Dirichlet process–based component detection in state-space models

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Abstract

We present an extension of the switching state-space models (SSSM) that allows arbitrary number of components in its architecture. The possibility to add/subtract components from the model is achieved by the introduction of a Dirichlet process prior that allows the inference of the number of linear models to be put into the mixture, whilst regular likelihood fitting is used to optimize each mixture component. We develop a distance measure in the space of linear Kalman filters with the use of the Kullback-Leibler divergence over the conditional probabilities induced by the individual Kalman filters. The introduced distance measure allows to remove components that are no longer relevant, making the algorithm more effective. The algorithm uses a Gibbs sampler to optimize the Dirichlet process and to assign each individual data point to a cluster. In spite of the sampling process, the results of simulating the model using artificial data show that the proposed architecture is fast and provides a meaningful segmentation of the mixture model. It is important to note that the presented component detection scheme is *unsupervised*: there is no "user" intervention required for the method to work, meaning that it can run without user intervention and the results are available for further processing. For further research steps, we hope that the results of this filtering and clustering can constitute a set of "simple" models that are used as building blocks for a hierarchical motion planning systems, forming the basis of a system that learns on the flight motion primitives. It would be interesting to evaluate the component detection scheme in conjunction e.g. with a reinforcement learning algorithm that can borrow templates from the SSKF. We test the algorithm on a 128-channel electroencefalogram data, recorded while the subject was performing various tasks or it was told to remain still. We hope to identify the periods of activity using the model.