Hidden Markov Model and Bayesian Inference

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Abstract

Hidden Markov Model is an example of a probabilistic model that was successfully used in various applications such as speech modelling [1]. Its success can be ascribed to its simplicity and availability of efficient algorithms for inference of the model. Namely, the Viterbi algorithm, the forward-backward algorithm and the Baum-Welch algorithm. Each of these algorithms has, however, hardcoded assumptions that often hold only approximately. The question is if we are able to improve performance of our application by a well motivated change of the model and the corresponding inference algorithms. We will approach this problem by noticing that the HMM is a special case in the family of dynamic Bayesian networks [2]. This family also includes linear state-space models, various models known from clustering and many more examples. Many of these models have their classical inference algorithms, which were designed for efficiency. This efficiency of the associated inference algorithms is also the reason why these models are used even if their assumption do not exactly match for the considered application. Due to recent advances in Bayesian theory, it is possible to make inference about almost any model from this class. Hence, it is now possible to relax the constraints on the choice of models which were imposed by our limited choice of the inference algorithm. Now, we can design models that respect the physics and rules of the application and the general inference schemes will take care of their inference. For this freedom, we typically pay by significant increase of computational requirements. However, this increase may pay off in terms of improved performance in many application domains. The talk is an attempt to explain the basic concept of the approach illustrated on simple examples.

Keywords: Passivity based control, Networked control systems

References:

[1] L. Rabiner, A tutorial on hidden Markov models and selected applications in speech recognition, Proceedings of the IEEE, 77(2):257286, 1989.
[2] K. Murphy, Dynamic Bayesian Networks: Representation, Inference and Learning, Ph.D. thesis, University of California, 2002.

Presenting Author's Biography

Vaclav Smidl was born in Rokycany, Czech Republic, in 1976. He received the Ing. degree from the University of West Bohemia in 1999, and the PhD degree from Trinity College Dublin, Ireland, in 2004. He is now working as a post-doctoral researcher in the Institute of Information Theory and Automation, Prague, Czech Republic. His research interests are Bayesian methods for system identification and control.