Multiplicative Updates in Coordination Games and the Theory of Evolution

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Why we chose this paper

The paper addresses an interesting question in evolution from a mathematical perspective: Why is sex worth it? In other words, why do organisms engage in the costly and energy-efficient process of combining genomes that might produce offspring inferior to both parents? The paper explores this topic in the regime of "weak selection" and is able to derive analytic results to equations that were intractable in previous work. The authors are able to show that evolution under sex promotes "mixability" of genes rather than raw "fitness", and ultimately promotes diversity in the gene pool. This partially answers one of the major questions raised in prior work, namely why evolution does not converge on a sparse gene pool containing only the select few "fittest" individuals, as opposed to the diverse gene pool observed in nature.

Both the theoretical results of this paper as well as the wider, practical implications make this paper very interesting to study. Particularly fascinating are the links the authors establish between evolution, game theory, and even statistics in linear systems.

What we hope to explore

There are a number of interesting avenues we could explore based on this work:

- **Simulation:** This paper immediately lends itself to simulation. We hope to implement a simple evolutionary simulator that emulates propagation of genes under the assumptions in the paper. This would allow us to numerically verify the predictions made in the paper, as well as test how well the theory holds up when assumptions are violated.
- **Literature research:** The paper references a interesting body of previous work covering biology, evolution, game theory and computer science. It would be interesting to explore the relevant papers and summarize how they relate to this work.
- **Theorem deepdive:** The key theorems of this paper are not obvious and the derivations are difficult to follow. We hope to unravel these theorems and provide a more intuitive explanation for why they are true and what they imply.