Jensen-Shannon Divergence in Statistics and Reliability

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1:00 PM, Monday, March 14, 2016
Cudahy Hall, Room 401

Mixtures of probability distributions appear in various statistical problems at all levels. In some problems like regression and clustering one unmixes a mixture in order to gain prediction accuracy for the price of increasing model complexity. In some problems like developing consensus forecasts and kernel estimation one seeks to construct mixtures in order to gain smoothness for the price of increasing uncertainty. Yet, in some other problems like system reliability one has no option and must use both, a mixture (the distribution of lifetime of a system) and its constituents (distributions of the lifetime of components). Any reasonable measure provides an assessment of the trade-off between the loss and gain in a mixture problem. The Jensen-Shannon (JS) divergence of mixture is such a measure. The JS has been developed in the information theory and is used in several fields (quantum physics, genomics, bioinformatics, machine learning, and quantitative study of history), but has been remarkably unnoticed in statistics. In this talk, I illustrate mixture formulations provides a unification of various statistical problems and present applications of the JS in three seeming unrelated problems: (a) measuring uncertainty and disagreement of economic forecasters about the US inflation rate; (b) nonparametric kernel estimation of the probability distribution function; and (c) information about the lifetime of a coherent system provided by the system signature defined as the probability that system will fail upon the ith failure of its components.