Software Metris and Quality Engineering

CSE 8314 — Fall 2019

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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

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

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

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:

  ▷ model types: Tian SQE Book, Ch.19
    − esp. risk id. models: Tian/SQE Ch.21
  ▷ input/output of the models

- Use of modeling results: assessment/prediction/control

In-/Ex-ternal Metrics: 5CM

- Putnam and Myers book

- Some of 5CM are external

  ▷ time
  ▷ effort
  ▷ quality
  ▷ productivity

- Some of 5CM are internal

  ▷ size (complexity, volumne, etc.)

- Key: relationship (Putnam model, etc.)

External Metrics: Quality

- Quality:

  ▷ different quality attributes "-ilities"
    − reliability, availability, usability, etc.
    − Tian/SQE Book Ch.2
  ▷ 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

- Performance measurement

  ▷ Task definition/modeling
  ▷ Performance benchmarks as basis for performance measurement

- Variations of performance metrics

  ▷ task/time or task/resouce
  ▷ total
  ▷ average
  ▷ variance (standard deviation)
  ▷ worst (boundary) case metrics
  ▷ real time system considerations

External Metrics: Quality

- Usability measurement

  ▷ typically more subjective
  ▷ rating vs task-oriented time

- Classical usability metrics

  ▷ learning time

  ▷ performance on tasks

  ▷ error rate or completion/success rate

  ▷ retention rate

  ▷ satisfaction or rating

External Metrics: Quality

- Usability measurement activities

  ▷ usability inspection, testing
  ▷ other UI/UX related activities
  ▷ data collection and processing
  ▷ dealing with customer/user relations

- recent work at SMU

  ▷ manual vs semi-automated approach
     comparing intended vs actual usage
  ▷ case study with web applications
  ▷ usability metrics uses:
     success rate, #steps, task time

External Metrics: Quality

- Other quality attributes: Generally involve field data

- Security measurement

  ▷ many sub-attributes
  ▷ more specialized

- Maintainability measurement

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

- Safety: focus on assurance instead of measurement (the infeasibility/impracticality)

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