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A Hierarchical Method for Multi-Class Probabilistic Classification Vector Machines

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Abstract : The Support Vector Machine (SVM) has become widely recognised as one of the leading algorithms in machine learning for both regression and binary classification. It expresses predictions in terms of a linear combination of kernel functions, referred to as support vectors. Despite its popularity amongst practitioners, SVM has some limitations, with the most significant being the generation of point prediction as opposed to predictive distributions. Stemming from this issue, a probabilistic model namely, Probabilistic Classification Vector Machines (PCVM), has been proposed which respects the original functional form of SVM whilst also providing a predictive distribution. As physical system designs become more complex, an increasing number of classification tasks involving industrial applications consist of more than two classes. Consequently, this research proposes a framework which allows for the extension of PCVM to a multi class setting. Additionally, the original PCVM framework relies on the use of type II maximum likelihood to provide estimates for both the kernel hyperparameters and model evidence. In a high dimensional multi class setting, however, this approach has been shown to be ineffective due to bad scaling as the number of classes increases. Accordingly, we propose the application of Markov Chain Monte Carlo (MCMC) based methods to provide a posterior distribution over both parameters and hyperparameters. The proposed framework will be validated against current multi class classifiers through synthetic and real life implementations.

Keywords : probabilistic classification vector machines, multi class classification, MCMC, support vector machines
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