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Uncertainty vs. Information (Invited)

Grey Nearing (1,2)
(1) NCAR RAL, Boulder, CO USA (grey@ucar.edu), (2) NASA GSFC, Greenbelt, MD, USA (grey.s.nearing@nasa.gov)

Information theory is the branch of logic that describes how rational epistemic states evolve in the presence of empirical data (Knuth, 2005), and any logic of science is incomplete without such a theory. Developing a formal philosophy of science that recognizes this fact results in essentially trivial solutions to several longstanding problems are generally considered intractable, including:

• Alleviating the need for any likelihood function or error model.
• Derivation of purely logical falsification criteria for hypothesis testing.
• Specification of a general quantitative method for process-level model diagnostics.

More generally, I make the following arguments:

1. Model evaluation should not proceed by quantifying and/or reducing error or uncertainty, and instead should be approached as a problem of ensuring that our models contain as much information as our experimental data. I propose that the latter is the only question a scientist actually has the ability to ask.

2. Instead of building geophysical models as solutions to differential equations that represent conservation laws, we should build models as maximum entropy distributions constrained by conservation symmetries. This will allow us to derive predictive probabilities directly from first principles.

Knuth, K. H. (2005) 'Lattice duality: The origin of probability and entropy', Neurocomputing, 67, pp. 245-274.