Software Metris and Quality Engineering

CSE 8314 — Fall 2015

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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 ⇒ 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

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
  - ▷ availability = MTTF / (MTTF + 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