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Info-Metrics: Theory and Examples

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We live in the information age. Information is all around us. But be it much or little information, perfect or blurry, complementary or contradicting, the main task is always how to process this information such that the inference – derivation of conclusions from given information or premises – is optimal.

Info-metrics is the science and art of quantitatively processing information and inference. It crosses the boundaries of all sciences and provides the universal mathematical and philosophical foundations for inference with finite, noisy or incomplete information. Info-metrics lies in the intersection of information theory, inference, mathematics, statistics, complexity, decision analysis and the philosophy of science. From mystery solving to the formulation of all theories – we must infer with limited and blurry observable information. The study of info-metrics helps in resolving a major challenge for all scientists and all decision makers of how to reason under conditions of incomplete information. Though optimal inference and efficient information processing are at the heart of info-metrics, these issues cannot be developed and studied without understanding information, entropy, statistical inference, probability theory, information and complexity theory as well as the meaning and value of information, data analysis and other related concepts from across the sciences. Entropic Inference – a core sub-field of info-metrics – is the science of modeling with incomplete or imperfect information. It is based on the notions of information, probabilities and relative entropy. It provides a unified framework for reasoning under conditions of incomplete information – a challenge to researchers across disciplines

In this talk I will discuss some of the issues related to information and information processing. I will concentrate on the basic problem of inference with finite information and with a minimal set of assumptions or structure. I will start by discussing the different types of available information. Then I will discuss some of the necessary requirements for constructing an efficient information processing rule. Building on the classical Maximum Entropy formalism (Jaynes, 1957), I will construct a generic and universal estimation framework (estimator). I will show that the class of information-theoretic estimation methods is a sub-class of this generic framework. I will pay special attention to the interpretation of the different quantities and for showing the relationships between Information-Theoretic (IT) estimation methods and traditional (including Bayesian) methods. Within the class of IT methods I will discuss the specific case of stochastic moments estimation methods and the advantages of this approach. I will also present a number of representative examples I will conclude with a discussion of some open questions in information processing.

Key Words: Entropy, Information, Information Processing, Maximum Entropy, Stochastic Moments