Wrocław University of Technology

Designing fusers on the basis of discriminants - evolutionary and neural methods of training

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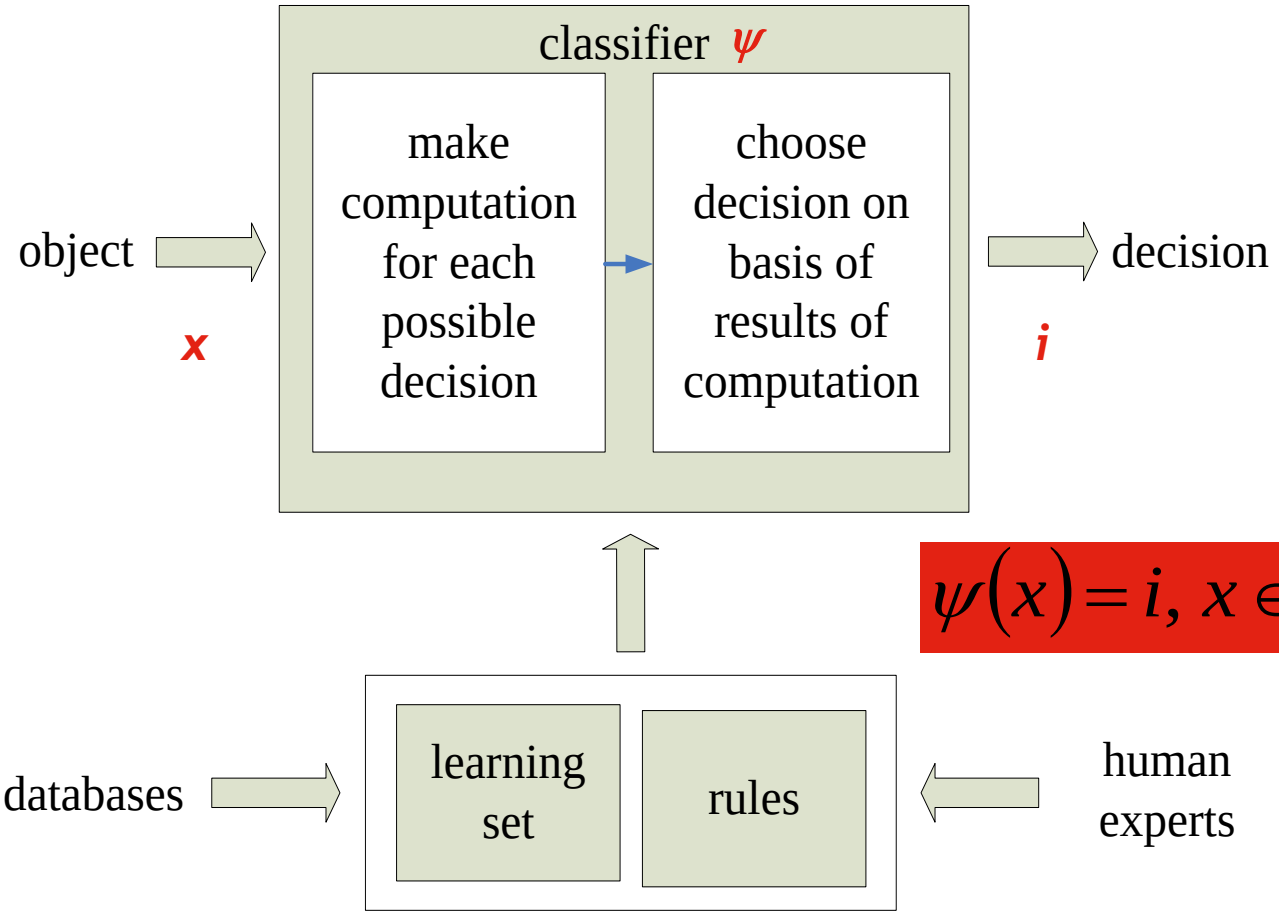
HAIS 2010, San Sebastian

Outline

- Pattern recognition
- Classifiers fusion
- Fuser training
- Experiments
- Conclusions

Pattern recognition task

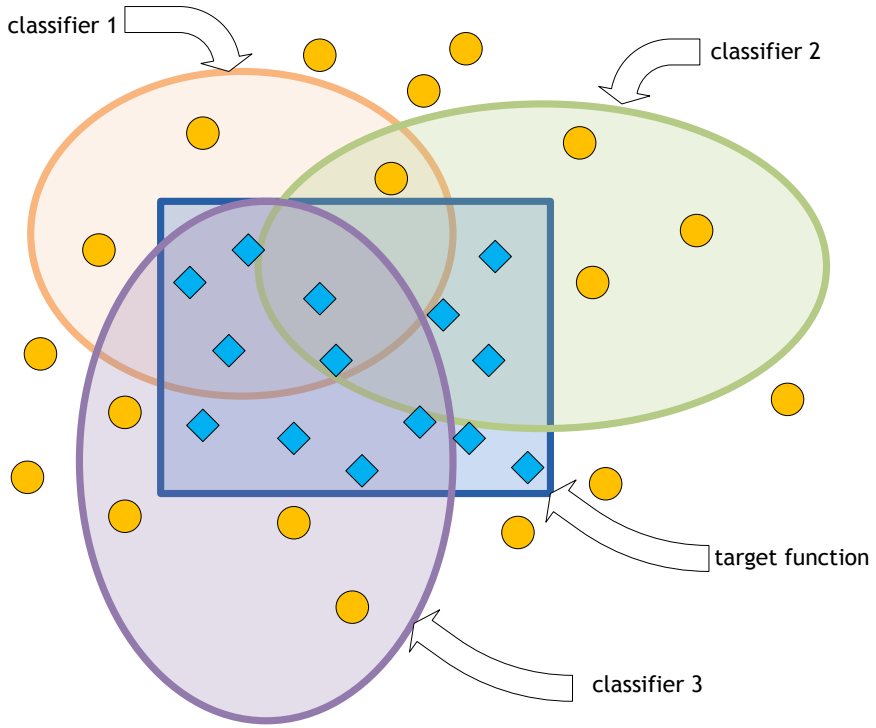


$$\psi(x) = i,\ x \in X,\ i \in \{1,\ldots,M\}$$

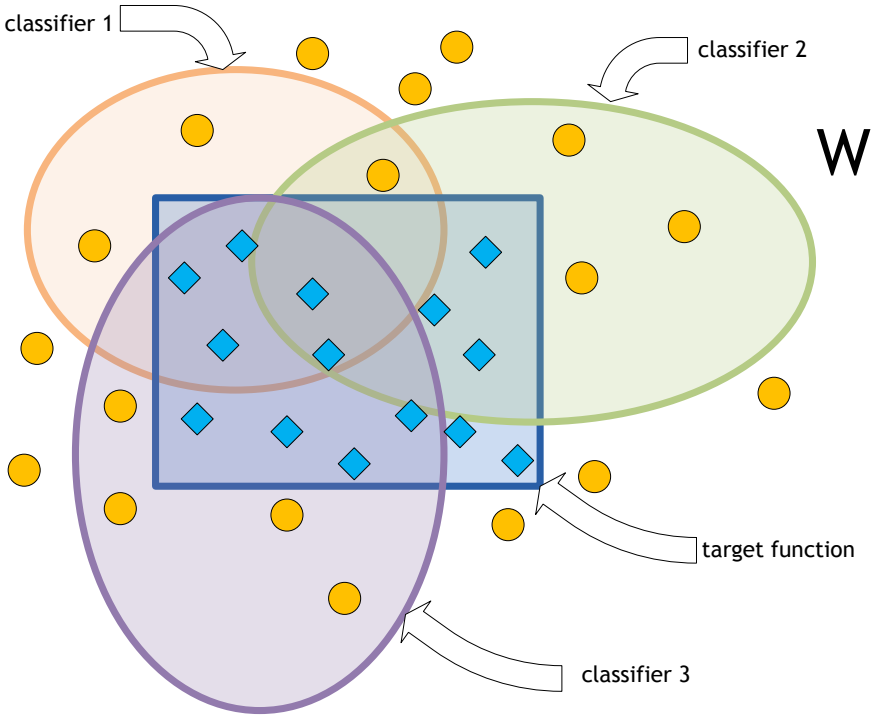
Pattern recognition task

Sources of misclassification

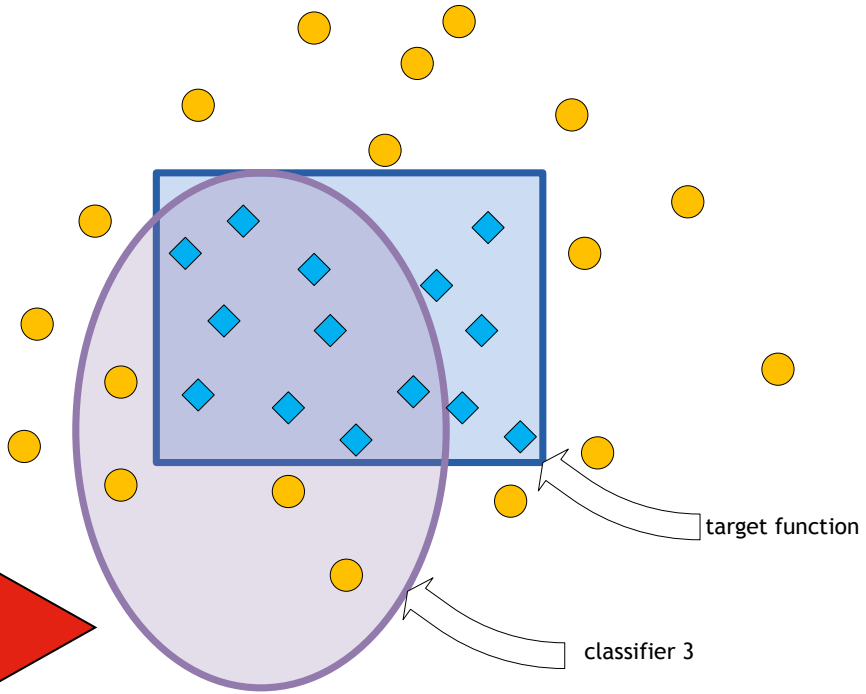
- Model
  - appropriate assumptions
  - imperfect representation
- Limited or inrepresenative training set
- Errors in examples
  - features values
  - labels



Pattern recognition task

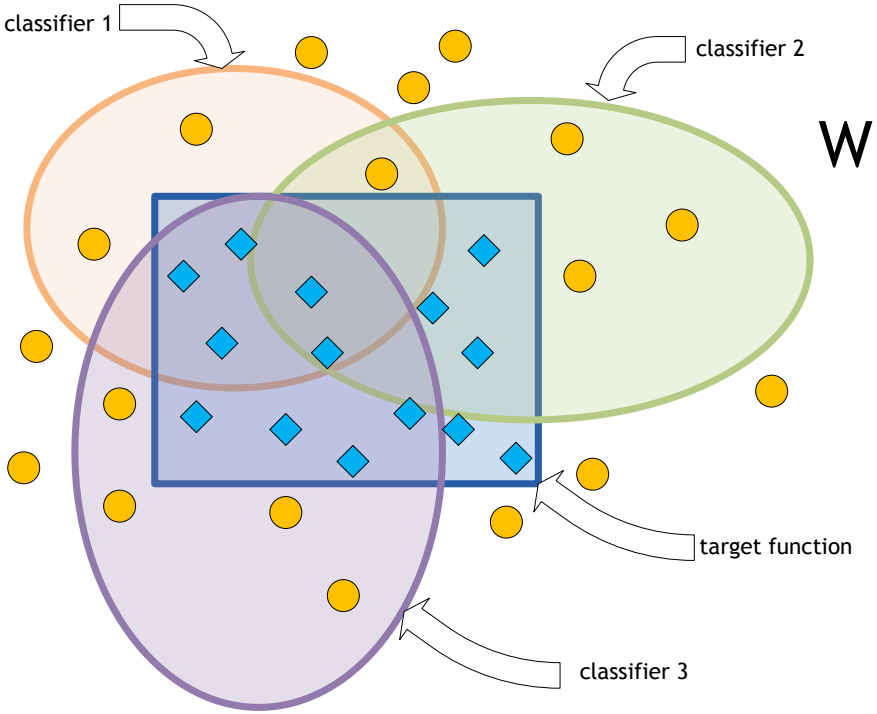


What can we do in this situation?

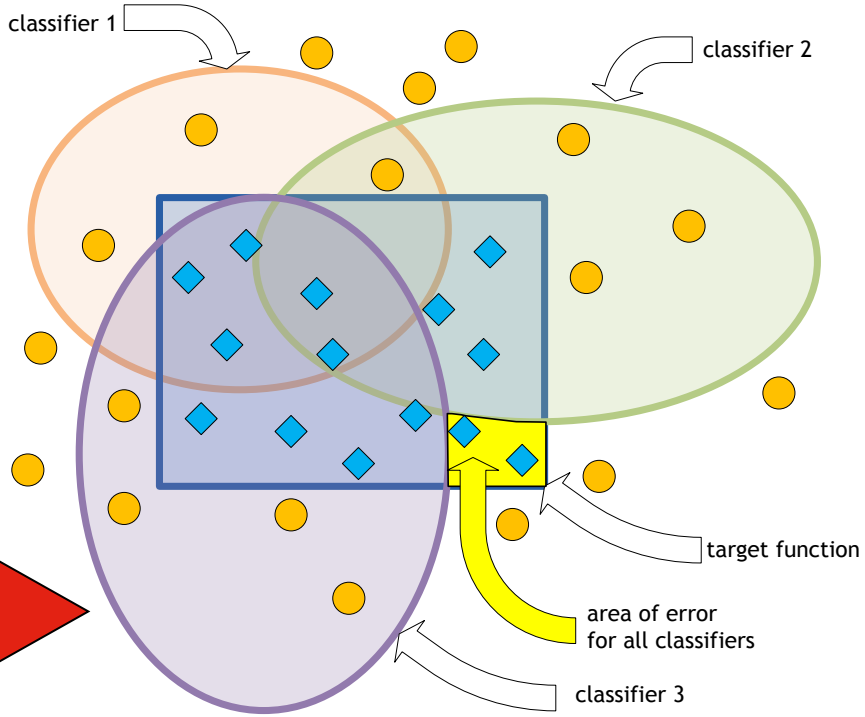


Evaluate each classifier and choose the best one

Pattern recognition task



What can we do in this situation?



Use all available classifiers

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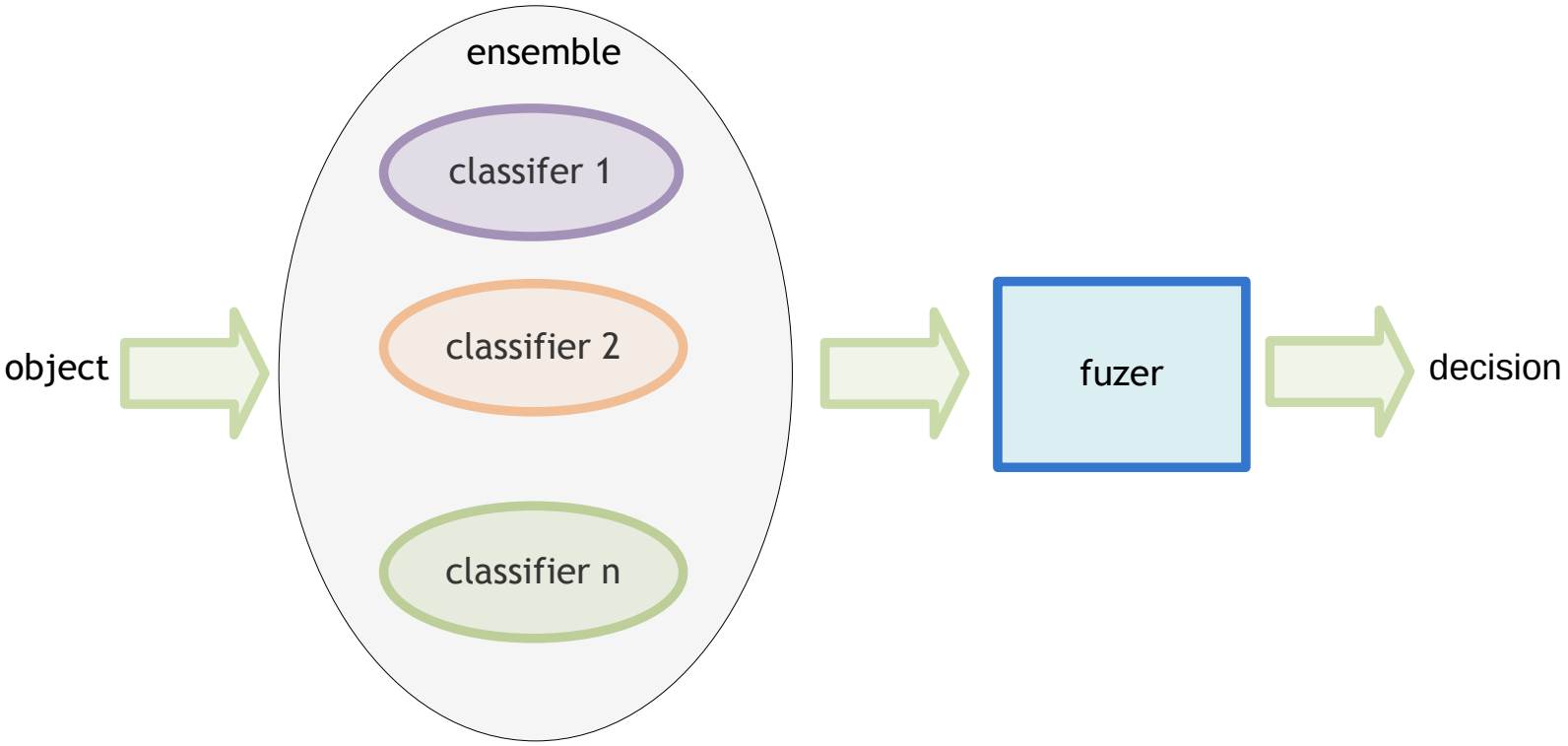
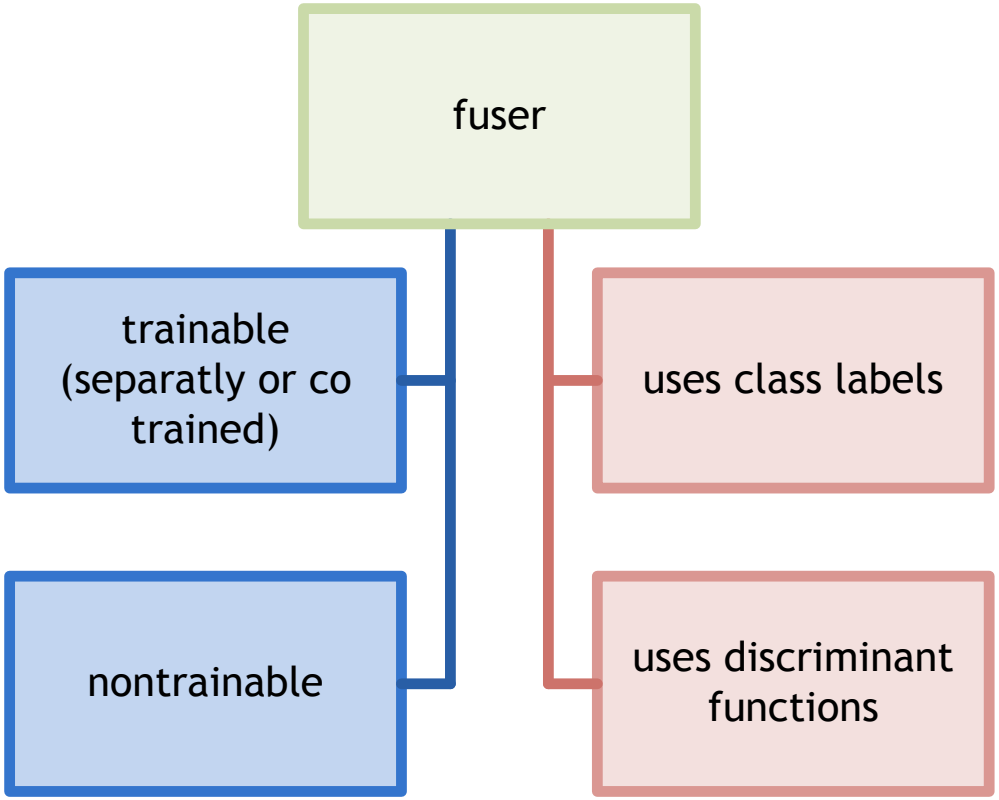
Classifier fusion



Classifier fusion



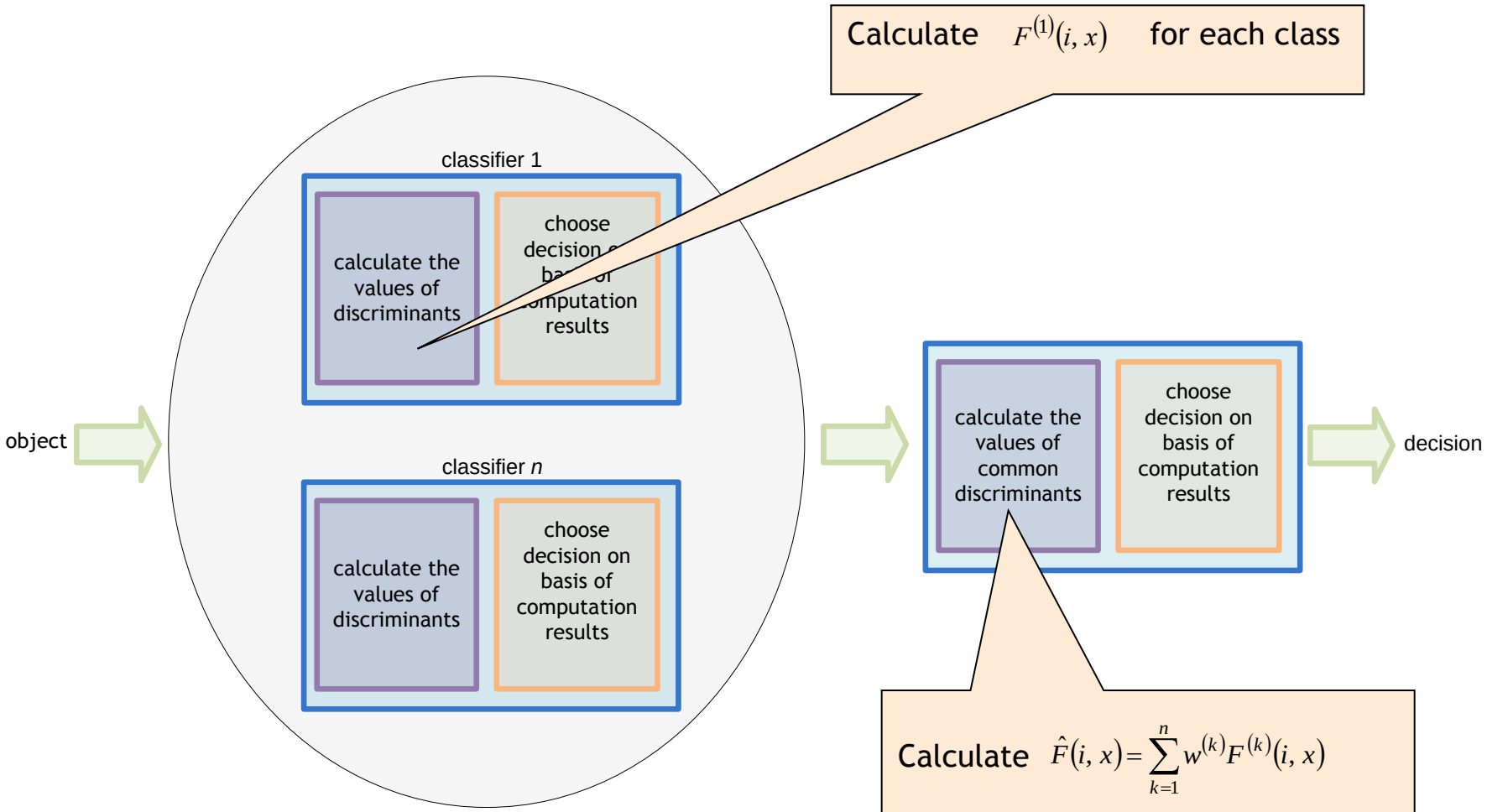
Classifier fusion

- Fuser could be realized as:
  - a classifier based on classifiers' outputs
  - a linear or a nonlinear combination of classifiers' outputs

it was considered e.g. by Raudys (Trainable fusion rules, *Neural Networks* 19, 2006)

our work deals with weights which could be assigned arbitraly or during training

Classifier fusion



Fuser based on discriminants

Classifier fusion

Fuser based on values of classifiers' discrimination function

- Weights dependent on classifier
- Weights dependent on classifier and feature vector
- **Weights dependent on classifier and class number**
- Weights dependent on classifier, class number, and feature vector

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Fuser training

An ensemble learning task leads to the problem of how to establish the following vector

$$W = \left[W^{(1)}, W^{(2)}, \ldots, W^{(n)} \right]$$

where

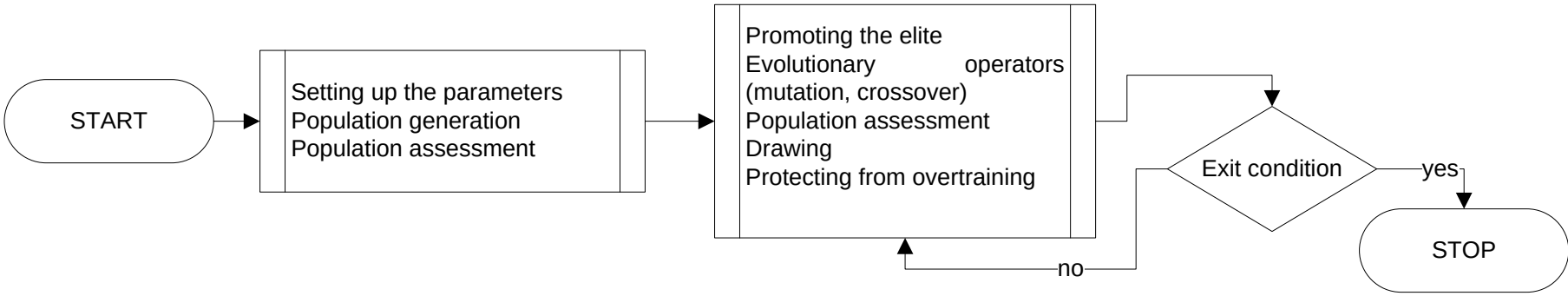
$$W^{(l)} = \left[w^{(l,i)}, w^{(l,i)}, \ldots, w^{(l,i)} \right]^T$$

The weights should be established in such a way as to maximize the accuracy probability of the fuser:

$$\Phi(W) = 1 - P_e(W)$$

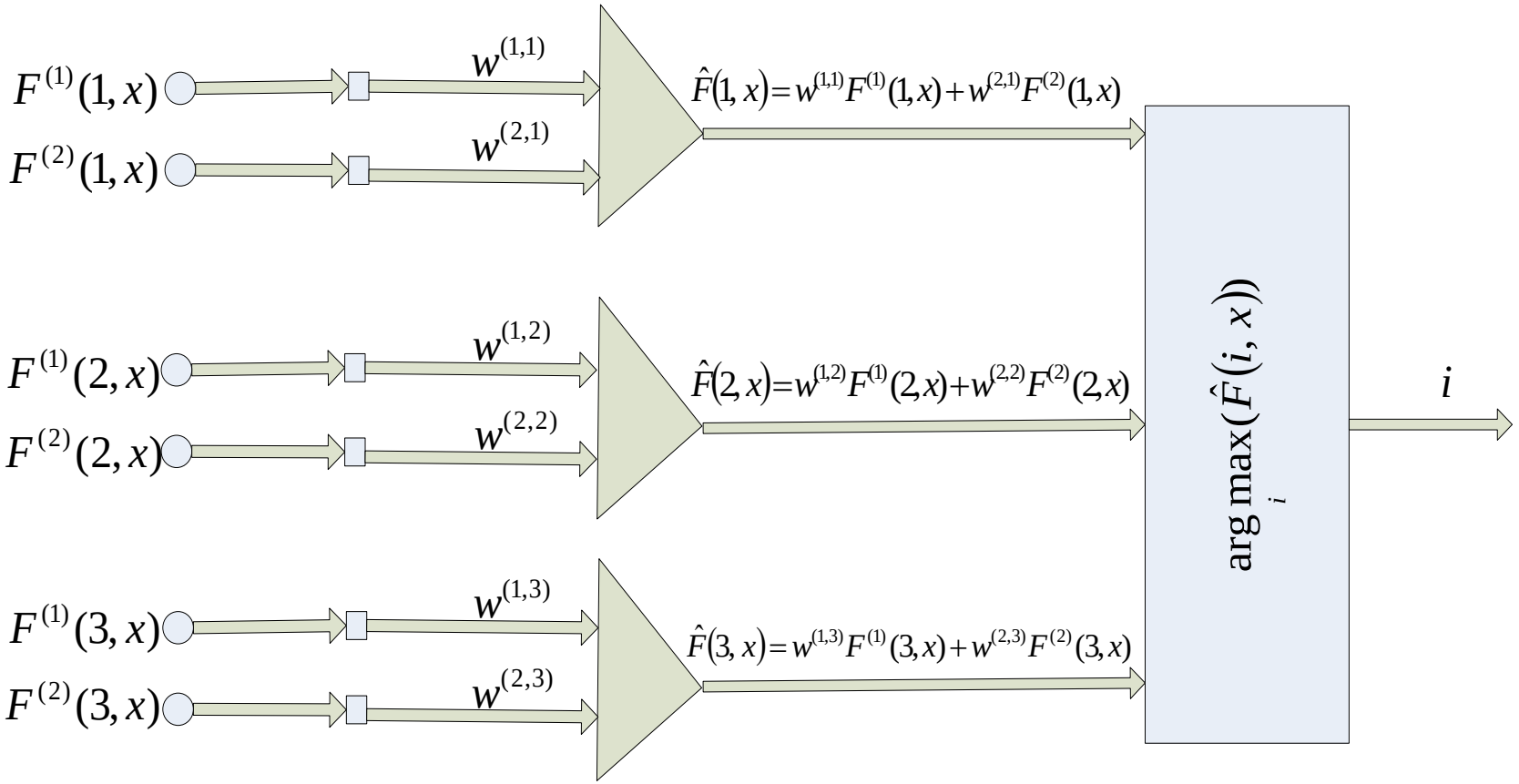
Fuzer training

Evolutionary approach



Fuzer training

- Neural nets



Oracle

- an abstract fusion model,
- if at last one of the classifiers from given pool recognizes object correctly, then *Oracle* points at correct class too,
- usually used in comparative experiments to show limits of classifier committee quality.

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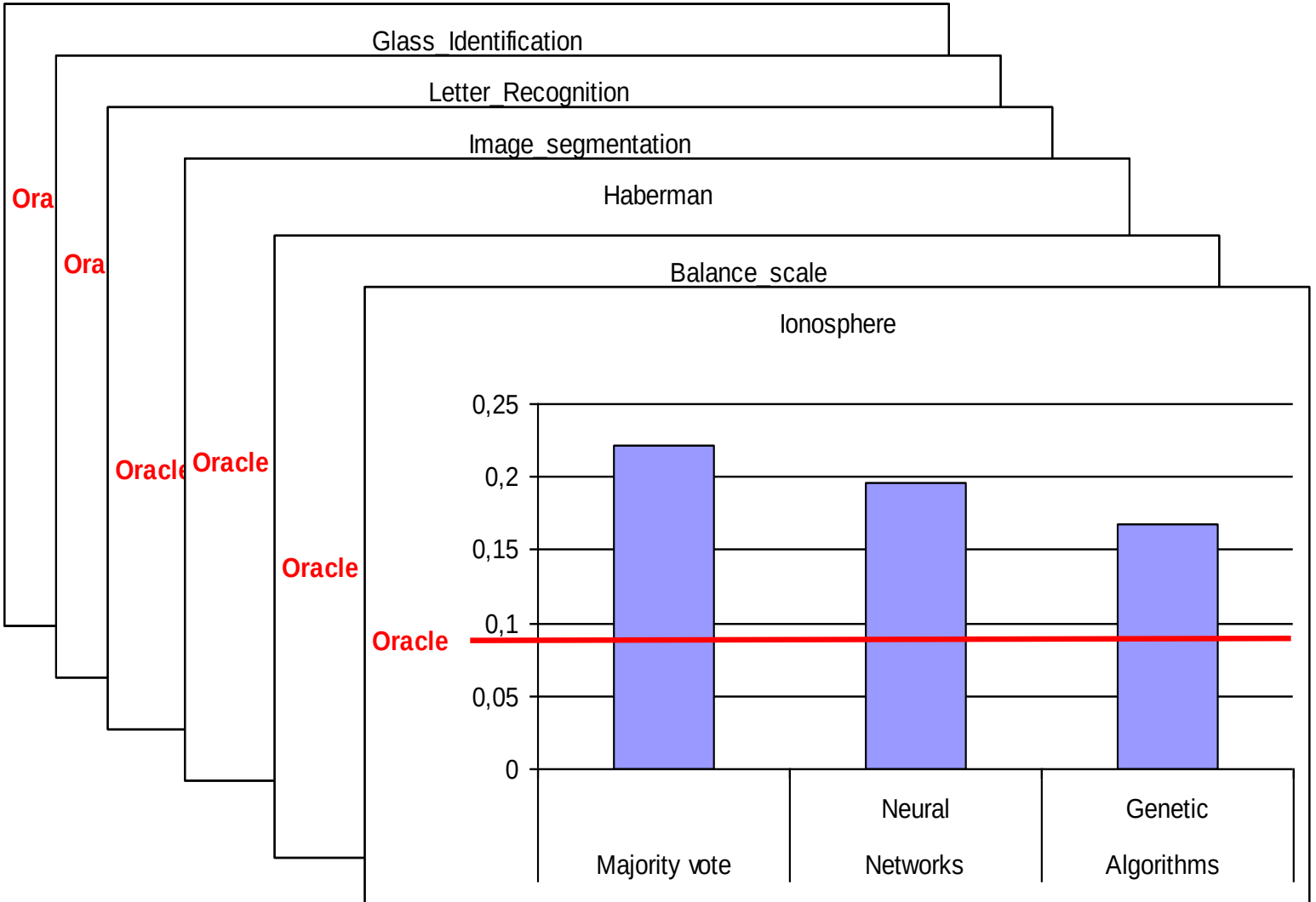
Experiments – set up

- 5 elementary classifiers consisting of slightly undertrained neural networks,
- 4 type of fuzers:
  - majority voting,
  - Oracle,
  - fuser based on discriminants and trained by evolutionary algorithm,
  - fuser based on discriminants and trained by neural algorithm.
- 6 datasets from UCI ML Rep. (Glass ident., Letter rec., Haberman, Balance scale, Ionosphere, Image seg.)
- Matlab environment using the PRtools toolbox and optimizing toolbox,
- Classifiers' errors were estimated using the ten fold cross validation method.

Experiments - results



Experiments - evaluation

- The results prove that genetic algorithms and neural networks are very good tools for solving optimization problems.
- Fuser which weights depend on the classifier and the class number could achieve results that are better than the *Oracle* classifier.

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Conclusions

- Some methods of classifier fusion were discussed.
- The possibility (not certain method) of constructing fuser better than Oracle was shown.
- Unfortunately, it is not possible to determine weight values in the analytical way therefore using heuristic methods of optimization (like evolutionary algorithms or neural nets) seem to be a promising research direction.

Thanks for your attention

CORES 2011 – the 7th International Conference on Computer Recognition Systems

HAIS 2011 - the 6th International Conference on Hybrid Artificial Intelligence Systems

Wrocław, Poland, May 23-25, 2011

http://cores.pwr.wroc.pl

Special issue on
“Hybrid Intelligent Fusion Systems„
DL: October 20, 2010