Embedding Hidden Markov Models into Reproducing Kernel Hilbert Spaces

Galyna Kriukova

National University of Kyiv-Mohyla Academy

Hidden Markov models (HMMs) are a widely used probabilistic graphical model for time series of discrete, partially observable stochastic processes. In this paper, we discuss an approach to extend the application of HMMs to non-Gaussian continuous distributions by embedding the belief about the state into a reproducing kernel Hilbert space (RKHS). This method may be applied to various statistical inference and learning problems, including Kalman Filters, belief propagation in probabilistic graphical models, planning Markov decision processes and partially observed Markov decision processes. This implies a necessity to consider a new regularization for the posterior embedding estimator. We investigate, theoretically and empirically, the effectiveness of kernel samples as landmarks in the Nyström method for low-rank approximations of kernel matrices, namely estimate the approximation error of the Nystr om method as a regularization of kernel embedding.

Furthermore, we discuss applications of the method to real-world problems, comparing the approach to several state-of-the-art algorithms.