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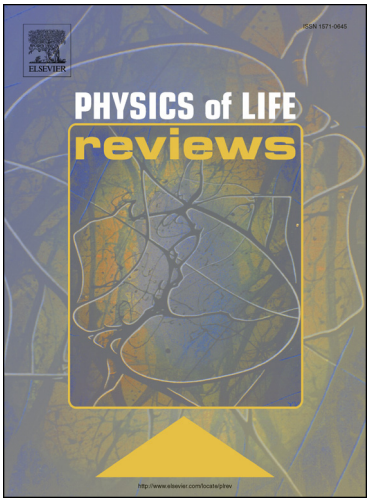

Mathematical approaches or agent-based methods?

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Mathematical approaches or agent-based methods? Comment on "Evolutionary Game Theory using Agent-based Methods" by Christoph Adami et al

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1 Introduction

Adami et al [1] review approaches and results obtained within the evolutionary game theory framework and raise a very important question: how much is our understanding of certain phenomena constrained by our ability to write the equations and do the analytics for those phenomena? Using compelling examples, Adami et al [1] argue that many realistic biological scenarios are often left unstudied due to a lack of a theoretical methodology or the ability to obtain mathematical solutions; they suggest that agent-based simulations are the way to go in those cases, with mathematics being used primarily as a validation tool in the limiting cases where it is feasible. It is certainly the case that some limits (e.g., weak selection, weak mutation) have been studied disproportionately due to their mathematical tractability. Numerical solutions and simulations for the broader parameter range (e.g. non-weak selection, non-low mutation) have convincingly shown that the intuition built in the limiting cases is at best insufficient and often misleading for the understanding of non-limiting cases [1,2].

Although I agree with the authors that our exploration of realistic biological scenarios should not be limited by the feasibility of mathematical solutions and that agent-based methods offer a very powerful way to move forward, I caution that in some cases in which mathematical solutions seem infeasible, this simply reflects a state-of-the-art of our mathematical techniques rather than a provable impossibility of developing new mathematical approaches (or adopting existing ones from other fields) that might allow for mathematical solutions. This is in many ways already apparent from the review by Adami et al [1]: although the original formulation of evolutionary game theory only considered infinite well-mixed populations and Evolutionarily Stable Strategies, subsequent advances introduced new measures (e.g., fixation probabilities) to allow the study of finite, not necessarily well-mixed (i.e. structured) populations [3-5]. This is in fact also true of the main limitation identified by Adami et al [1], the case of non-weak mutation. When mutation is not weak, strategies