A Qualitative Comparison of Three Aspect Mining Techniques

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Aspect mining

- Identification of crosscutting concerns in existing software systems
- Starting point for system exploration
- Support program comprehension, software maintenance and evolution
  - e.g. migrating to an AOP solution

Goal: high degree of automation
Comparison and combination of mining techniques

• Understand what “assumptions” (about crosscutting concerns) the techniques rely on
• Evaluate strengths and weaknesses
• Mutual filtering / completion
• Enhance automation through a multi-technique approach and tool
Three aspect mining techniques

– Identifier Analysis –

Use FCA to group classes/methods with similar names

|                                      | figure | drawing | request | remove | update | change | event | ...
|--------------------------------------|--------|---------|---------|--------|--------|--------|-------|--------
| drawingRequestUpdate(DrawingChangeEvent e) | -      | X       | X       | -      | X      | -      | -     | ...
| figureRequestRemove(FigureChangeEvent e) | X      | -       | X       | X      | -      | -      | -     | ...
| figureRequestUpdate(FigureChangeEvent e) | X      | -       | X       | -      | X      | -      | -     | ...
| figureRequestRemove(FigureChangeEvent e) | X      | -       | X       | X      | -      | -      | -     | ...
| figureRequestUpdate(FigureChangeEvent e) | X      | -       | X       | -      | X      | -      | -     | ...
| figureRequestUpdate(FigureChangeEvent e) | X      | -       | X       | -      | X      | -      | -     | ...
| ...                                  | ...    | ...     | X       | ...    | ...    | ...    | ...   | ...    |
Three aspect mining techniques
– Dynamic Analysis –

Use FCA to associate methods with the most specific use case scenarios in which they are executed

<table>
<thead>
<tr>
<th>scen 1</th>
<th>meth 1</th>
<th>meth 2</th>
<th>meth 3</th>
<th>meth 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>scen 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>scen 3</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Concept lattice with sparse labeling
Three aspect mining techniques

– Fan-in analysis –

Concerns

• Contract enforcement
• Consistent behavior
• Scattered implementation relying on common functionality
• Design patterns with specific structure

Persistence concern

write(StorableOutput)

implementations

calls

StorableOutput.writeStorable(Storable)
JHotDraw
– common benchmark for aspect mining –

- Framework for 2D graphics
- ~18,000NCLOC
- Open-source (jhotdraw.org)
- Good design – GoF patterns (Gamma et al.)
## Comparison

<table>
<thead>
<tr>
<th>Concern</th>
<th>Fan-in analysis</th>
<th>Identifier Analysis</th>
<th>Dynamic Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observer</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Consistent Behavior / Contract Enforcement</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Command Execution</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Bring to front / Send to back</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Manage Handles</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Move Figures</td>
<td>+ (discarded)</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Conclusions drawn from the results

• Limitations
  – **Dynamic** analysis: misses functionalities exercised by *all* traces
  – **Fan-in**: only crosscutting with large extent
  – **Identifier** analysis: relies on naming conventions

• Combination (orthogonal properties) – enhance automation and improve individual results
Combination of techniques

• **Increased coverage**
  - the union of discovered results (fan-in + dynamic)

• **Improved completeness** for the discovered aspect “seeds”
  - more elements relevant to the aspect (+ identifier)

• **Coarse-grained aspects**
  - grouping of identifier analysis concepts (fan-in/dynamic)

• **Filtering**
  - Discard irrelevant concepts
Resources

• Detailed results
  – **Fan-in**: swerl.tudelft.nl/amr
  – **Dynamic analysis**: star.itc.it/dynamo/jhotdraw-detailed-results.html
  – **Identifier analysis**: ask me 😊

• *JHotDraw* as benchmark and *AJHotDraw* as showcase for aspect refactoring

• Tools: *Dynamo, FanInTool, DelfSTof*

• Collaborations
  – *AIRCo/AIRPort*