

Software Metrics and Quality Engineering

CSE 8314 — Fall 2017

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Module II: Metrics and Models

- Metrics: Internal vs. External
- Metrics and Models
- External Quality Metrics
- Other External Metrics

Software Measurement

Basic assumption: The lower the complexity or other metrics values, the more desirable:

- ▷ cheaper to build;
- ▷ easier to maintain;
- ▷ more reliable;
- ▷ ...

Desirable? can it be quantified?

Relationship: internal/external \Rightarrow target external

- ▷ target external metrics as output/response/dependent variables
- ▷ internal (& other external) metrics as input/predictor/stimulus/independent variables

Internal/External Measures

External Measures: depend also on other external factors — so called *-lities*.

Internal Measures: depend on programs only.
complexity measures \subset internal measures;

Relations: correlated but not uniquely determined. To use internal measures to predict external measure, we need:

- ▷ Discover *appropriate* internal measures;
- ▷ Establish *predictive* relations;
- ▷ Use and validate predictions.

External Measures: Why?

External Measures: depend also on other external factors — so called *-lities*.

Perspective: typically customer/user view

- ▷ reliability example:
 - defect exposure in environment
- ▷ customer satisfaction
- ▷ cost/schedule/etc from management view

Granularity: "whole"

External Measures: What?

Quality: many metrics

- ▷ different quality attributes "-ilities"
- ▷ reliability, availability, usability, etc.
- ▷ compound/collection of metrics:
dependability example

Other (non-quality) metrics

- ▷ customer satisfaction
- ▷ cost,
- ▷ effort,
- ▷ schedule, etc.

External Measures: Difficulties

Time: typically only measured accurately late

- ▷ OK for post-mortem analysis
- ▷ prediction and control desirable

Granularity: "whole"

- ▷ more intangible,
- ▷ harder to pin-point/manage/etc.

Need: predictors, leading indicators, controllers, etc.

Internal Measures: Why?

Difficulties with external metrics above

Need: predictors, leading indicators, controllers, etc.

Internal metrics as answers

- ▷ must be available earlier
- ▷ controllability and observability
- ▷ finer granularity

Granularity: "whole, parts and details"

Internal Measures: What?

Complexity:

general terms, often to indicate all internal metrics

- ▷ complexity dimensions
 - control (algorithm, decisions)
 - data
 - presentation (organization)
- ▷ many metrics, long history

Other metrics

- ▷ size, often as separate metrics
- ▷ information contents
- ▷ volume
- ▷ algorithmic
- ▷ non-code-based metrics

In-/Ex-ternal Metrics: Usage

1. Use GQM to select metrics
 - ▷ existing pool vs new metrics
 - ▷ other selection approaches under GQM guideline

2. Measurement
 - ▷ tools for measurement activities?
 - ▷ data tracking and management

3. Analysis/modeling

4. Use of modeling results

5. Assessment of overall measurement experience for future (EF idea)

Metrics and Models

- Use GQM to select metrics above
 - ▷ external metrics more directly related to goals
 - ▷ internal metrics as leading indicator/control
 - ▷ relationship: analysis and modeling

- Analysis/modeling
 - ▷ types of models
 - ▷ input/output of the models

- Use of modeling results

In-/Ex-ternal Metrics: 5CM

1. Some of 5CM are external

- ▷ time
- ▷ effort
- ▷ quality
- ▷ productivity

2. Some of 5CM are internal

- ▷ size (complexity, volume, etc.)

3. Key: relationship (Putnam model, etc.)

External Metrics: Quality

- Quality:
 - ▷ different quality attributes "-ilities"
 - ▷ reliability, availability, usability, etc.
 - ▷ compound/collection of metrics:
dependability example

- Defect measurement
 - ▷ required, typically as raw data
 - ▷ analysis and classification
 - see Tian/SQE Chapter 20

- Reliability measurement:
Tian/SQE Chapter 22 slides

External Metrics: Quality

- Availability measurement
 - ▷ $\text{availability} = \text{MTTF} / (\text{MTTF} + \text{MTTR})$
 - ▷ MTTF as a summary reliability measure
 - ▷ MTTR repair

- Measurement issues:
 - ▷ counting/measurement rules
 - down time vs repair time
 - partially operational system?
 - scope and severity of failure
 - ▷ time unit?

External Metrics: Quality

- Availability management
 - ▷ reliability vs repair
 - ▷ types and scopes of outage
 - ▷ software rejuvenation

- Software rejuvenation: observations
 - ▷ aging: yet, possible rejuvenation?
 - ▷ non-deterministic/unforeseen events in field

- Software rejuvenation: how
 - ▷ system restart
 - ▷ system cleanup (partial rejuvenation)
 - ▷ application/process restart (partial rej.)
 - ▷ node/application failover (load balancing)

External Metrics: Quality

- Performance measurement
 - ▷ sometime included as a quality metric
 - ▷ but typically has separate metrics/tools

- Commonly used performance metrics
 - ▷ time: several variations
 - response time
 - turnaround time
 - ▷ task/time: throughput
 - ▷ resource utilization: memory, CPU etc.

External Metrics: Quality

- Usability measurement
 - ▷ typically more subjective
 - ▷ rating vs task-oriented time

- usability inspection, testing, improvement
 - ▷ recent work at SMU
 - ▷ manual vs semi-automated approach
 - ▷ case study with web applications
 - ▷ idea: path, ideal vs. actual
 - ▷ other work: #navigation paths

External Metrics: Quality

- Other quality attributes

- Security measurement
 - ▷ many sub-attributes
 - ▷ more specialized

- Maintainability measurement
 - ▷ typically effort on task
 - ▷ related to others, portability etc.

- Generally involve field data

External Metrics: Customer Satisfaction

- Kan/MMinSQE Chapter 14

- Customer satisfaction surveys
 - ▷ carefully constructed surveys
 - ▷ sampling method and size
 - ▷ compare to survey for OP development in UBST (CSE 7314)

- Data analysis
 - ▷ ordinal scale
 - ▷ meaningful analysis
 - percentages
 - logistic analysis
 - ▷ details in Kan book

- Generally involve field data

External Metrics: Effort

- Laird&Brennan/SME Chapter 6

- Effort measurement
 - ▷ "the mythical man-month"
 - Fred Brooks' famous book
 - ▷ measurement vs. estimation
 - estimation more meaningful

- Effort estimation
 - ▷ different techniques
 - ▷ size (and other metrics) as input
 - ▷ compare to Tian/SQE Chapter 19 (QMM)

External Metrics: Cost

- Laird&Brennan/SME Chapter 12

- Cost measurement
 - ▷ cost factors/items
 - salary/overhead/risk/capital
 - ▷ cost-benefit analysis:
 - also need to quantify benefit (harder!)
 - ▷ estimation vs measurement?

- Cost estimation
 - ▷ different techniques
 - ▷ size (and other metrics) as input
 - ▷ similarity with effort estimation