CPS 108
Software Design and Implementation

Owen Astrachan

http://www.cs.duke.edu/courses(cps108/current
What is Computer Science?

What is it that distinguishes it from the separate subjects with which it is related? What is the linking thread which gathers these disparate branches into a single discipline? My answer to these questions is simple --- *it is the art of programming a computer*. It is the art of designing efficient and elegant methods of getting a computer to solve problems, theoretical or practical, small or large, simple or complex.

C.A.R. (Tony) Hoare
CPS 108, Fall 2001

● Software Design and Implementation
  ➢ Object oriented programming and design
    • good design helps do away with late night Teer-fests, but some late nights are inevitable
    • your toolkit must include mastery of language/programming and design

● What’s in the course?
  ➢ C++ and Java, team projects, mastery exams
    • team projects can be more and less than the sum of their parts
  ➢ high-level abstractions, low-level details
    • patterns, heuristics, and idioms
Program Design and Implementation

- **Language independent principles of design and programming**
  - **design heuristics**
    - coupling, cohesion, small functions, small interfaces ...  
  - **design patterns**
    - factories, adapter, MVC aka observer/observable, ...

- **Language specific:**
  - **Idioms**
    - smart pointers, vectors/arrays, overloaded operators ...
  - **idiosyncracies, idiocies**
    - must define virtual destructor, stream zoo in Java, ...
Administrivia

- check website and news regularly
  - duke.cs.cps108

- Grading (see web pages)
  - group projects: small, medium, large
  - mastery programs (solo or semi-solo endeavors)
  - readings and summaries
  - tests

- Evaluating team projects, role of TA, UTA, consultants
  - face-to-face evaluation, early feedback

- Compiling, tools, environments, Linux, Windows
  - g++ 2.95, Java 2 aka 1.4 (or 1.3), JRE, ...
C++ idioms/general concepts

- **Genericity**
  - Templates, STL, containers, algorithms
- **Copy/Assignment/Memory**
  - Deep copy model, memory management “required”
- **Low-level structures**
  - C-style arrays and strings compared to STL, Tapestry
- **const**
  - Good for clients, bad for designers/coders?
- **From C to C++ to Java**
  - function pointers, function objects, inheritance
From C++ to Java

- **Java history**: Oak, toaster-ovens, internet language, panacea
  - Not really a standard language like C++
  - Arguably proprietary (and arguably not)
  - Precursor to C#?

- **What it is**
  - O-O language, not a hybrid (like C++)
  - Compiled to byte-code, executed on JVM
  - Byte-code is “highly-portable”, write once run “anywhere”
    - Simple, object-oriented, portable, interpreted, robust, secure,
      architecture-neutral, distributed, dynamic, multithreaded,
      high performance
Classes: Review/Overview

- **A class encapsulates state and behavior**
  - Behavior first when designing a class
  - Information hiding: who knows state/behavior?

- **State is private/protected; some behavior is public**
  - Private/protected helper functions
  - A class is called an *object factory*, creates lots of instances

- **Classes communicate and collaborate**
  - Parameters: send and receive
  - Containment: has a reference to
  - Inheritance: is-a
C++ (and Java) class construction

- **C++ uses .h and .cpp, Java uses .java**
  - Documentation different (javadoc vs. ???)

- **Default, overloaded, copy constructor**
  - tvector, string, Date
  - Default constructor needed in C++, where?
  - Copy constructor needed to avoid shallow copy
  - In C++ destructors needed to free resources/self, Java?
  - Clone makes copy in Java (rare), share is default

- **Private, protected, public, (package)**
  - Private default in C++, package default in Java
  - Per method declaration in Java, class sections in C++
Design Criteria

*Good design comes from experience, experience comes from bad design*

Fred Brooks (or Henry Petroski)

- **Design with goals:**
  - ease of use
  - portability
  - ease of re-use
  - efficiency
  - first to market
  - ??????
How to code

- Coding/Implementation goals:
  - Make it run
  - Make it right
  - Make it fast
  - Make it small

- Spiral design (or RAD or Waterfall or ...)
  - What’s the design methodology?
XP and Refactoring

*See books by Kent Beck (XP) and Martin Fowler (refactoring)*

- **eXtreme Programming (XP) is a lightweight design process**
  - Communication: unit tests, pair programming, estimation
  - Simplicity: what is the simplest approach that works?
  - Feedback: system and clients; programs and stories
  - Courage: throw code away, dare to be great/different

- **Refactoring**
  - Change internal structure without changing observable behavior
  - Don’t worry (too much) about upfront design
  - Simplicity over flexibility (see XP)
Design Heuristics: class/program/function

(see text by Arthur Riel)

● **Coupling**
  - classes/modules are independent of each other
  - goal: minimal, loose coupling
  - do classes collaborate and/or communicate?

● **Cohesion**
  - classes/modules capture one abstraction/model
  - keep things as simple as possible, but no simpler
  - goal: strong cohesion (avoid kitchen sink)

● **The open/closed principle**
  - classes/programs: open to extensibility, closed to modification
Stories

- Who is Shawn Fanning and what did he do (19 years old)?
- Who is Marc Andreessen and what did he do (21 years old)?
- Who is Claude Shannon and what did he do (21 years old)?
- Who is Linus Torvalds and what did he do (21 years old)?
- Who is Dmitry Sklyarov and what did he do (26 years old)?
- Who is Tim Berners-Lee and what did he do (35 years old)?
- Who is Kary Mullis and what did he do (39 years old)?
What’s hard about itoa (or atoi)?

- What’s the naïve way of coding itoa?
  - Performance implications?
  - Alternatives?
  - What does the standard do?

- What’s the naïve way of coding atoi?
  - Where can problems happen?
  - What are choices for dealing with them?
  - What does the standard do?

- What will you do?
Tapestry classes -> STL

- **What’s the difference between tvector and vector**
  - Safety and the kitchen sink
    - What happens with t[21] on a 21-element vector?
    - Part of STL means crufty code (whose viewpoint?)
  - What about Java analog?

- **Differences in wordlines.cpp and tapwordlines.cpp**
  - Map compared to tmap, what other kinds of maps?
  - Sets and vectors, which is easier to use?

- **Anything not clear in either program? Are these programs object-oriented?**