Multi-objective learning of accurate and comprehensible classifiers – a case study

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Introduction

• **Motivation:**
  – Learn hybrid trees reflecting the knowledge of human expert: partially comprehensible and accurate.

• **Ph.D. in progress:**
  – Constructing understandable and accurate classifiers using data mining algorithms

• **STAIRS paper and poster:**
  – A brief algorithm description
  – Using the algorithm in practical application

• **ECAI 2014 Paper:** Multi-objective learning of hybrid classifiers
  – A detailed algorithm description
  – Algorithm evaluation
Activity recognition

Activity recognition learning set:
• 10 classes, 61 attributes, 48,000 instances

Classifier accuracy:
• Random forest: 90.6 % (not comprehensible)
• C4.5 tree: 76.1 % (14.5 % lower accuracy)
• Hybrid tree: 84.1 % (72.1 % comprehensibility)
Generating hybrid trees

- **Input**: dataset, classification tree, black-box (BB) classifier.

<table>
<thead>
<tr>
<th>Node</th>
<th>Description</th>
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<tbody>
<tr>
<td>A_2</td>
<td></td>
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<tr>
<td>A_3</td>
<td></td>
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<tr>
<td>L_1</td>
<td>+ comprehensible</td>
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<tr>
<td>L_2</td>
<td>- lower accuracy</td>
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<tr>
<td>A_1</td>
<td></td>
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<tr>
<td>L_4</td>
<td>- not comprehensible</td>
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<tr>
<td>L_5</td>
<td>+ higher accuracy</td>
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<td>A_1</td>
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<td>L_4</td>
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<td>L_5</td>
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Black-box classifier
Generating hybrid trees

- **Input**: dataset, classification tree, black-box (BB) classifier.
- **Algorithm**: replace leaves for BB to produce hybrid trees.

Diagram:

- + comprehensible
- - not comprehensible
- + higher accuracy
- - lower accuracy
Generating hybrid trees

- **Input:** dataset, classification tree, black-box (BB) classifier.
- **Algorithm:** replace leaves for BB to produce hybrid trees.
- **Output:** set of the best (i.e. non-dominated) hybrid trees.

![Diagram showing the process of generating hybrid trees](image)

- + comprehensible
- - not comprehensible
- + higher accuracy
- - lower accuracy

hybrid trees with different accuracy-comprehensibility trade-offs
Activity recognition hybrid trees

classification tree

black-box classifier

comprehensibility

accuracy
Activity recognition hybrid trees

selected hybrid tree
Activity recognition hybrid tree

black-box leaves - use BB instead of majority class
Quality of rules in hybrid tree

The higher number of black stars represent better rules corresponding to leaves.

Leaves with the same accuracy: the left one is much better since even BB can’t achieve higher accuracy, while there is more room for accuracy improvement in the other leaf.
Using the Pareto front

• Are hybrid better then the baseline?
• How many hybrid trees will be generated?
• Does the user have to examine all hybrid trees?
• How to validate the leaves based on the algorithm output?
• Errors in the estimated comprehensibility and accuracy!
Acknowledgement

My attendance at the conference was supported by the ECCAI Travel Award.