

Looking for Patterns in Data: An Evolutionary Game-Theoretic Perspective

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Abstract

What is a pattern or, equivalently, how to find patterns in data? These elusive questions, which lie at the very heart of AI and cognitive science, have occupied the mind of many a scholar over decades and are still waiting for a definitive answer. In our endeavor to provide a formal definition of the notion of a pattern, we found that evolutionary game theory offers an elegant and general perspective that serves well our purposes. In particular, we developed an equilibrium-based perspective according to which the emergence of a pattern is viewed from an evolutionary viewpoint, whereby local (intrinsic) and global (contextual) information interact harmoniously in a manner which is reminiscent of the spontaneous formation of a *Gestalten* in visual perception. Within this context, we prove that the notion of a pattern turns out to be formally equivalent to that of evolutionary stable strategy (ESS), a classical equilibrium concept from evolutionary game theory. ESS-patterns can be found using replicator dynamics, a classic formalization of a natural selection process or, more generally, by payoff-monotonic game dynamics. Both theoretical properties and experimental results on various problems will be presented which confirm the validity of the proposed idea.