EGU21-3034
https://doi.org/10.5194/egusphere-egu21-3034
EGU General Assembly 2021

Information Theory: A Swiss Army Knife for system characterization, learning and prediction

Uwe Ehret
Karlsruhe Institute of Technology KIT, Institute of Water Resources and River Basin Management, Karlsruhe, Germany
(uwe.ehret@kit.edu)

In this contribution, I will – with examples from hydrology - make the case for information theory as a general language and framework for i) characterizing systems, ii) quantifying the information content in data, iii) evaluating how well models can learn from data, and iv) measuring how well models do in prediction. In particular, I will discuss how information measures can be used to characterize systems by the state space volume they occupy, their dynamical complexity, and their distance from equilibrium. Likewise, I will discuss how we can measure the information content of data through systematic perturbations, and how much information a model absorbs (or ignores) from data during learning. This can help building hybrid models that optimally combine information in data and general knowledge from physical and other laws, which is currently among the key challenges in machine learning applied to earth science problems.

While I will try my best to convince everybody of taking an information perspective henceforth, I will also name the related challenges: Data demands, binning choices, estimation of probability distributions from limited data, and issues with excessive data dimensionality.