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GAMES WITH RESOURCES IN MODELING OF CANCER CELL INTERACTIONS

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ABSTRACT

In this study we propose to endow evolutionary game models with changes of the phenotypes' adjustment during the transient generations within the population. These changes are performed by the parameters in the payoff matrix, which determine the fitness (payoff, adjustment) resulting from different interactions between players (taking into account both the benefits and costs of particular actions and strategies). Alteration of these parameters changes them into functions that simulate (within this model) the changes within the environment and define their different impacts on the fitness. In the case of spatial games, these functions are represented by an additional lattice where another and parallel game based on cellular automata is performed. The main assumption of the spatial games presented in [1] is that each cell on the lattice is represented by a player following only one strategy. The local payoff for each player is the sum of payoffs due to interactions (according to the payoff matrix) with cells in the neighbourhood. We will refer to this approach as the classical one or SEGT. Cells on the spatial lattice can also be considered as heterogeneous (instead of homogeneous), so that each particular player may contain mixed phenotypes. Spatial games of the type proposed by us in [2] are called mixed spatial evolutionary games (MSEG). Hence, in MSEG different degrees of playing a particular strategy are treated as different characteristics that define different phenotypes. It may happen that within the population, all of the players have diverse phenotypes (which probably better describes biological phenomena). In fact, the game is performed on a multidimensional lattice (dependent on the number of defined phenotypes in the model), where each layer represents a particular phenotype (as the frequency of occurrence) of the player. For the computation of the local adaptation, the sum of the payoffs between each phenotype (within two players) multiplied by their rate of occurrence is calculated first. The second step is the summing of these values for each player in the neighbourhood. The proposed modification which takes into account changes in the generalized resources (SEGR) needs yet another additional lattice to be used. It is equivalent to the increased order of dynamics considered in replicator dynamics. The important implication is that even in the case of three phenotypes when the order of replicators dynamics is two, introduction of resources increases an order of dynamics to three which, because of its nonlinearity, allows to expect possibly complex phenomena. This abstract is a summary of a part of results published by us in [3].

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