Metrics for Model Transformations

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Model-Driven Engineering

Goal

Raising the level of abstraction

... from the computing domain to the problem domain

MDE combines:

- Domain-specific modeling languages
- Model transformations
Quality of Model Transformations

Research Goal

Make the quality of model transformations measurable
Quality of Model Transformations

Quality Attributes

1. Understandability
2. Modifiability
3. Reusability
4. Modularity
5. Completeness
6. Consistency
7. Correctness

ISO/IEC 9126-1: *Software engineering – Product quality – Part 1: Quality model*
ISO/IEC 25000: *Software engineering – Software product Quality Requirements and Evaluation (SQuaRE)*
Quality of Model Transformations
Internal versus External Quality

Model $\text{Metamodel}_A$

Meta-metamodel

Model $\text{Model}_A$

Transformation Definition

Transformation

Model $\text{Model}_B$

Metamodel $\text{Metamodel}_B$
Quality of Model Transformations
Internal versus External Quality

Internal Quality

Metamodell_A \(\xrightarrow{\text{conforms to}}\) Meta-metamodell

Transformation Definition

\text{Transformation}

\text{Model}_A \(\xrightarrow{\text{input of}}\) \text{Transformation} \(\xrightarrow{\text{output of}}\) \text{Model}_B

\text{Metamodell}_B \(\xrightarrow{\text{conforms to}}\) Metamodell

\text{Model}_B \(\xrightarrow{\text{instance of}}\) Transformation

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Quality of Model Transformations
Internal versus External Quality

External Quality

Meta-metamodel

Metamodel$_A$

Transformation Definition

Metamodel$_B$

Model$_A$

Transformation

Model$_B$
Quality Assessment of Model Transformations
Direct versus Indirect Assessment

![Diagram]

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Quality Assessment of Model Transformations
Direct versus Indirect Assessment

Indirect Assessment
Quality Assessment of Model Transformations
Direct versus Indirect Assessment

Direct Assessment

Quality Assessment of Model Transformations
Direct versus Indirect Assessment
Quality Assessment of Model Transformations
Indirect Quality Assessment of Model Transformations

Model_A → Transformation → Model_B
Quality Assessment of Model Transformations

Indirect Quality Assessment of Model Transformations

Model_A → Transformation → Model_B

Metrics_A → Compare → Metrics_B
Quality Assessment of Model Transformations

Direct Quality Assessment of Model Transformations

Transformation Definition

Metrics
## Quality Assessment of Model Transformations

### Summary

<table>
<thead>
<tr>
<th>Quality Type</th>
<th>Assessment technique</th>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>✓</td>
<td></td>
<td>Not using metrics</td>
</tr>
<tr>
<td>External</td>
<td>×</td>
<td></td>
<td>if $f(M)$ and $g(M')$ are comparable</td>
</tr>
</tbody>
</table>
Quality Assessment of Model Transformations
Model Transformations Formalisms

- ATL
- QVT Operational Mappings
- Xtend
### Quality Assessment of Model Transformations

**Metrics for Model Transformations**

<table>
<thead>
<tr>
<th>Category</th>
<th>Example metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td># Transformation functions</td>
</tr>
<tr>
<td></td>
<td># Helper functions</td>
</tr>
<tr>
<td><strong>Function complexity</strong></td>
<td>Cyclomatic complexity</td>
</tr>
<tr>
<td></td>
<td># Variables per function</td>
</tr>
<tr>
<td><strong>Modularity</strong></td>
<td># Modules</td>
</tr>
<tr>
<td></td>
<td># Functions per module</td>
</tr>
<tr>
<td><strong>Inheritance</strong></td>
<td>Depth of transformation function inheritance tree</td>
</tr>
<tr>
<td></td>
<td># Overloadings of transformation functions</td>
</tr>
<tr>
<td><strong>Dependency</strong></td>
<td>Fan-in/out of transformation functions</td>
</tr>
<tr>
<td></td>
<td>Fan-in/out of helper functions</td>
</tr>
<tr>
<td><strong>Consistency</strong></td>
<td># Unused elements</td>
</tr>
<tr>
<td></td>
<td># Calls to log functions</td>
</tr>
<tr>
<td><strong>In-/Output</strong></td>
<td># Involved metamodels</td>
</tr>
<tr>
<td></td>
<td># Involved models</td>
</tr>
</tbody>
</table>
Quality Assessment of Model Transformations

Quality Model

- Understandability
- Modularity
- Modifiability
- Reusability
- Conciseness
- Consistency
- Completeness
Toolset

ATL files → ATL injector → ATL models → ATL metrics extractor

QVTTo files → QVTTo injector → QVTTo models → QVTTo metrics extractor

Xtend files → Xtend parser → Xtend ASTs → Xtend metrics extractor

Metrics model → Pretty printer

CSV file → LaTeX file
Conclusions and Future Work

Conclusions

- Importance of quality analysis for model transformations
- Internal and external quality
- Direct and indirect measurement
- Categorization of metrics
- Three metrics sets
Questions