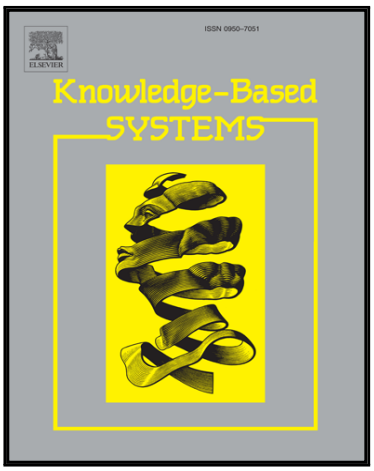

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Stochastic Dynamics of Division of Labor Games in Finite Populations☆

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Abstract

A theoretical investigation on the strategy evolution in the self-organized division of labor dilemma is performed by means of evolutionary game theory. The often-used Fermi function is employed for driving the strategy updating, based on which the *fixation probability* of the involved strategy (performing which task) is calculated. Results about the evolution dynamics of the division of labor for two-player games are: (1) the *fixation probability* for any selection intensity is derived; (2) the *fixation probability* and *fixation time* under weak selection are gained and a comparison with neutral selection is performed. In this case, the conditions to facilitate cooperation in division of labor are found. Then we extend the model to a multi-player one to describe the self-organized task allocation when multiple players are involved in one game. Relevant results for weak selection to favor the coexistence state of the two strategies for the multi-player games are gained. These results help understand and design effective mechanism where self-organized collective dynamics occurs in the form of maximizing the benefit of the multi-agent system.

Keywords: `Cooperation; Fixation probability; Evolutionary game theory`

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