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On evaluating the information content of observation data

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Abstract: The problem of how to characterize magnitudes and sources of hydrological model uncertainty has received considerable attention in the literature. These sources can be divided into two main categories, (1) lack of sufficient information provided by observation data (including data measurement error) and (2) poor exploitation by the model of the information contained in the raw data (ie. model structure inadequacy and parameter uncertainty). Much published research has shown that "data driven" models (based, for example in Artificial Neural Networks or Support Vector Machines), can often provide better predictions of the observed system outputs than conceptual-physical hydrologic models, implying that the input data does, in fact, contain sufficient information to support a good prediction. On the other hand, research based in Bayesian methods suggests that the input/output observation errors can be quite large. In this presentation, we will discuss a quite general approach to explicitly computing the information content in raw data, and thereby quantify the Best Achievable Performance (BAP) of any model seeking to exploit that information for the purposes of input-output or input-state-output prediction. We used the method to evaluate the performance of three models applied to three catchments in the US and China, and obtained meaningful confidence intervals on model performance, while finding that considerable head-room for model structural improvements remains.

Keywords: information theory; Model Structure Adequacy; Uncertainty Analysis; Entropy; Mutual Information