Introduction to Computers and Programming

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Lecture 14
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Outline

- Bhorbugs and Heisenbugs

- Designing Large Programs
  - Software design quality
  - Modularity
  - Design by Contract

Real Bugs and Software Bugs

- Bugs **adjust** to the level of experience of the programmer
- Bugs **invade** the test environment
- Bugs **replace** previously caught bugs

Taxonomy of Bugs

- Reproducible bugs / Bohrbugs
- Unreproducible / Heisenbugs
- Tasking /Timing bugs

Reproducible Bugs/ Bhorbugs

Always cause a failure and can be **reproduced**

- Try **explaining** what should be happing
- **Verbalization** often clarifies muddled thoughts
- Have a **friend** do a quick sanity check
- **Don’t randomly** change things, your actions should have a purpose

Heisenbugs

A bug that **disappears** or **changes behavior** when you are trying to track it down

- Try to make the bug reproducible by switching platforms
- Insert checks for invariants and have the program stop everything when one is violated
- Verify each layer with small, simple tests
- Find the smallest system which demonstrates the bug

Tasking / Timing Bugs

- Synchronization properties are not specified
- Unconditional waits
- Deadlocks and races

Software Design Quality

- What is quality?
  - Construction quality
  - Aesthetic quality
  - Fit for purpose?
- How can we measure quality?
- Design quality : Fitness to purpose
- Quality is a measure of Software together with its application domain
  - Requirements analysis
  - **Quality predictors**

Quality Predictors

- **Simplicity**
  - Meets its objectives, without any extra decorations
  - Look for complexity
    - Control flow complexity
    - Information flow complexity
    - Name space complexity

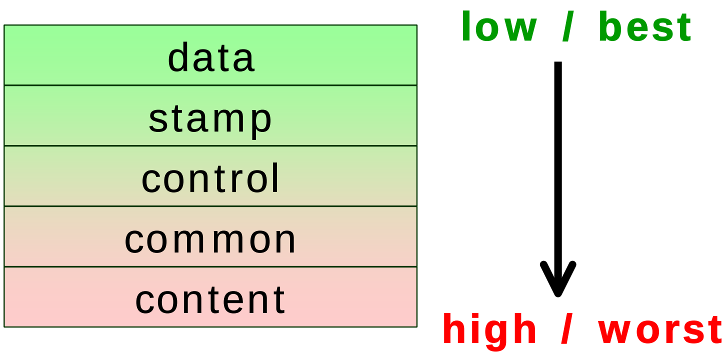
Quality Predictors

- **Modularity** is a logical partitioning of the software design that allows complex software to be manageable for purposes of implementation and maintenance
  - ↓ **Coupling**
    - Property of a collection of modules
  - ↑ **Cohesion**
    - Property or characteristic of an individual module

Coupling

- Coupling indicates:
  - how closely two modules interact or how interdependent they are
  - the degree of coupling between two modules depends on their interface complexity

Classes of Coupling



data

stamp

control

common

content

low / best

high / worst

Coupling

- **Data** coupling: Two modules are data coupled if they communicate via a parameter (+++)
- **Stamp** coupling: Two modules are stamp coupled if they communicate through a composite data structure (+)
- **Control** coupling: Data from one module is used to control the direction of the execution in the other module (0)

Coupling

- **Common** Coupling: Two modules are said to be common coupled when both reference the same shared/global data (-)
- **Content** Coupling: Two modules are said to be content coupled when they share code (---)

Concept Question

Test_stack.adb and my_stack package are:

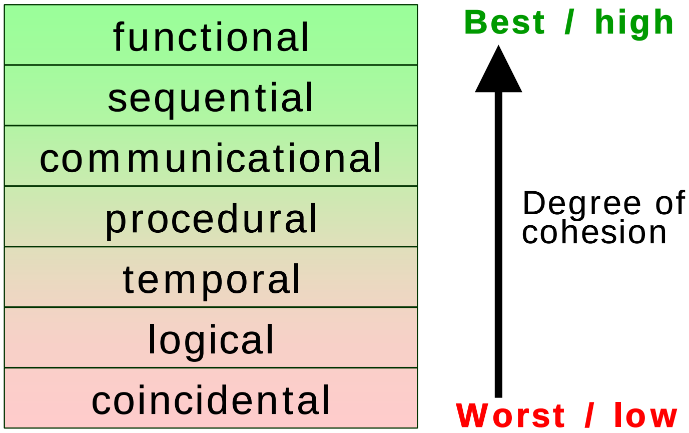
1. Not Coupled

2. Are Content Coupled

3. Stamp Coupled

4. I still don’t understand coupling

Classes of Cohesion



functional

sequential

communicational

procedural

temporal

logical

coincidental

Best / high

Degree of cohesion

Worst / low

Cohesion

- **Coincidental** cohesion exists when subprograms in the module relate to each other very loosely, if at all (---)

- **Logical** cohesion exists when all elements in the module perform similar operations (---)

Cohesion

- **Temporal** cohesion exists when a module contains tasks that must be executed within the same time span (+)

- **Procedural** cohesion exists when the subprograms in the module are part of the same algorithm (+)

Cohesion

- **Communication** cohesion exists when all subprograms in the module reference or update the same data structure (+)

- **Sequential** cohesion exists when elements of a module form different parts of a sequence, i.e., output from one element of the sequence is input to the next (++)

Cohesion

- **Functional** cohesion exists when all subprograms in the module cooperate to achieve a single function (+++)

Effects: initialize the data structures **and** initialize the screen display **and** initialize the history stack **and** initialize the layout defaults **and** display an introductory text

Describe the functions in a single sentence

Effects: **if** x =0 **then** returns size(a[]) **else if** x=1 **then** returns sum(a[]) **else if** x=2 **then** returns mean(a[]) **else if** x=3 **then** returns median(a[])

Concept Question

my_stack package has:

1. Logical cohesion

2. Functional cohesion

3. No Cohesion

4. I still don’t understand cohesion