

Symmetry and Collective Fluctuations in Evolutionary Games (IOP Expanding Physics)

Eric Smith, Supriya Krishnamurthy

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When can a finite, coarse-grained theory adequately describe an infinitely more complicated world? This question is central to the choice and calibration of evolutionary models. The same question was at the center of progress in condensed matter physics and particle theory in the 20th century, where it led to a reconceptualization of the nature of objects and interactions in statistical terms. The key concepts in this new understanding were the roles of symmetry and collective fluctuations.

This review considers the problem of modeling stochastic evolutionary dynamics from the perspective that all evolutionary theories are ultimately effective theories: the robust properties and predictions of models are those that do not depend sensitively on the many parameters in any real system that are impossible to estimate or even identify. The tool to extract such robust properties is the large-deviations theory of stochastic population processes. Games enter evolutionary modeling as a general framework to capture the constructive dynamics that map genotypes in their population context to phenotypes and fitness consequences.

In this book, the authors present methods to derive large-deviations limits for population processes, and apply these to game models illustrating the many roles of symmetry and collective fluctuations in evolutionary dynamics. Problems considered include the origin of dynamics that span large scales from individuals to populations, the spontaneous emergence of multilevel selection, subtleties of the gene concept, and corrections to fitness from evolutionary entropies in systems with neutral directions.



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