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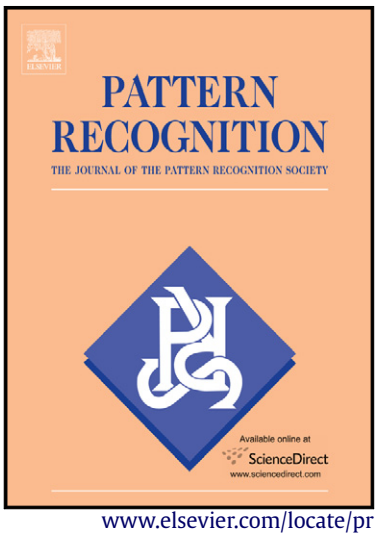

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Bartosz Krawczyk, Michał Woźniak, Francisco Herrera

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On the Usefulness of One-Class Classifier Ensembles for Decomposition of Multi-Class Problems

Bartosz Krawczyk[a,*], Michał Woźniak[a], Francisco Herrera[b,c]

[a]*Department of Systems and Computer Networks, Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland*
[b]*Department of Computer Science and Artificial Intelligence, University of Granada, P.O. Box 18071, Granada, Spain*
[c]*Faculty of Computing and Information Technology - North Jeddah, King Abdulaziz University, 21589, Jeddah, Saudi Arabia*

Abstract

Multi-class classification can be addressed in a plethora of ways. One of the most promising research directions is applying the divide and conquer rule, by decomposing the given problem into a set of simpler sub-problems and then reconstructing the original decision space from local responses.

In this paper, we propose to investigate the usefulness of applying one-class classifiers to this task, by assigning a dedicated one-class descriptor to each class, with three main approaches: one-versus-one, one-versus-all and trained fusers. Despite not using all the knowledge available, one-class classifiers display several desirable properties that may be of benefit to the decomposition task. They can adapt to the unique properties of the target class, trying to fit a best concept description. Thus they are robust to many difficulties embedded in the nature of data, such as noise, imbalanced or complex distribution. We analyze the possibilities of applying an ensemble of one-class methods to tackle multi-class problems, with a special attention paid to the final stage - reconstruction of the original multi-class problem. Although binary decomposition is more suitable for most standard datasets, we identify the specific areas of applicability for one-class classifier decomposition.

To do so, we develop a double study: first, for a given fusion method, we compare one-class and binary classifiers to find the correlations between classifier models and fusion algorithms. Then, we compare the best methods from each group (one-versus-one, one-versus-all and trained fusers) to draw conclusions about the overall performance of one-class solutions. We show, backed-up by thorough statistical analysis, that one-class decomposition is a worthwhile approach, especially in case of problems with complex distribution and a large number of classes.

Keywords: one-class classification, multi-class classification, classifier ensemble, decomposition strategies, classifier fusion, binary classification.

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