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# Performance Assessment of Multi-Level Ensemble for Multi-Class Problems

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**Abstract :** Many supervised machine learning tasks require decision making across numerous different classes. Multi-class classification has several applications, such as face recognition, text recognition and medical diagnostics. The objective of this article is to analyze an adapted method of Stacking in multi-class problems, which combines ensembles within the ensemble itself. For this purpose, a training similar to Stacking was used, but with three levels, where the final decision-maker (level 2) performs its training by combining outputs from the tree-based pair of meta-classifiers (level 1) from Bayesian families. These are in turn trained by pairs of base classifiers (level 0) of the same family. This strategy seeks to promote diversity among the ensembles forming the meta-classifier level 2. Three performance measures were used: (1) accuracy, (2) area under the ROC curve, and (3) time for three factors: (a) datasets, (b) experiments and (c) levels. To compare the factors, ANOVA three-way test was executed for each performance measure, considering 5 datasets by 25 experiments by 3 levels. A triple interaction between factors was observed only in time. The accuracy and area under the ROC curve presented similar results, showing a double interaction between level and experiment, as well as for the dataset factor. It was concluded that level 2 had an average performance above the other levels and that the proposed method is especially efficient for multi-class problems when compared to binary problems.

**Keywords :** stacking, multi-layers, ensemble, multi-class
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