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

Function

User needs

Actual system capabilities

Time

\( t_0 \quad t_1 \quad t_2 \quad t_3 \quad t_4 \)
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