

Where is the Action in Information Theory?

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Abstract

Many fields — such as Stochastic control, Learning, Markov Decision Processes, Dynamic Programming — have a mathematically crisp notion of 'Action'. But where is the 'Action' in Information Theory? We introduce the notion of an 'Action' into two classical Shannon-theoretic frameworks.

The first is the problem of source coding with side information. We revisit and extend this problem to the case where the coding system takes actions affecting the nature, quality, or availability of the side information. Actions may have costs commensurate with the quality of the side information they yield, and an overall per-symbol cost constraint may be imposed. We characterize the achievable tradeoff between rate, distortion, and cost.

The second is the problem of communication in the presence of channel state information, which we revisit and extend to channels with action-dependent states. We characterize the capacity of such channels under possible cost constraints on the actions and/or the channel inputs.

Among our findings is the fact that even in the absence of cost constraints, both for the source coding and the channel coding problems, greedily choosing the action associated with the 'best' side information/channel state is, in general, sub-optimal.

Our results cover a variety of new coding scenarios of practical significance, such as source coding under a limited budget of measurements, and coding for channels with a 'Rewrite' option. A few examples are worked out in detail.

The first part of the talk is based on a collaboration with Haim Permuter. More details can be found in:

http://www.ee.technion.ac.il/people/tsachy/recent_work.html