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The σ law of evolutionary dynamics in community-structured populations

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Evolutionary game dynamics in finite populations provides a new framework to understand the selection of traits with frequency-dependent fitness. Recently, a simple but fundamental law of evolutionary dynamics, which we call {\sigma} law, describes how to determine the selection between two competing strategies: in most evolutionary processes with two strategies, A and B, strategy A is favored over B in weak selection if and only if {\sigma}R + S > T + {\sigma}P. This relationship holds for a wide variety of structured populations with mutation rate and weak selection under certain assumptions. In this paper, we propose a model of games based on a community-structured population and revisit this law under the Moran process. By calculating the average payoffs of A and B individuals with the method of effective sojourn time, we find that {\sigma} features not only the structured population characteristics but also the reaction rate between individuals. That's to say, an interaction between two individuals are not uniform, and we can take {\sigma} as a reaction rate between any two individuals with the same strategy. We verify this viewpoint by the modified replicator equation with non-uniform interaction rates in a simplified version of the prisoner's dilemma game (PDG).

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