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On the Existence of Weak Learners and Applications to Boosting*

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ABSTRACT

We consider the existence of a weak learner for boosting learning algorithms. A weak learner for binary classification problems is required to achieve a weighted empirical error in the training set which is bounded from above by $1/2-\gamma$, $\gamma>0$, for any distribution on the data set. Moreover, in order that the weak learner be useful in terms of generalization, γ must be sufficiently far from zero. While the existence of weak learners is essential to the success of boosting algorithms, a proof of their existence has been hitherto lacking. In this work we provide a proof that, under appropriate conditions, weak learners actually exist. In particular, we show that under certain natural conditions on the data set, a linear classifier is a weak learner. Our results can be directly applied to generalization error bounds for boosting, leading to closed-form bounds. We also provide a procedure for dynamically determining the number of boosting iterations required to achieve low generalization error. Finally, using the results of Kearns and Mansour, our results may also be applied to top-bottom decision trees with oblique splits.

Key words: Boosting, Weak learner, Geometric discrepancy

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