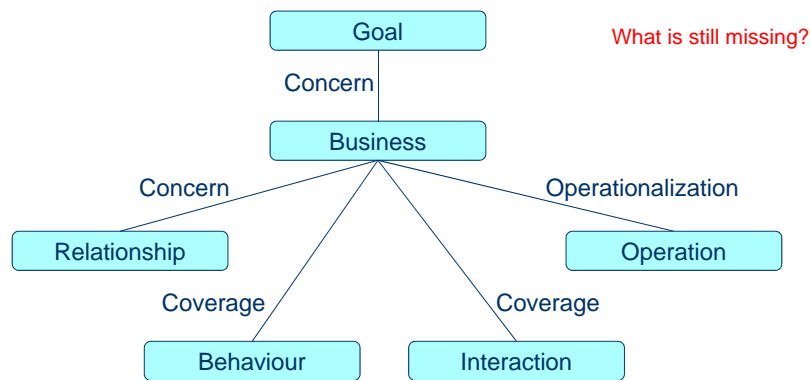
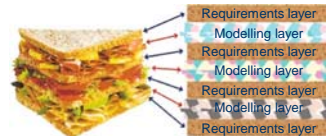


SENG 471

Software Requirements Engineering

Non-functional Requirements

Modellings - so far



Differences

- Product A



- Product B



Dr. Y. Hu

3

NFR Categories - Product-oriented

- Usability



- Time/space bounds



- Capability

- Volume of users

- Robustness

- Restart after failure,
- Percentage of events causing failure

- Reliability



- Security



- Survivability

- Against natural catastrophes, etc.



- Availability

- Extent to which system is available to users

Dr. Y. Hu

6

NFR Categories - Process-oriented

- Modifiability 
- Maintainability
 - Easily modified (fixes, extension)
- Efficiency
- Testability 
- Portability
 - Able to work on different platforms

7

Measurable Attributes

Application Architecture Standards

- Multilayer design compliance (UI vs App Domain vs Infrastructure/Data)
- Data access performance
- Coupling Ratios
- Component (or pattern) reuse ratios

Coding Practices

- Error/exception handling (all layers UI/Logic/data)
- If applicable - compliance with OO and structured programming practices
- Secure controls (access to system functions, access controls to programs)

Complexity

- Transaction
- Algorithms
- Programming practices (eg use of polymorphism, dynamic instantiation)
- Dirty programming (dead code, empty code...)

Documentation

- Code readability and structuredness
- Architecture - program, - and code-level documentation ratios
- Source code file organization

Portability: Hardware, OS and Software component and DB dependency levels

Technical and Functional Volumes

- # LOC per technology, # of artifacts, files
- Function points - Adherence to specifications (IFPUG, Cosmic references...)

Desirable Characteristics

Reliability

Security

Efficiency

Maintainability

Size

NFR Challenges

- Hard to model
 - The existing notations?
- Informally stated and thus
 - Clarity?
 - Enforceable?
 - Verifiable?
- Hard to make NFR measurable
 - State NFR for measuring how well they've been met

8

Dr. Y. Hu

Measuring Software Quality

- For a chair:
 - construction quality?
 - aesthetic value?
 - elegance ...
 - fit for purpose?
- For software:
 - construction quality?
 - aesthetic value?
 - the user interface
 - fit for purpose?



→ Qualitative measures
→ Quantitative metrics

10

Dr. Y. Hu

Qualitative Measures

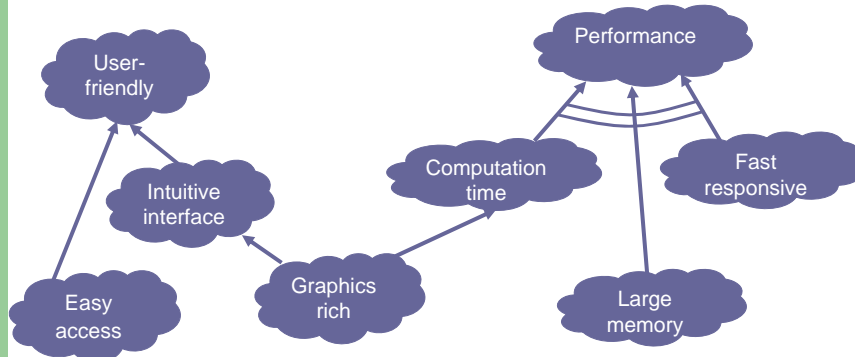
- Using **goal-modelling** to examine soft goals and their interdependencies
 - NFR → soft goals
 - NFR → conflict and interdepend
- Evaluation of goals
 - Satisfied
 - Denied
 - Conflicting
 - Undetermined



11

Dr. Y. Hu

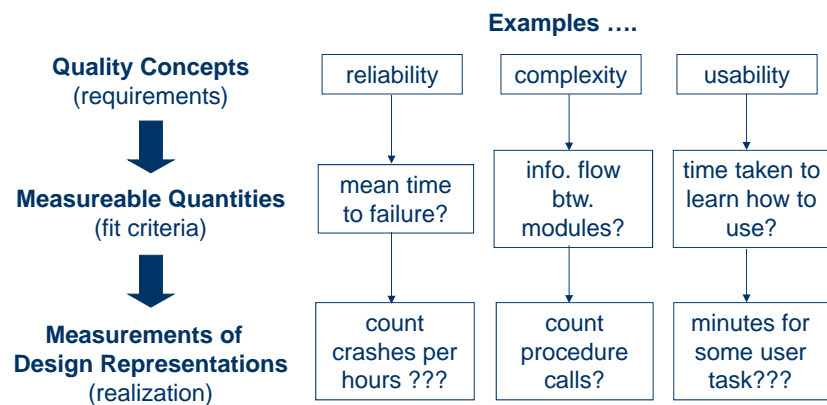
Qualitative Measures - Example



12

Dr. Y. Hu

Quantitative Measures - Metrics



15

Dr. Y. Hu

Quantitative Metrics: Examples

Quality	Metric
Performance	transactions/sec; response time; screen refresh time
Size	Mbytes; number of RAM chips
Usability	training time; number of help frames
Reliability	mean-time-to-failure; probability of unavailability; rate of failure, availability
Robustness	time to restart after failure; percentage of events causing failure
Portability	percentage of target-dependent statements; number of target systems

16

Dr. Y. Hu

Measuring Reliability

- Definition of reliability:
 - the ability of a system to behave consistently in a user-acceptable manner when operating within the environment for which it was intended.
- Different meaning for different applications:
 - Telephone network:
 - Patient monitoring system:
- Example:
 - “The system should fail no more than, on average, 0.5 hour per year.”



17

Dr. Y. Hu

Measuring Reliability - Techniques

- Monte Carlo techniques:

$$\frac{\# \text{ unseeded bugs}}{\# \text{ seeded bugs}} \leftarrow \frac{\# \text{ detected unseeded bugs}}{\# \text{ detected seeded bugs}}$$

- Problems with this approach:
 - Not all bugs are equal
 - Fixing bugs will create more bugs

18

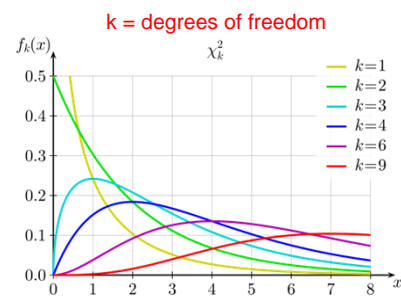
Dr. Y. Hu

Measuring Reliability - Techniques

- Mean Time to the First Failure (MTTF)
 - T_{dh} : the total device x hours
 - X_k^2 : the upper 60% confidence limit of a chi-square distribution
 - N_f : the number of failures

$$MTTF = 2T_{dh} / X_k^2 (2N_f+2)$$

$$k = 2N_f+2$$



19

Dealing with Conflicts

- NFR are often related:
 - Each factor depends on a number of associated criteria:
 - correctness ← completeness, consistency, traceability, ...
 - verifiability ← modularity, self-descriptiveness, simplicity, ...
- During Analysis:
 - Identify the relative importance of each NFR
 - Rank the requirements by priority

20

Dr. Y. Hu

Recap

- What are non-functional requirements (NFRs)?
- How to measure NFRs?

21

Dr. Y. Hu