Learning Label-Specific Features for Decomposition-based Multi-Class Classification

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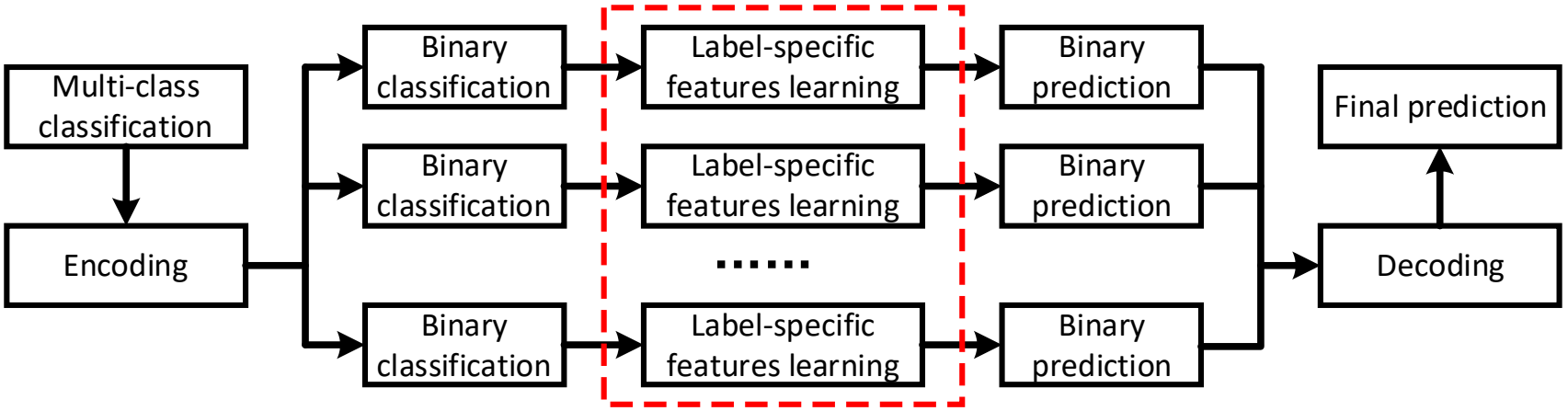
Problems & Ideas

- Problems of decomposition-based multi-class classification:
  - Existing works solve these decomposed binary classification problems in the original feature space.
  - It might be suboptimal as different binary classification problems correspond to different positive and negative examples.
- Ideas: Learning **label-specific features** for decomposition-based multi-class classification



Learning label-specific features for decomposition-based multi-class classification. The main idea is to learn label-specific features for each decomposed binary classification problem to consider the specific characteristics containing in its positive and negative examples, then it can be expected to obtain more effective binary classifiers and improve the performance of decomposition-based multi-class classification solutions with the same encoding and decoding strategy.

Main Contributions

- Contributions:
  - Proposing to learn label-specific features for decomposition-based multi-class classification solutions, which suggests a novel perspective to learn decomposition-based multi-class classifier;
  - Generating label-specific features via clustering analysis for each binary classification problem to put this idea into practice;
  - Conducting extensive comparative studies and the experimental results clearly validate the effectiveness of learning label-specific features for decomposition-based multi-class classification solutions.

Wilcoxon signed-ranks test for “Specific” against “Original” (at 0.05 significance level; p-values shown in the brackets)

Decomposition Strategy	Support Vector Machine (SVM)		Logistic Regression (LR)	
	Accuracy	*Average*-F1	*Accuracy*	*Average*-F1
OvO	**win**[9.77e-03]	**win**[1.95e-02]	**win**[1.95e-02]	**win**[3.71e-02]
OvR	**win**[1.95e-03]	**win**[5.86e-03]	**win**[2.73e-02]	**win**[2.73e-02]
ECOC	**win**[1.95e-03]	**win**[1.95e-03]	**win**[7.81e-03]	**win**[5.86e-03]

Here, “Specific” and “Original” respectively denote that the decomposed binary classification problems are solved based on the learned label-specific and original features. It is shown that no matter SVM or LR is employed as the binary classifier, “Specific” always achieves statistically better performance than “Original” over the whole benchmark data sets in terms of both the two evaluation metrics for all the three decomposition strategies. These experimental results clearly validate the effectiveness of learning label-specific features for decomposed binary classification problems in decomposition-based multi-class classification solutions.