Finally we investigate various lifetime distributions and find fat tail distributions similar to those often observed for real systems and discuss the mathematical theory.