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Density estimation with minimization of U-divergence

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Abstract This paper is concerned with density estimation based on the stagewise minimization of the U-divergence. The U-divergence is a general divergence measure involving a convex function U which includes the Kullback-Leibler divergence and the L_2 norm as special cases. The algorithm to yield the density estimator is closely related to the boosting algorithm and it is shown that the usual kernel density estimator can also be seen as a special case of the proposed estimator. Non-asymptotic error bounds of the proposed estimators are developed and numerical experiments show that the proposed estimators often perform better than several existing methods for density estimation.

Keywords Density estimation · Boosting · Stagewise minimization · U-divergence

1 Introduction

Recently, there has been renewed widespread interest in supervised learning in regard to regression, classification and pattern recognition. Boosting has been known as a promising technique with feasible computational algorithms that have received a great deal of attention. Boosting attempts to create a strong committee from a suitable combination of weak learners, and was first proposed by Schapire (1990). Subsequent studies on boosting are summarized in Bishop (2006) and Hastie et al. (2009).

In contrast to supervised learning, boosting approaches to unsupervised learning, such as density estimation, appear to be less developed. Although it is understood that unsupervised learning is more difficult than supervised learning, there is a need for an effective learning method for density estimation. The purpose of this study is to develop a general

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