Departments of Computer Science, Mathematics, Statistics, and the Computation Institute

SCIENTIFIC AND STATISTICAL COMPUTING SEMINAR

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The Decay of Information: In Theory and in Practice

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Eckhart 133, 5734 S. University Avenue

ABSTRACT

Information regarding the state of a dynamical system typically decays with time after an "observation." In linear systems this decay depends on the state of the system, but is easily captured; nonlinear systems are shown to display a richer variety behaviour. In both cases, a probabilistic description captures the decay of information quantitatively and accurately.

In practice, our models are imperfect mathematical representations of their target system; structural model error is shown to have much more fundamental impacts than parameter uncertainty or imprecision in the initial state. While the decay of information within the model state-space remains informative regarding the future states of the system in practice, the connection is different in kind from theoretical case where the model and system are identical. The impact this has in practice on data assimilation and forecast interpretation is discussed. Challenges to Bayesian forecast updating are noted, but the focus is on the geometric relationships between model trajectories (amongst themselves and with respect to the observed state of the system) with the aim of identifying weaknesses of a given operational model; visualisation can be a challenge in the rather high dimensional model-state spaces (often ten-million dimensional). Finally, the emergence of information regarding the state of the system as one approaches a particular (fixed) time in the future is considered. Here again, the idea of interpreting model-based predictive distributions as probabilities is challenged, particularly in applications of decision support.

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