

Software

Its Nature and Qualities

Outline

- **Software engineering (SE) is an intellectual activity and thus human-intensive**
- **Software is built to meet a certain functional goal and satisfy certain qualities**
- **Software processes also must meet certain qualities**

Software product

- Different from traditional types of products
 - intangible
 - difficult to describe and evaluate
 - malleable
 - human intensive
 - involves only trivial “manufacturing” process

Classification of sw qualities

- **Internal vs. external**
 - External → visible to users
 - Internal → concern developers
- **Product vs. process**
 - Our goal is to develop software products
 - The process is how we do it
- **Internal qualities affect external qualities**
- **Process quality affects product quality**

Correctness

- Software is correct if it satisfies the functional requirements specifications
 - assuming that specification exists!
- If specifications are formal, since programs are formal objects, correctness can be defined formally
 - It can be proven as a theorem or disproved by counterexamples (testing)

The limits of correctness

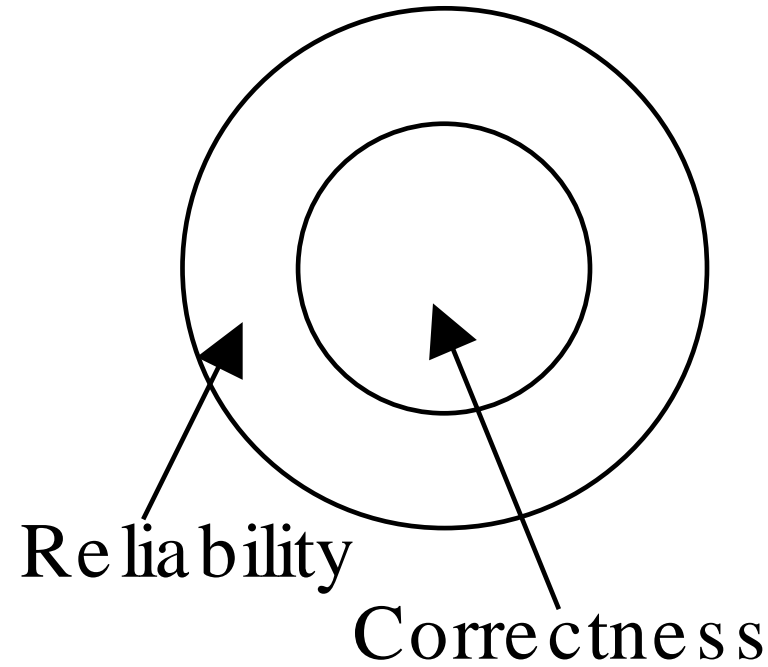
- It is an absolute (yes/no) quality
 - there is no concept of “degree of correctness”
 - there is no concept of severity of deviation
- What if specifications are wrong?
 - (e.g., they derive from incorrect requirements or errors in domain knowledge)

Reliability

- Reliability
 - informally, user can rely on it
 - can be defined mathematically as “probability of absence of failures for a certain time period”
 - if specs are correct, all correct software is reliable, but not vice-versa (in practice, however, specs can be incorrect ...)

Idealized situation

- Requirements are correct



Robustness

- Robustness
 - software behaves “reasonably” even in unforeseen circumstances (e.g., incorrect input, hardware failure)

Performance

- **Efficient use of resources**
 - memory, processing time, communication
- **Can be verified**
 - complexity analysis
 - performance evaluation (on a model, via simulation)
- **Performance can affect scalability**
 - a solution that works on a small local network may not work on a large intranet

Usability

- Expected users find the system easy to use
- Other term: user-friendliness
- Rather subjective, difficult to evaluate
- Affected mostly by *user interface*
 - e.g., visual vs. textual

Verifiability

- How easy it is to verify properties
 - mostly an internal quality
 - can be external as well (e.g., security critical application)

Maintainability

- **Maintainability: ease of maintenance**
- **Maintenance: changes after release**
- **Maintenance costs exceed 60% of total cost of software**
- **Three main categories of maintenance**
 - *corrective*: removing residual errors (20%)
 - *adaptive*: adjusting to environment changes (20%)
 - *perfective*: quality improvements (>50%)

Maintainability

- Can be decomposed as
 - Repairability
 - ability to correct defects in reasonable time
 - Evolvability
 - ability to adapt sw to environment changes and to improve it in reasonable time

Reusability

- Existing product (or components) used (with minor modifications) to build another product
 - (Similar to evolvability)
- Also applies to process
- Reuse of standard parts measure of maturity of the field

Portability

- Software can run on different hw platforms or sw environments
- Remains relevant as new platforms and environments are introduced
- Relevant when downloading software in a heterogeneous network environment

Understandability

- Ease of understanding software
- Program modification requires program understanding

Interoperability

- Ability of a system to coexist and cooperate with other systems
 - e.g., word processor and spreadsheet

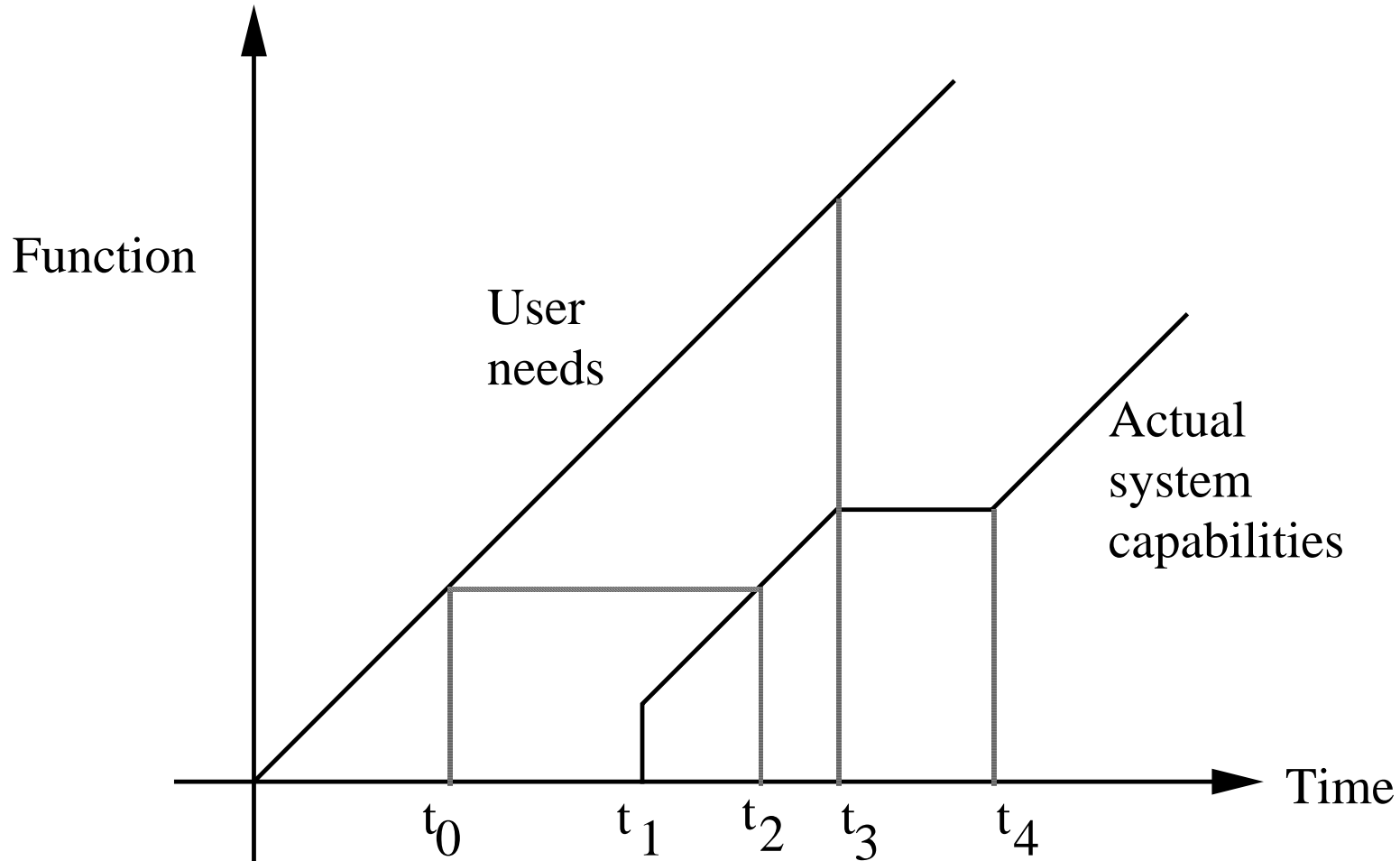
Typical process qualities

- **Productivity**
 - denotes its efficiency and performance
- **Timeliness**
 - ability to deliver a product on time
- **Visibility**
 - all of its steps and current status are documented clearly

Timeliness: issues

- Often the development process does not follow the evolution of user requirements
- A mismatch occurs between user requirements and status of the product

Timeliness: a visual description of the mismatch



Application-specific qualities

- E.g., information systems
 - Data integrity
 - Security
 - Data availability
 - Transaction performance.

Quality measurement

- Many qualities are subjective
- No standard metrics defined for most qualities