DRCW-OVO: Distance-based Relative Competence Weighting Combination for One-vs-One Strategy in Multi-class Problems

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Abstract. This is a summary of our article published in Pattern Recognition [2], which follows our previous works on the topic [3, 1], presented to the Multi- Conference CAEPIA'15 - TAMIDA'15 KeyWorks.

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1 Summary

Decomposition strategies [4] are commonly used to address multi-class classification problems. Among them, One-vs-One (OVO) scheme is one of the most popular techniques. In OVO, multi-class problems are divided into binary subproblems (as many as possible pairs of classes), which are independently learned by different base classifiers whose outputs are then combined to classify new instances.

This final combination or aggregation phase is a key factor in ensembles of classifiers. Several aggregation mechanisms for OVO strategy can be found in the specialized literature [3]. The voting strategy is the most intuitive one, where each classifier gives a vote for its predicted class and that reaching the largest number of votes is finally predicted.

In OVO, in contrast with classic ensemble methods, there are some difficulties inherent to the way in which the decomposition is performed. The problem of non-competent classifiers is one of them. This problem refers to the fact that each classifier in OVO is learned using only the instances of its corresponding pair of classes, which makes it not competent to classify instances belonging to the rest of the classes; nevertheless, in the classification step all the outputs of the classifiers has to be taken into account because the competence is unknown a priori. Otherwise, the classification problem would be solved. However,

these outputs can affect the final decision of the system, leading to incorrect classifications.

The competence of a classifier in OVO strategy cannot be established before classification. In that case the classification problem would be solved before hand because the output class of the instance to be classified would be known. Taking this issue into account, we aim to manage the non-competence using the information available prior to the classification, considering the closeness to the instances of each class in the training set. Our assumption is that the outputs considering nearer classes should be more competent, since the classifier has probably been trained with instances of that class. On this account, we develop a distance-based combination strategy, which weights the competence of the outputs of the base classifiers depending on the closeness of the query instance to each one of the classes. In this way, we aim at reducing the effect of the non-competent classifiers and enhancing the results obtained by the state-of-the-art combinations for One-vs-One strategy.

Therefore, the proposed Distance-based Relative Competence Weighting combination method for OVO (DRCW-OVO) relies on how far are the nearest neighbors of each class in the problem to weight the outputs of each classifier in the final aggregation stage. This way, the larger the distance is, the lower weight the output has, and vice versa.

We carry out a thorough experimental study, supported by the proper statistical analysis, showing that the results obtained by the proposed method outperform, both in terms of accuracy and kappa measures, the previous combinations for One-vs-One strategy. We also try to explain why the method works. Our approach is compared with the state-of-the-art combinations for the different base classifiers and our previous Dynamic Classifier Selection (DCS) approach [1] aimed at getting rid of non-competent classifiers.

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References

1. Galar, M., Fernández, A., Barrenechea, E., Bustince, H., Herrera, F.: Dynamic classifier selection for one-vs-one strategy: Avoiding non-competent classifiers. Pattern Recognition 46(12), 3412–3424 (2013)
2. Galar, M., Fernández, A., Barrenechea, E., Herrera, F.: DRCW-OVO: Distance-based relative competence weighting combination for one-vs-one strategy in multiclass problems. Pattern Recognition 48(1), 28–42 (2015)
3. Galar, M., Fernández, A., Barrenechea, E., Bustince, H., Herrera, F.: An overview of ensemble methods for binary classifiers in multi-class problems: Experimental study on one-vs-one and one-vs-all schemes. Pattern Recognition 44(8), 1761 – 1776 (2011)
4. Lorena, A.C., Carvalho, A.C., Gama, J.M.: A review on the combination of binary classifiers in multiclass problems. Artificial Intelligence Review 30(1-4), 19–37 (2008)