Frontier of Statistical Physics and Information Processing 2013

On Estimation Accuracy of Latent Variables in Hierarchical Learning Models

Keisuke Yamazaki
Department of Computational Intelligence and Systems Science,
Tokyo Institute of Technology

Hierarchical learning models, such as Gaussian mixtures, Bayesian networks, and hidden Markov models, are widely used in information processing. The models consist of observable and latent variables, which represent the given data and the underlying structure of data generation, respectively. The use of the models determines which variable the estimation target is. The unseen observable variable is estimated when we predict future data. In a clustering task, missing labels expressed by the latent variables are often estimated on the basis of the Gaussian mixture. Statistical properties of the observable-variable (OV) estimation are clarified in many cases; the generalization error measures the accuracy and its asymptotic convergence speed with respect to the number of training data is revealed. On the other hand, the latent-variable (LV) estimation has not been studied well. In this presentation, the framework of the LV estimation is summarized, and two representative estimation methods are introduced: the maximum-likelihood and the Bayes methods. Then, the error function is formulated in a density-based manner, where the asymptotic form of the function is shown in the both estimation methods. Moreover, we compare the results with the accuracy of the OV estimation.