Efficient pairwise classification using Local Cross Off strategy

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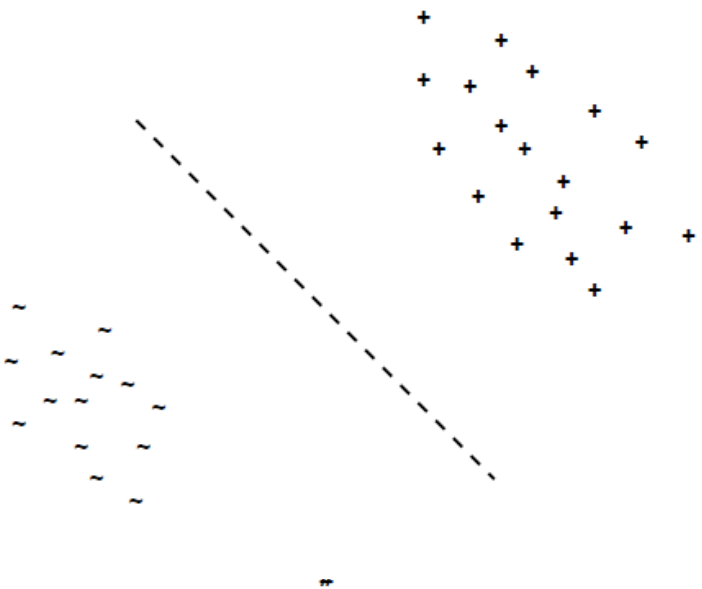
Binary vs. Multiclass Classification

- Real word applications



- *Class binarization*
  - *One-versus-all (OVA)*
  - *One-versus-one (OVO)*
  - *Error Correcting Output Codes (ECOC)*

Error Correcting Output Codes

- Idea: designing a codeword for each of the classes
- matrix M of size $L \times Nc$: each cell is *{-1,+1}*
  - Column ---> dichotomy classifier
  - Row: is a unique codeword that is associated with an individual target class

- Sparse ECOC
  - Adding 0 to the matrix

Class	h_1	h_2	h_3	h_4	h_5	h_6
ω_1	1	-1	1	-1	-1	1
ω_2	1	1	-1	-1	1	-1
ω_3	-1	1	-1	1	-1	1
ω_4	-1	-1	1	-1	1	1

Drawbacks of OVO

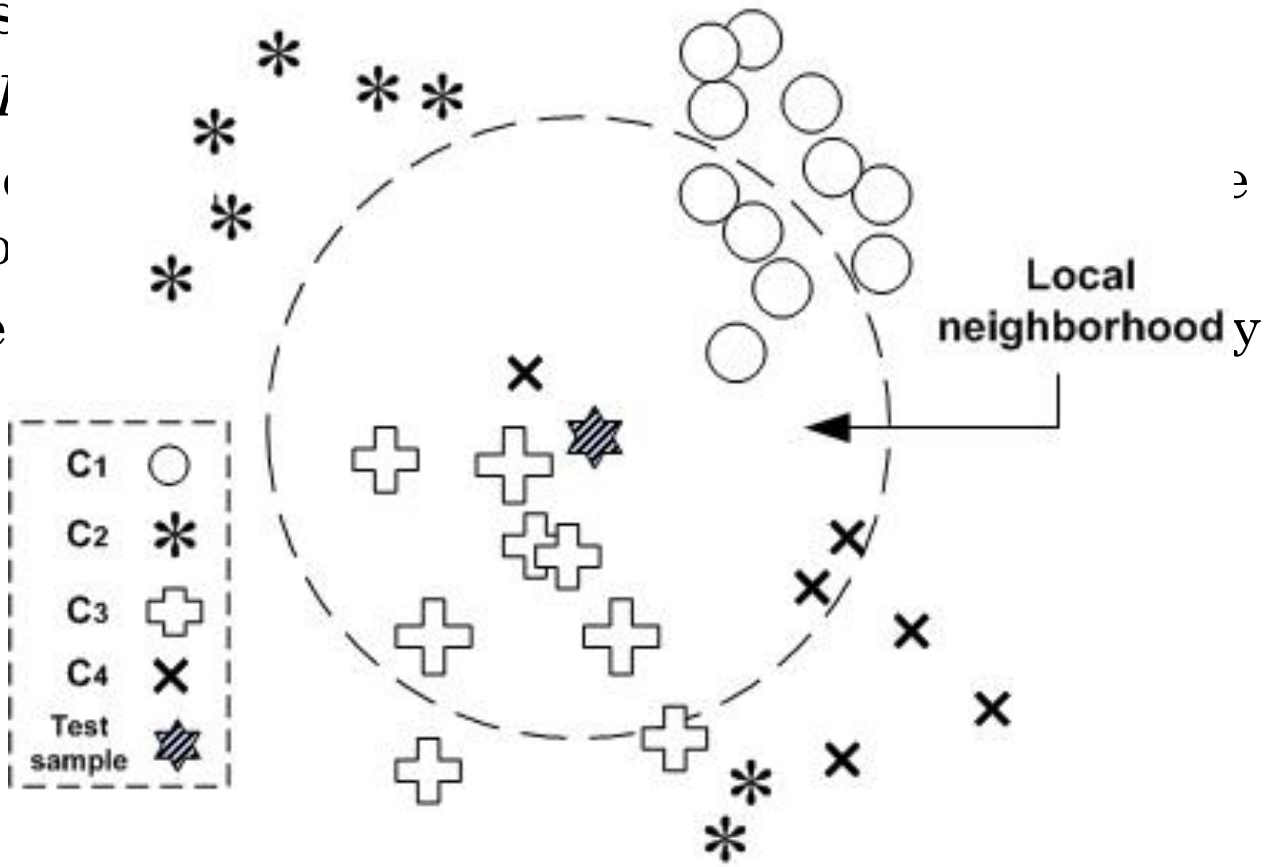
- *incompetent classifiers*

- Suppose a problem with 4 classes
  - new test instance belongs to C3
  - Training phase: 1vs2 . 1vs3 . 1vs4 . 2vs3 . 2vs4 . 3vs4
  - Testing phase:
    - $h_{12} \rightarrow 1$
      $h_{13} \rightarrow 3$
      $h_{14} \rightarrow 1$
      $h_{23} \rightarrow 2$
      $h_{24} \rightarrow 4$
      $h_{34} \rightarrow 3$
- Several methods has been proposed: A&O, CC, …

Proposed Method

- Training phase: build pair classifiers

- Test phas
  - Define *k*
  - figures
    neighbo
  - Choose



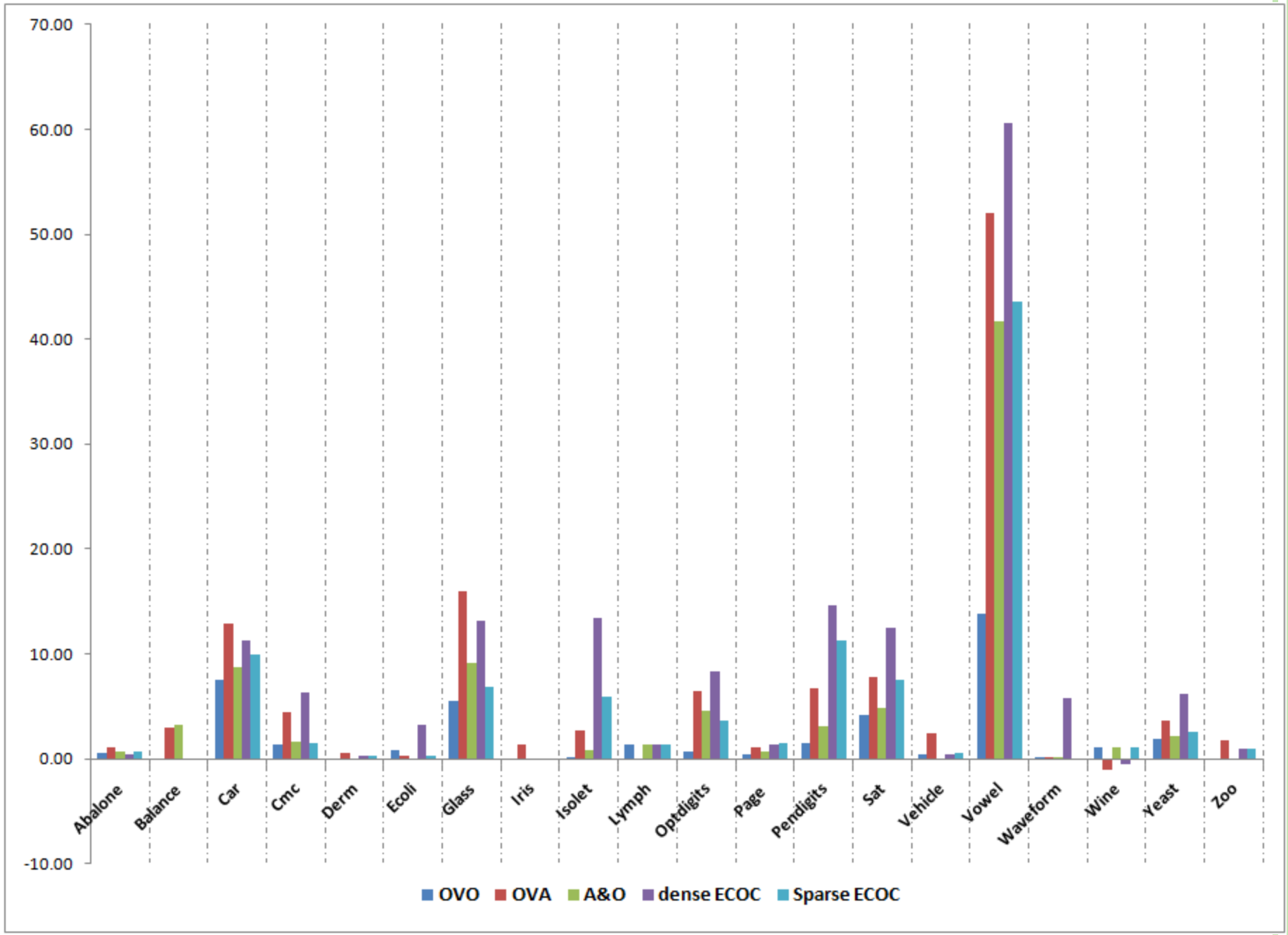
Main idea: remove the irrelevant classifiers
Local Cross Off

- LCO-Version 1:
  - The two most frequent classes of the nearest K neighbors in the training set of each test pattern are found
  - one binary classifier is selected to classify test pattern

- LCO-Version 2:
  - All target classes of the nearest K neighbors in the training set of each test pattern are found.
  - Classifiers that correspond to all pairwise combinations of these classes are then nominated
  - Majority voting

Validation over benchmark datasets

- Methods:
  - OVO, OVA, A&O, and ECOC
- In modified -nearest neighbor algorithm: $K=5$
- Base learners:
  - Linear Support Vector Machine
  - Multilayer Perceptron (MLP).
- Evaluation
  - Accuracy based on 10-fold cross-validation
  - fair comparison !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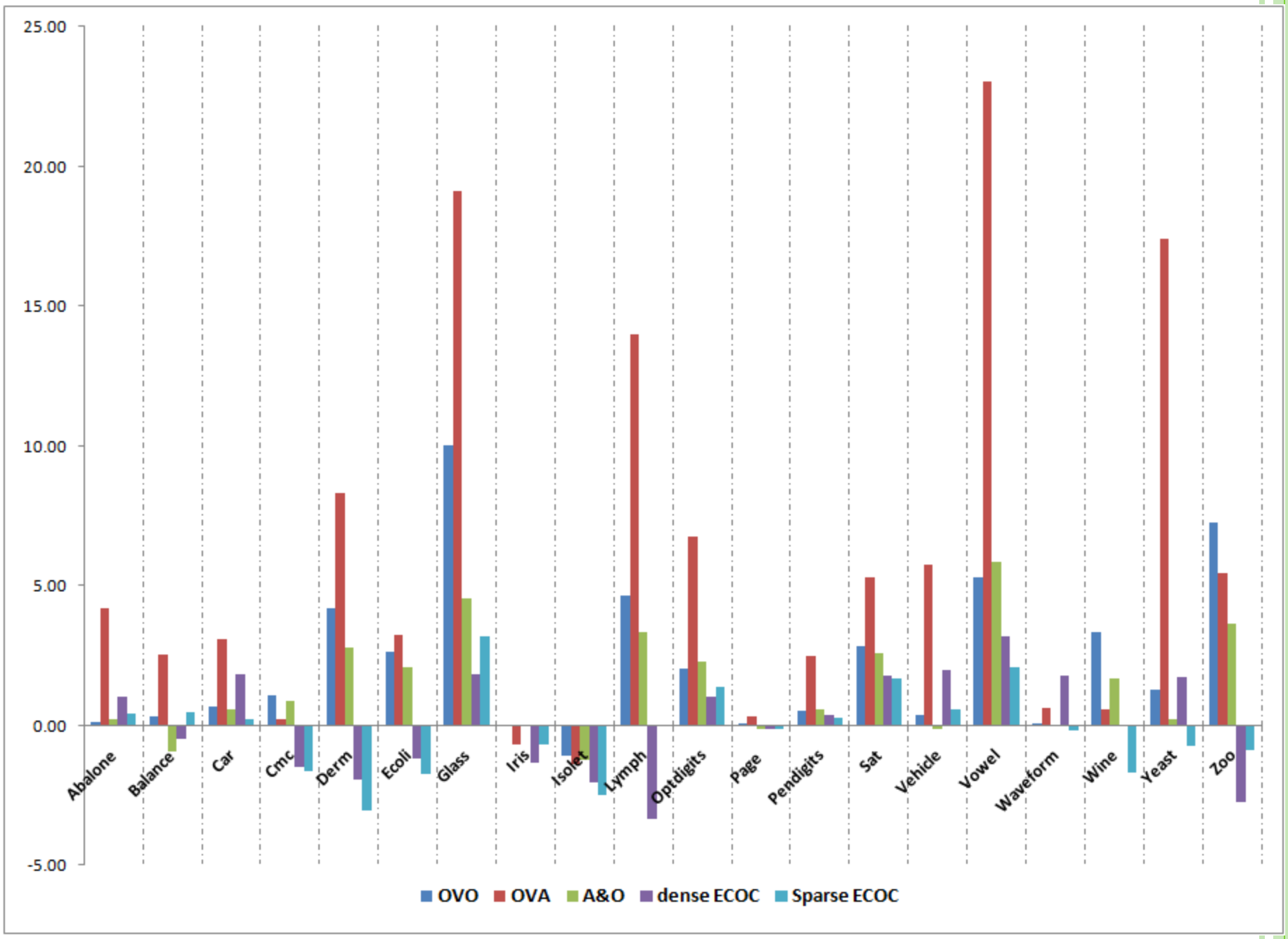
Cmc
Derm
Ecoli
Glass
Iris
Isolet
Lymph
Optdigits
Page
Pendigits
Sat
Vehicle
Vowel
Waveform
Wine
Yeast
Zoo
OVO
OVA
A&O
dense ECOC
Sparse ECOC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Vowel
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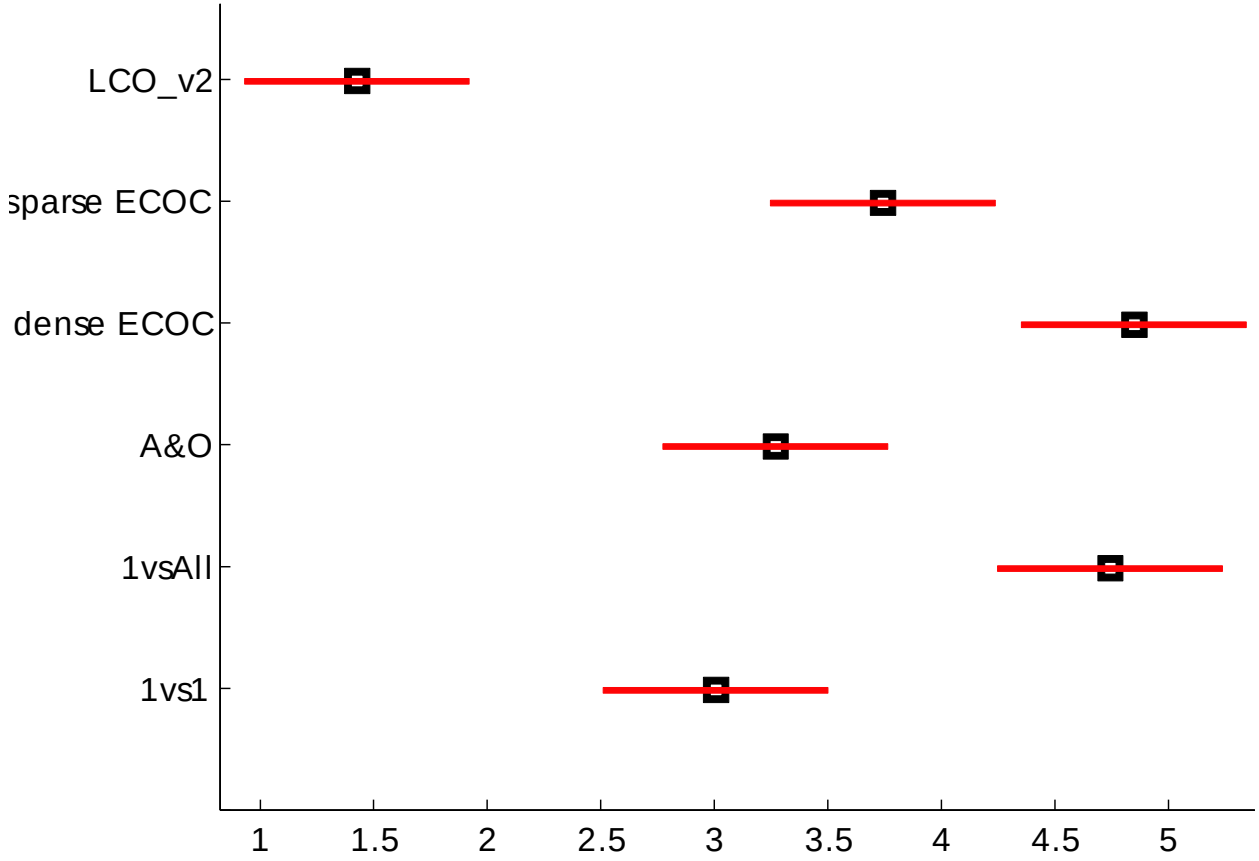
dense ECOC
Sparse ECOC

Validation over benchmark datasets : Statistical analysis

- Recommendations of Demsar: non-parametric tests
- General procedure:
  - Iman–Davenport test ---> Nemenyi test
- Iman–Davenport test:
  - rank competing methods for each dataset
  - The method's mean rank by averaging its ranks across all experiments
  - Applying the Iman–Davenport formula

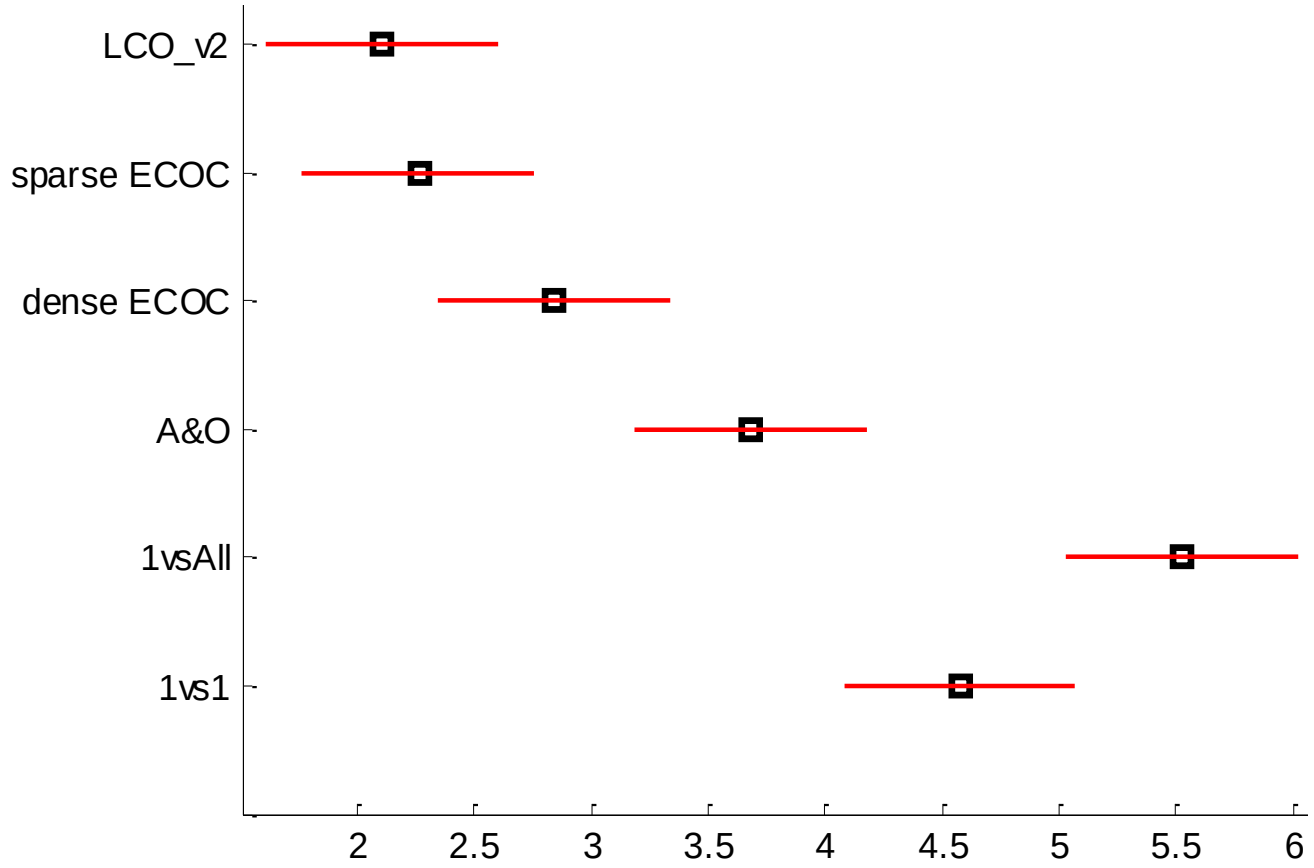
Validation over benchmark datasets

- Nemenyi test - SVM



Validation over benchmark datasets

- Nemenyi test - MLP



Conclusions

- We presented a novel strategy for pairwise classification approach to deal with multiclass problems
- The proposed technique is based on omitting the votes of irrelevant binary classifiers, in order to improve final classification accuracy.
- The proposed LCO method validated over a set of benchmark dataset

Conclusions

- The experimental evaluation shows some strong and consistent evidence of performance improvements compared to the one-versus-one, one-versus-all, A&O, and ECOC methods.

- The main reason behind this improvement is that the LCO approach is benefited from efficient nearest neighbor rule as a preprocessing step in pairwise structure and the strength of the other adapted powerful binary classifiers.

Thanks

Questions