Requirements

QA (Testing, Software)

Formal Verif.)

L 17: 24.7., Mon

Vorallem hoffe ich auf eine sinnvolle Verbindung zum Softwarepraktikum.

•

T 5: 13.7., Thu

have some fun, learn a lot [...] not only for the further studying or working

•

T 3: 12.6., Mon

but also for life

•

L 13: 6.7., Thu

get to know industry standards, investigate their strengths /weaknesses

•

L 12: 3.7., Mon

learn how to specify the requirements

•

L 11: 26.6., Mon

implicitly" in smaller, self-made projects

•

L 10: 22.6., Thu

mishaps at each step

•

T 2: 18.5., Thu

how to estimate cost/time, without resorting to years of experience

•

L 9: 19.6., Mon

understanding the procedure of software production, including common

•

L 8: 1.6., Thu

know about trustful internet sources to get such information while

•

L 7: 29.5., Mon

get to know industry standards, investigate their strengths /weaknesses

•

L 6: 22.5., Mon

learn how to properly document the work

•

L 5: 15.5., Mon

communicate results to other people

•

L 4: 11.5., Thu

become acquainted with the most common procedures of software

•

L 3: 8.5., Mon

different life stages of a software

•

L 2: 27.4., Thu

development

•

L 1: 24.4., Mon

get an overview, terminology, and references for own enquiries

•

T 1: 4.5., Thu

learn how things are done in real companies

•

T 2: 18.5., Thu

project management

•

T 3: 12.6., Mon

finance part: how much money can can you demand for software?

•

T 5: 13.7., Thu

selection of right process for a project.

•

L 18: 27.7., Thu

I especially hope for a meaningful connection to the Softwarepraktikum.
(ii) Measure attributes which indicate architecture problems, then re-factor accordingly.

Examples are not defined and in practice hardly enforceable are clearly regulated, cannot be excluded.

Warranty and liability are different things.

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Recall: Software Quality

ISO/IEC 9126-1:2000

– 2 – 2017-04-27 – Sgoals –

13

- software related quality
- process
- quality
- functionality
- suitability
- accuracy
- interoperability
- security
- reliability
- maturity
- fault tolerance
- recoverability
- usability
- understandability
- learnability
- operability
- attractiveness
- efficiency
- time behaviour
- resource utilisation
- maintainability
- analysability
- changeability
- stability
- testability
- portability
- adaptability
- installability
- co-existence
- replaceability

Useful Metrics

– 2 – 2017-04-27 – Sgoals –

14

• For material goods, useful metrics are often pretty obvious:

• Not so obvious for immaterial goods, like software.

Content

– 2 – 2017-04-27 – Scontent –

15

• Survey:
  - Expectations on the Course
  - Software Metrics
  - Motivation
  - Vocabulary
  - Requirements on Useful Metrics
  - Excursion: Scales
  - Excursion: Mean, Median, Quartiles
  - Example: LOC
  - Other Properties of Metrics
  - Base Measures vs. Derived Measures
  - Subjective and Pseudo Metrics
  - Discussion

Requirements on Useful Metrics

– 2 – 2017-04-27 – Sreqonmetrics –

16

Definition.

A software metric is a function \( m : P \rightarrow S \) which assigns to each proband \( p \in P \) a valuation yield \( m(p) \in S \). We call \( S \) the scale of \( m \).

In order to be useful, a (software) metric should be:

- differentiated: worst case: same valuation yield for all probands
- comparable: ordinal scale, better: rational (or absolute) scale
  \( \rightarrow \) in a minute
- reproducible: multiple applications of a metric to the same proband should yield the same valuation
- available: valuation yields need to be in place when needed
- relevant: wrt. overall needs
- economical: worst case: doing the project gives a perfect prognosis of project duration — at a high price;
- irrelevant: metrics are not economical (if not available for free)
- plausible: \( \rightarrow \) pseudo-metric
- robust: developers cannot arbitrarily manipulate the yield; antonym: subvertible

Excursion: Scales

– 2 – 2017-04-27 – Sscales –

18

Scales and Types of Scales

Scales are distinguished by supported operations:

- \( = \), \( \neq \)
- \( < \), \( > \) (with transitivity)
- \( \text{min} \), \( \text{max} \)
- percentiles, e.g. \( \text{median} \)
- \( \Delta \) proportion
- natural \( 0 \) (zero)

Nominal scale
- nationality, gender, car manufacturer, geographic direction, train number, …
- Software engineering example: programming language \( S = \{ \text{Java}, \text{C}, \ldots \} \)

→ There is no (natural) order between elements of \( S \); the lexicographic order can be imposed ("C < Java"), but is not related to the measured information (thus not natural).

Interval scale (with units)
- \( \text{Celsius, Fahrenheit, Kelvin, etc.} \)
### Scales and Types of Scales

<table>
<thead>
<tr>
<th>Scale Type</th>
<th>Operations</th>
<th>Proportional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Only equality</td>
<td>×</td>
</tr>
<tr>
<td>Ordinal</td>
<td>&gt;, &lt;, =, ≠</td>
<td>×</td>
</tr>
<tr>
<td>Interval</td>
<td>&gt;, &lt;, =, ≠</td>
<td>✔</td>
</tr>
<tr>
<td>Ratio</td>
<td>&gt;, &lt;, =, ≠</td>
<td>✔</td>
</tr>
</tbody>
</table>

#### Examples

**Nominal Scale**
- Gender (male, female, other)
- Marital status (single, married, divorced)

**Ordinal Scale**
- Movie ratings (1 star to 5 stars)
- Job satisfaction (very dissatisfied to very satisfied)

**Interval Scale**
- Temperature in Fahrenheit
- Age (in years)

**Ratio Scale**
- Height in meters
- Time in seconds

#### Remarks

- A rational scale requires a metric space.
- An absolute scale has a median.
- The McCabe metric (in a minute) is sometimes called complexity metric.
- A metric space requires more than a rational scale.
A software metric is a function \( m : P \to S \) which assigns to each proband \( p \in P \) a valuation yield ("Bewertung") \( m(p) \in S \). We call \( S \) the scale of \( m \).

**Requirements Engineering**

- **Here:** \( P \) is the set of participants in the survey of the course "Software Engineering".
- **Scale:** \( S = \{0, \ldots, 10\} \) (ordinal scale; has \( = \) and \( \neq \), \(<\) and \(>\), \(\min\) and \(\max\)).
- **Measurement procedure:** self-assessment (subjective measure).

**Reduce Information Further**

- **Arithmetic mean:** 2.284 (not in the scale!)
- **Minimum and maximum:** 0 and 10
- **Median:** 1 (the value such that 50% of the probands have yields below and above)
- **1st and 3rd Quartile:** 1 and 4 (25%, 50%)

A boxplot visualises 5 aspects of data at once (whiskers sometimes defined differently):

- 100 % (maximum)
- 75 % (3rd quartile)
- 50 % (median)
- 25 % (1st quartile)
- 0 % (minimum)

**RE Experience 2017**

- **Median:** 1
- **Average:** 2.091

**RE Experience 2016**

- **Median:** 1
- **Average:** 2.0909

**Management 2017**

- **Median:** 1
- **Average:** 2.2069

**Management 2016**

- **Median:** 3
- **Average:** 3.9432

**Programming 2017**

- **Median:** 3
- **Average:** 3.7922

**Programming 2016**

- **Median:** 1
- **Average:** 2.1932

**Modelling 2017**

- **Median:** 1
- **Average:** 1.4459

**Modelling 2016**

- **Median:** 1
- **Average:** 2.5682

**QA 2017**

- **Median:** 1
- **Average:** 2.3766

**QA 2016**

- **Median:** 2
- **Average:** 2.1932
In order to be useful, a (software) metric should be:

- differentiated
  - worst case: same valuation yield for all probands
- comparable
  - ordinal scale, better: rational (or absolute) scale
- reproducible
  - multiple applications of a metric to the same proband should yield the same valuation
- available
  - valuation yields need to be in place when needed
- relevant
  - wrt. overall needs
- economical
  - worst case: doing the project gives a perfect prognosis of project duration — at a high price;
  - irrelevant metrics are not economical (if not available for free)
- plausible
  - → pseudo-metric
- robust
  - developers cannot arbitrarily manipulate the yield; antonym: subvertible

Example: Lines of Code (LOC)
Could be useful measure for, e.g., team performance.

Productivity then cycle free.

Let \( G \) be a graph comprising \( V, E \). The cyclomatic number is defined as \( \text{cyclicity} = |V| - |E| + 1 \).

Intuition tutorials)), \( \rightarrow \) If LOC was (or could be made non-subvertible (\

\[ x := y + z; \]

\[ \text{false negative} \]

\[ \text{true negative} \]

\[ \text{false positive} \]

\[ \text{true positive} \]

The degree to which a system or component has a design or implementation that is difficult to understand and verify. Contrast with: simplicity.

Note that we really measure average LOC per module: derived, not pseudo.

Pseudo-metric: measure

• Not robust if easily subvertible (see exercises).

Example, general collection of simple base measures

Advantages

• Usable?

• Maintainable;

• How much effort is needed until completion?

• How is the software?

Disadvantages

• Maintainability; average-LOC is only measure

• Sometimes it matters if we don't really measure average LOC per module.

• How is the software people?

• Expert review

• How is the documentation?

• How is the effort?

• How is the product?

• How is the maintainability?
Discussion

• Subjective and Pseudo Metrics

• Base Measures vs. Derived Measures

• Example: LOC

Software Engineering


Excursion Excursion: Mean, Median, Quartiles

Metrics and models in Software Quality Engineering


References

Requirements on Useful Metrics

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Information technology – Software product quality – Part 1:Quality model


Vocabulary

• . 15939:2011.

Information technology – Software engineering – Software measurement process


Motivation

• . Std 610.12-1990.

IEEE Standard Glossary of Software Engineering Terminology


Software Metrics


Expectations on the Course

Survey

• IEEE Transactions on


References

Content