A Bayesian Network Approach to Assess and Predict Software Quality Using Activity-Based Quality Models

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ISO 9126

- **functionality**
  - suitability
  - accuracy
  - interoperability
  - security
  - functionality
  - compliance

- **reliability**
  - maturity
  - fault tolerance
  - recoverability
  - reliability
  - compliance

- **usability**
  - understandability
  - learnability
  - operability
  - attractiveness
  - usability
  - compliance

- **efficiency**
  - time behaviour
  - resource utilisation
  - efficiency
  - compliance

- **maintainability**
  - analysability
  - changeability
  - stability
  - testability
  - maintainability
  - compliance

- **portability**
  - adaptability
  - installability
  - co-existence
  - replaceability
  - portability
  - compliance

ISO 9126, 2003
Activity-Based Quality Models (ABQM)

Boehm et al. (1978)

- Maintainability
  - Modification
  - Modifiability
  - Testability
- Maintenance
  - Testing
  - Understandability
  - Understanding
- Augmentability
- Structuredness
- Communicativeness
- Accessibility
- Self-Descriptiveness
- Conciseness
- Legibility

[F. Deissenboeck et al. ICSM. IEEE CS Press, 2007.]
Activity-Based Quality Models (ABQM)

- Modification
- Maintenance
  - Testing
  - Understanding

[F. Deissenboeck et al. ICSM. IEEE CS Press, 2007.]
Activity-Based Quality Models (ABQM)

- Modification
- Testing
- Understanding
- Dynamics
- Concurrency
- Recursion
- Identifiers
- Statics
- Code Format

[F. Deissenboeck et al. ICSM. IEEE CS Press, 2007.]
Activity-Based Quality Models

- Maintenance
  - Understanding
  - Testing
  - Modification

- Product
  - Dynamics
    - Concurrency
    - Recursion
  - Statics
    - Identifiers
    - Code Format

[F. Deissenboeck et al. ICSM. IEEE CS Press, 2007.]
Current Usage of ABQMs

• Generation of guidelines and checklists
• Derivation of static and dynamic analyses
• Measurement of facts

• No support for assessment and prediction
Example: Average Maintenance Effort

• NASA CM1 system
• Space craft instrument
• Developed in C

• How will the average change effort be?

• Usage of existing maintainability model
Bayesian Networks

• Cause effect graphs
• Based on Bayesian inference
• Are therefore able to model uncertainty
• Node Probability Table (NPT) for each node
• $N \times M$
• $N$ states in the node
• $M$ product of the cause node states

$P(C|A, B)$

$P(A)$

$P(B|A)$

$P(T|A, B)$

$A$

$B$

$C$

$T = 0.6$

$F = 0.4$

<table>
<thead>
<tr>
<th></th>
<th>$T$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Med</td>
<td>0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>High</td>
<td>0.2</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Micro-ABQM for Example

- Maintenance
  - Implementation
  - Quality Assurance
  - Analysis
    - Comprehension
      - Code Reading
- Modification
- Testing
- Appropriateness of Comments
- Regularity of Implementation
- Extent of Modules

+  

-
Mapping to Bayesian Network

- Maintenance
  - Implementation
  - Quality Assurance
    - Testing
  - Analysis
  - Comprehension
  - Code Reading
  - Extent of Modules

- Modification
  - Appropriateness of Comments
  - Regularity of Implementation
  - Extent of Modules

Arrows indicate dependencies or influences between the concepts.
Quantification

- Mainly ranked nodes
- Method by Fenton, Neil and Galan Caballero
- Empirical data for indicator nodes
Summary

- Quality assessment with Bayesian networks based on ABQM
- Proven basis for relationships between factors
- Quantification with BN
- Only proof of concept
- Needs more experimentation
Current Work: Study on Quality Models in Practice

- Large scale study on quality model usage in practice
- Phase I (until end of May)
  - Interviews with experts from industrial partners (SAP, Siemens, Capgemini sd&m, itestra)
  - What models?
  - What quality attributes?
  - What improvements?
  - Qualitative und quantitative analysis
- Phase II (starting June)
  - Broad web questionnaire
  - World-wide distribution to experts
  - Mainly quantitative analysis
- If you’re interested, mail me: wagnerst@in.tum.de

www.quamoco.de