

---

# CSE 331

## Software Design & Implementation

Dan Grossman  
Winter 2014

Module Design and General Style Guidelines  
(Based on slides by Mike Ernst, David Notkin, Hal Perkins)

---

---

## Style



“Use the active voice.”  
“Omit needless words.”



“Don't patch bad code - rewrite it.”  
“Make sure your code 'does nothing' gracefully.”

CSE331 Winter 2014

2

---

## Modules

A *module* is a relatively general term for a class or a type or any kind of design unit in software

A *modular design* focuses on what modules are defined, what their specifications are, how they relate to each other

- Not the implementations of the modules
- Each module respects other modules' abstraction barriers!

CSE331 Winter 2014

3

---

## Ideals of modular software

**Decomposable** – can be broken down into modules to reduce complexity and allow teamwork



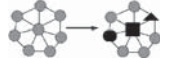
**Composable** – “Having divided to conquer, we must reunite to rule [M. Jackson].”



**Understandable** – one module can be examined, reasoned about, developed, etc. in isolation



**Continuity** – a small change in the requirements should affect a small number of modules



**Isolation** – an error in one module should be as contained as possible



CSE331 Winter 2014

4

---

## Two general design issues

**Cohesion** – how well components fit together to form something that is self-contained, independent, and with a single, well-defined purpose

**Coupling** – how much dependency there is between components

Guideline: *decrease* coupling, *increase* cohesion

Applies to modules and smaller units

- Each method should do one thing well
- Each module should provide a single abstraction

CSE331 Winter 2014

5

---

## Cohesion

The common design objective of *separation of concerns* suggests a module should represent a single concept

- A common “concept” is an ADT

If a module implements more than one abstraction, consider breaking it into separate modules for each one

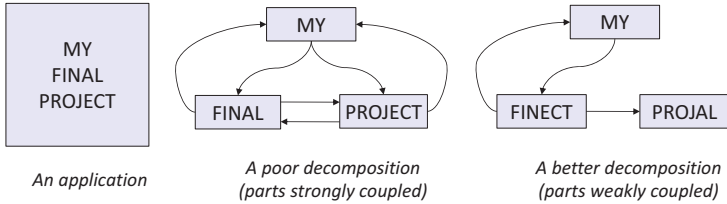
CSE331 Winter 2014

6

## Coupling

How are modules dependent on one another?

- Statically (in the code)? Dynamically (at run-time)? More?
- Ideally, split design into parts that don't interact much



Roughly, the more coupled modules are, the more they need to be reasoned about as though they are a single, larger module

CSE331 Winter 2014

7

## Coupling is the path to the dark side

Coupling leads to complexity

Complexity leads to confusion

Confusion leads to suffering

Once you start down the dark path, forever will it dominate your destiny, consume you it will



CSE331 Winter 2014

8

## God classes

*god class*: a class that hoards much of the data or functionality of a system

- Poor cohesion – little thought about why all the elements are placed together
- Reduces coupling but only by collapsing multiple modules into one (which replaces dependences between modules with dependences within a module)

A god class is an example of an *anti-pattern*: a known bad way of doing things

CSE331 Winter 2014

9

## Cohesion again...

Methods should do one thing well:

- Compute a value but let client decide what to do with it
- Observe or mutate, don't do both
- Don't print as a side effect of some other operation

Don't limit future possible uses of the method by having it do multiple, not-necessarily-related things

"Flag" variables are often a symptom of poor method cohesion

CSE331 Winter 2014

10

## Method design

Effective Java (EJ) Tip #40: Design method signatures carefully

- Avoid long parameter lists
- Perlis: "If you have a procedure with ten parameters, you probably missed some."
- Especially error-prone if parameters are all the same type
- Avoid methods that take lots of Boolean "flag" parameters

EJ Tip #41: Use overloading judiciously

Can be useful, but avoid overloading with same number of parameters, and think about whether methods really are related

CSE331 Winter 2014

11

## Field design

A variable should be made into a field if and only if:

- It is part of the inherent internal state of the object
- It has a value that retains meaning throughout the object's life
- Its state must persist past the end of any one public method

All other variables can and should be local to the methods in which they are used

- Fields should not be used to avoid parameter passing
- Not every constructor parameter needs to be a field

Exception to the rule: Certain cases where overriding is needed

- Example: `Thread.run`

CSE331 Winter 2014

12

## Constructor design

---

Constructors should take all arguments necessary to initialize the object's state – no more, no less

Object should be completely initialized after constructor is done (i.e., the rep invariant should hold)

Shouldn't need to call other methods to "finish" initialization

## Good names

---

EJ Tip #56: Adhere to generally accepted naming conventions

- Class names: generally nouns
  - Beware "verb + er" names, e.g. **Manager**, **Scheduler**, **ShapeDisplayer**
- Interface names often –able/-ible adjectives:  
**Iterable**, **Comparable**, ...
- Method names: noun or verb phrases
  - Nouns for observers: **size**, **totalSales**
  - Verbs+noun for observers: **getX**, **isX**, **hasX**
  - Verbs for mutators: **move**, **append**
  - Verbs+noun for mutators: **setX**
  - Choose affirmative, positive names over negative ones  
**isSafe** not **isUnsafe**  
**isEmpty** not **hasNoElements**

## Bad names

---

**count**, **flag**, **status**, **compute**, **check**, **value**, **pointer**, names starting with **my**...  
– Convey no useful information

Describe what is being counted, what the "flag" indicates, etc.

**numberOfStudents**, **isCourseFull**, **calculatePayroll**, **validateWebForm**, ...

But short names in local contexts are good:

Good: `for (i = 0; i < size; i++) items[i]=0;`

Bad: `for (theLoopCounter = 0; theLoopCounter < theCollectionSize; theLoopCounter++) theCollectionItems [theLoopCounter]=0;`

## Class design ideals

---

Cohesion and coupling, already discussed

*Completeness*: Every class should present a complete interface

*Consistency*: In names, param/returns, ordering, and behavior

## Completeness

---

Include *important* methods to make a class easy to use

Counterexamples:

- A mutable collection with **add** but no **remove**
- A tool object with a **setHighlighted** method to select it, but no **setUnhighlighted** method to deselect it
- **Date** class with no date-arithmetic operations

Also:

- Objects that have a natural ordering should implement **Comparable**
- Objects that might have duplicates should implement **equals** (and therefore **hashCode**)
- Most objects should implement **toString**

## But...

---

*Don't* include everything you can possibly think of

- If you include it, you're stuck with it forever (even if almost nobody ever uses it)

Tricky balancing act: include what's useful, but don't make things overly complicated

- You can always add it later if you really need it

"Everything should be made as simple as possible, but not simpler."

- Einstein

## Consistency

---

A class or interface should have consistent names, parameters/returns, ordering, and behavior

Use similar naming; accept parameters in the same order

Counterexamples:

```
setFirst(int index, String value)
setLast(String value, int index)

Date/GregorianCalendar use 0-based months

String methods: equalsIgnoreCase,
                compareToIgnoreCase;
                but regionMatches(boolean ignoreCase)

String.length(), array.length, collection.size()
```

CSE331 Winter 2014

19

## Open-Closed Principle

---

Software entities should be *open for extension*, but closed for modification

- When features are added to your system, do so by adding new classes or reusing existing ones in new ways
- If possible, don't make changes by modifying existing ones – existing code works and changing it can introduce bugs and errors.

Related: Code to interfaces, not to classes

Example: accept a `List` parameter, not `ArrayList` or `LinkedList`

EJ Tip #52: Refer to objects by their interfaces

CSE331 Winter 2014

20

## Documenting a class

---

Keep internal and external documentation separate

External: `/** ... */` Javadoc for classes, interfaces, methods

- Describes things that clients need to know about the class
- Should be specific enough to exclude unacceptable implementations, but general enough to allow for all correct implementations
- Includes all pre/postconditions, etc.

Internal: `//` comments inside method bodies

- Describes details of how the code is implemented
- Information that clients wouldn't and shouldn't need, but a fellow developer working on this class would want – invariants and internal pre/post conditions especially

CSE331 Winter 2014

21

## The role of documentation From Kernighan and Plauger

---

- If a program is incorrect, it matters little what the docs say
- If documentation does not agree with the code, it is not worth much
- Consequently, code must largely document itself. If not, rewrite the code rather than increasing the documentation of the existing complex code. Good code needs fewer comments than bad code.
- Comments should provide additional information from the code itself. They should not echo the code.
- Mnemonic variable names and labels, and a layout that emphasizes logical structure, help make a program “self-documenting”

CSE331 Winter 2014

22

## Enums help document

---

Consider use of `enums`, even with only two values – which of the following is better?

```
oven.setTemp(97, true);
oven.setTemp(97, Temperature.CELSIUS);
```

CSE331 Winter 2014

23

## Choosing types – some hints

---

Numbers: Favor `int` and `long` for most numeric computations

EJ Tip #48: Avoid `float` and `double` if exact answers are required

Classic example: Money (round-off is bad here)

Strings are often overused since much data is read as text

CSE331 Winter 2014

24

## Independence of views

---

- Confine user interaction to a core set of “view” classes and isolate these from the classes that maintain the key system data
- Do not put print statements in your core classes
  - This locks your code into a text representation
  - Makes it less useful if the client wants a GUI, a web app, etc.
- Instead, have your core classes return data that can be displayed by the view classes
  - Which of the following is better?

```
public void printMyself()  
public String toString()
```

## Last thoughts (for now)

---

- Always remember your reader
  - Who are they?
    - Clients of your code
    - Other programmers working with the code
      - (including yourself in 3 weeks/months/years)
  - What do they need to know?
    - How to use it (clients)
    - How it works, but more important, *why* it was done this way (implementers)
- Read/reread style and design advice regularly
- Keep practicing – mastery takes time and experience
- You’ll always be learning. Keep looking for better ways to do things!