Variational Bayes Approximation for Distributed Fully Probabilistic Design

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Variational Bayes is a well known technique of approximate Bayesian estimation, [3]. It is based on approximation of the true multivariate posterior density by a product of conditionaly independent densities defined on disjoint parts of the parameters space. The approximate posterior is found by minimization of the Kullback-Leibler divergence between a conditionally independent density and the true posterior. The solution is typically found iteratively using moments of one density to find shaping parameters of the others. This is sometimes known as message passing [5]. Fully probabilistic design of control strategy is an alternative formulation to the classical dynamic programming, [1, 2]. It is based on the use of Kullback Leibler divergence as loss function in dynamic decision-making. The resulting control strategy is found explicitely in the form of probability density function.

In this contribution, we investigate application of the Variational Bayes idea in fully probabilistic design. We are concerned with multi-input multi-output systems, where we seek conditionally independent approximation of the multivariate control strategy. Application of the Variational Bayesian theorem is straightforward. What results is an iterative algorithm in which the conditionally independent startegies are computed in parallel. As typical for Variational Bayes approximations, each startegy needs moments generated withing design of the remaining startegies. The resulting scheme corresponds to the scheme of distributed control where autonomous desision-making units exchange messages with the neighbours. In this particular case, the messages are in the form of conditional probability density functions.

The approach is studied in simulation on a simple 2-input 3-output example. Results are compared with other techniques of distributed fully probabilistic control schemes [4].

References

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