Maximum Entropy Explanations in Biology

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Abstract

Symposium: The space of explanations in evolutionary biology. (Huneman, Ariew, Darden, Lyon, Strevens, Walsh)
There are many robust and simple patterns in biology that arise out of the aggregation of a myriad of chaotic, and complex processes. A phenotypic trait such as height is the outcome of a huge complex array of interactions between genes and the environment. However, as Galton (1889) and many others have noticed, such traits often exhibit a very simple pattern: they are often normally distributed. Similarly simple patterns occur all throughout nature: the log-normal, power law, and exponential distributions—-just to name a few.

Recent work, particularly by Frank (2009), has shown that these distributions can, in some sense, be explained by their maximum entropy properties. Frank argues that by maximising the entropy of a probability subject to a few informational constraints, one obtains a framework that neatly unifies and explains many of the robust and simple patterns that we observe in biology. However, it's not at all clear how entropy and its maximisation can explain anything in nature. Entropy, in this context, is usually understood in terms of information, or the lack of information, that some ideal epistemic agent has (e.g., Frank 2009, Jaynes 2003). But how can the information that some agent has explain why, for example, heights are normally distributed? Intuitively, it can't. In this paper, I survey a number of interpretations of the entropy of a probability distribution and examine how they can be embedded in a theory of explanation so that we can make sense of such maximum entropy explanations in biology.

References

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