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Philosophical Foundations of Hydrologic Uncertainty

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There is significant discussion and disagreement about the role of hypothesis testing in Hydrology (e.g., Blöschl, 2017). Hydrologic modeling, as a discipline has reached a point where certain fundamental problems at foundations of the philosophy of science represent major obstacles to improved hydrologic modeling and uncertainty quantification (Nearing et al., 2017). I propose that we might accelerate progress against some of the "hard" problems in the discipline by doing a better job of connecting those problems with their epistemological foundations.

In this work, I do three things. First, I propose that hypothesis testing is tautologically unrelated with any meaningful concept of uncertainty. Second, I propose that certain logical inconsistencies inherent in uncertainty-based philosophies of science (e.g., Popper, Neyman, Savage, Jaynes, etc.) are naturally remedied by an information-based philosophy of science. Third, I develop an information-theoretic[1] hypothesis testing framework, and prove that it is robust (in the sense that it admits zero potential for Type I error) to arbitrary errors in empirical data.

From a practical perspective, this offers solutions to two problems that are typically considered intractable:
• It alleviates the need for any type of likelihood function, including any data-error model or data-error distribution.
• It allows for the derivation of purely objective falsification criteria; contrary to Neyman's (1957) proposal that falsification is fundamentally subjective.

In addition, this information-theoretic philosophy of science provides a foundation for quantitative process-level model diagnostics.

[1] Information theory here refers to the branch of logic that describes how rational (i.e. consistent with Aristotelian logic) doxastic states evolve in the presence of empirical data (Knuth, 2005).

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