Active Learning with Adaptive Heterogeneous Ensembles

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Introduction
The combination of ensemble methods and active learning is promising.

Given a data set, how to choose an appropriate base classifier, or a combination of base classifiers is challenging.

The focus of our work is developing algorithms that can automatically find ensembles with appropriate combination of classifier types.

Adaptive Heterogeneous Ensembles (AHE)
The random subspace method (RSM) is used to obtain multiple instances of different classifier types. C4.5 and Naïve Bayes classifiers are employed as the classifier types. Experiments were conducted on five UCI data sets.

Table 1. Results of AHE on five UCI data sets.

<table>
<thead>
<tr>
<th>Data Set</th>
<th>C4.5 with uncertainty</th>
<th>Naïve Bayes</th>
<th>RSM random sampling</th>
<th>Boosting random</th>
<th>Bagging random</th>
<th>RSM random</th>
<th>AHE random</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iris</td>
<td>4.93 ± 2.52</td>
<td>4.80 ± 0.64</td>
<td>4.80 ± 1.64</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.8 ± 1.50</td>
</tr>
<tr>
<td>satImg</td>
<td>4.96 ± 2.52</td>
<td>4.80 ± 0.64</td>
<td>4.80 ± 1.64</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.8 ± 1.50</td>
</tr>
<tr>
<td>spam</td>
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<td>4.80 ± 0.64</td>
<td>4.80 ± 1.64</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.8 ± 1.50</td>
</tr>
<tr>
<td>pendigit</td>
<td>4.93 ± 2.52</td>
<td>4.80 ± 0.64</td>
<td>4.80 ± 1.64</td>
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<td>4.80 ± 1.50</td>
<td>4.80 ± 1.50</td>
<td>4.8 ± 1.50</td>
</tr>
</tbody>
</table>

Table 2. Win-tie-loss of VAHE compared with other methods on 18 UCI data sets.

Conclusions and Future Work
Adaptive heterogeneous ensembles work consistently better than homogeneous ensembles and state-of-the-art ensemble methods.

Future work:
- better adaptation method
- in-depth analysis of the algorithm

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Adaptive Informative Sampling (AIS)
Diversity of ensemble members obtained through stochastic optimization.

Adapt the ratio of involving classifier types towards better performance.

In this work, Artificial Neural Networks (ANN) and Decision Trees (DT) serve as the classifier types.

In Progress
- kNN added as the third classifier type
- both ratio of classifier types and ensemble sizes are adapted

Figure 1. Algorithm Framework

Figure 2. Results of Adaptive Informative Sampling

Figure 3. Adaptation method of AHE.

Figure 4. Results of AHE on “mfeat-pixel” data set.

Figure 5. Adaptation method of VAHE.

Figure 6. Results of VAHE on “isolet” data set.

Figure 7. Results of Adaptive Informative Sampling