



The student's dilemma: ranking and improving prediction at test time without access to training data

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The standard approach to rank the performance of several classifiers for a given classification problem is via an independent labeled validation dataset. However, in various applications only unlabeled data and several pre-constructed classifiers are provided, without access to labeled training or validation data. This begs the following questions: given only the predictions of several classifiers over a large set of unlabeled test data, is it possible to a) reliably rank their expected performances? and b) construct a meta-classifier more accurate than any individual classifier in the ensemble? Here we present a spectral approach to address these questions. First, assuming errors of different classifiers are statistically independent, we show that the off-diagonal terms of their covariance matrix correspond to a rank-one matrix. Moreover, the entries of its leading eigenvector are proportional to the (balanced) accuracies of the classifiers. Second, using this eigenvector and without labeled data, we construct a novel spectral meta-learner (SML), which is a weighted linear combination of the classifiers in the ensemble. We interpret our SML as an approximation of the maximum likelihood estimator (MLE). Not only does SML typically achieve a higher accuracy than most classifiers in the ensemble, it also provides a better starting point for iterative estimation of the MLE than majority voting. Further, we show that SML is robust to the presence of small malicious groups of classifiers designed to veer the ensemble prediction away from the (unknown) ground truth. We demonstrate our unsupervised methods on several simulated and real datasets.

Comments: Supplementary Information is included at the end of the manuscript

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