

INFORMATION, GEOMETRY, AND PHYSICS

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Abstract

Consider the following outrageous notion: *The laws of physics are not laws of nature but merely rules to process information about the world.* If this turns out to be true then, in addition to the obvious constraints imposed by experiment, the laws of physics should also be constrained by the standard probabilistic and entropic rules for processing information. Here I discuss how it is that the basic fact that physical theories are so deeply geometrical suggests that my statement above might turn out not be so outrageous after all.

The goal of this tutorial is to provide a brief introduction to the subject of *information geometry* and its likely relevance to physics. The idea is that a family of probability distributions that are labeled by some continuous parameters can be thought as a space, each distribution being a “point”, while the parameters play the role of coordinates. A question that immediately arises is whether there is a natural way to measure the extent to which neighboring “points” can be distinguished from each other. The answer is that such a measure exists, that it is unique, and most remarkably, that it has all the properties one would wish to impose upon a measure of distance. Thus, *distinguishability is distance*, which raises the possibility that perhaps the familiar notion of *physical spatial distance might itself be explained in terms of distinguishability*.

As an application of these ideas to a physically relevant model I will show how once the appropriate information is codified into a statistical manifold – the statistical model – then standard principles of inference allow us to reproduce Newtonian mechanics. Naturally, such an unusual perspective yields new insights into the physics.