Future Information Minimization as PAC Bayes regularization in Reinforcement Learning

A video lecture by Prof. Naftali Tishby in NIPS workshop on frontiers of model order estimation.

The Information Bottleneck method (IB) was introduced as a way of computing approximate minimal sufficient statistics from empirical data, through a continuous trade-off between (model) complexity and accuracy, given the joint distribution of data and relevant variables. The original algorithm for solving the problem was a converging alternating projection (EM, Arimoto Blahut like), but was not guaranteed to converge to the global optimum in general. An important exception was the multivariate Gaussian case, for which the IB recovers the classical Canonical Correlation Analysis (CCA), with an important addition of a principled model dimension estimation through the complexity accuracy trade-off. For this case the optimal representation can be found efficiently even for very large datasets.

In this paper we present a recent generalization of Gaussian IB, using the Kernel trick, which corresponds to the Kernel-CCA, with the additional principled information theoretic model-order estimation. This new algorithm not only makes the IB practical for large classes of real data, but provides a systematic approach to both dimension reduction and Kernel selection, by optimizing the information accuracy complexity curve. Moving from low to high model complexity requires in general a change in the Kernel structure in ways that can simplify the representation. Exceptions to this are self-similar structures (like fractals, or some natural datasets) where the same Kernel can be optimal for all scales. We provide examples of applications to both images and time-series data.
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