Using Introspective Reasoning to Improve CBR System Performance

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Outline

• Research Goal
• The Metareasoning Model
• Introspective Reasoner
• Experiments
• Conclusions
Research Goal

• to improve system performance refining the function of reasoning mechanisms
  – monitoring the reasoning process
  – detecting reasoning failures
  – determining causes of failures
  – acting on the reasoning process

Applying *Introspective Reasoning* at multiple points in the Case-Based Reasoning process
The Metareasoning Model

Ground Level

Object Level

Meta-Level

User

CBR Reasoning

Metareasoning

Change Monitoring
The Metareasoning Model (2)

Ground Level

Object Level

Meta-Level

User

CBR Reasoning

Metareasoning

Query

Proposal

Revise

Change

Monitoring
Approach

- A model of the correctly-functioning CBR process
- A taxonomy of reasoning failures
- Learning goals
- Failures modeled as *conflicts* between observed performance and predictions from the model

<table>
<thead>
<tr>
<th>Explanation of Failure</th>
<th>Learning Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing Index</td>
<td>Create Index</td>
</tr>
<tr>
<td>Broad Index</td>
<td>Refine Index</td>
</tr>
<tr>
<td>Underestimated Weight</td>
<td>Adjust Weighting</td>
</tr>
<tr>
<td>Inappropriate interpolation</td>
<td>Change shape Increase slope</td>
</tr>
</tbody>
</table>
Introspective Reasoner

Meta-Model
Reasoning-Failures
Learning-Goals

Inference
Trace

Monitoring

Hypothesis
Generation

Hypothesis
Evaluation

Blame
Assessment

Quality
Assessment

Solution
Quality

Retrieved
Adapt
Proposed
Solution
Confidence

Revise
Final
Solution
Retain

Problem
User
The Metareasoning Model (3)
Outline

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Testing Scenario

- **Five Reasoning Strategies**
  - *No-Retain*: New solved problems *NOT* incorporated
  - *Retain*: New solved problems incorporated
  - *Introspective-Retrieval*: Introspective reasoning for *retrieval*
  - *Introspective-Adapt*: Introspective reasoning for *adaptation*
  - *Introspective-Complete*: *Complete* Introspective reasoning

- **510 designs (300 cases & 210 problems)**
  - Presented in chronological order & 10 random orders
Results

- No-Retain
- Retain
- Intr-Retr
- Intr-Adapt
- Intr-Compl

- 0%
- 25%
- 50%
- 75%
- 100%

- Low Quality
- Medium Quality
- High Quality
Results (II)

Summary of the number of times learning goals were triggered

<table>
<thead>
<tr>
<th></th>
<th>Failures</th>
<th>Hypoth.</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indexing Knowledge</td>
<td>12</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Ranking Knowledge</td>
<td>83</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>Adaptation Knowledge</td>
<td>74</td>
<td>56</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>169</td>
<td>102</td>
<td>23</td>
</tr>
</tbody>
</table>
Conclusions

- The introspective reasoner improved the performance of the system

- Currently working on another design problem

- Defining *synthetic/artificial* problems for a better understanding of the introspection contribution