CPS 108, Spring 2004

- **Software Design and Implementation**
  - **Object oriented programming and design**
    - Language independent concepts including design patterns, e.g., Model-View-Controller, iterator, factory, bridge, …
    - Design independent concepts, e.g., coupling, cohesion, testing, refactoring, profiling, …

- **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

Application Programming Interface, API

- Standard C++ headers, STL headers
  - Curses
  - wxWindows
- Java API
  - java.util, javax.swing, java.net, javax.crypto, …
  - Eclipse SWT
- Google API
- Gracenote API

Program Design and Implementation

- **Language independent principles of design and programming**
  - **design heuristics**
    - coupling, cohesion, small functions, small interfaces ...
  - **design patterns**
    - factories, adapter, MVC, decorator, iterator, …
- **Language specific:**
  - **Idioms**
    - smart pointers, vectors/arrays, overloaded operators ...
  - **idiosyncracies, idiocies**
    - must define virtual destructor, stream zoo in Java, ...

Administrivia

- check website and bulletin board regularly
  - `http://www.cs.duke.edu/courses/cps108/current/`
  - See links to bulletin board and other stuff
- 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, Mac
  - g++ 3.3, Java 2 aka 1.4, JRE, …

wordlines.cpp, understanding code

```
typedef map<string, set<int> > linemap;

while (getline(input,line)) {

    linecount++;
    istringstream iline(line);
    while (iline >> w) {
        linemap::iterator it = info.find(w);
        if (it == info.end()) {
            set<int> si;
            si.insert(linecount);
            info.insert(make_pair(w,si));
        }
        else {
            it->second.insert(linecount);
        }
    }
}
```

Questions about wordlines.cpp

- Conceptually, what's a map and what's a set?
- In terms of implementation how do they work?
- What's an iterator (abstractly and concretely)
- What are streams? ifstream, cin/cout, istring/ostring, …
- What's a templated class?
- Other questions?

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 ctor, copy constructor, destructor, assignment operator
  - tvector, string, Date
  - 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

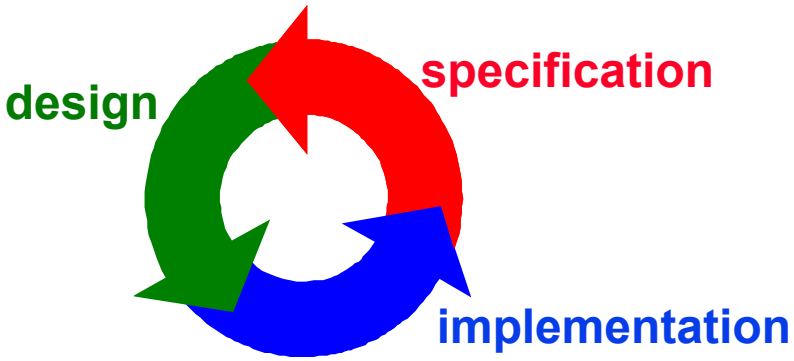
Good design comes from experience, experience comes from bad design

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 an *agile* 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)**

Modules, design, coding, refactor, XP

- Make it run, make it right, make it fast, make it small
- Do the simplest thing that can possibly work (XP)
  - Design so that refactoring is possible
  - Don't lose sight of where you're going, keep change in mind, but not as the driving force [it will evolve]

- Refactor: functionality doesn't change, code does
  - Should mean that new tests aren't written, just re-run
  - Depends on modularity of code, testing in pieces

- What's a module in C++
  - Could be a class, a file, a directory, a library, a namespace
  - We should, at least, use classes, files, directories

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

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

Standard Libraries

- In C++ there is the *Standard Library*, formerly known as the *Standard Template Library* or *STL*
  - Emphasizes generic programming (using templates)
  - Write a sorting routine, the implementation depends on
    - Elements being comparable
    - Elements being assignable

  We should be able to write a routine not specific to int, string or any other type, but to a generic type that supports being comparable/assignable
- In C++ a templated function/class is a code-factory, generates code specific to a type at compile time
  - Arguably hard to use and unsafe

Eric Raymond

- Open source evangelist
  - The Cathedral and the Bazaar

http://ot.op.org/cathedral-bazaar.html

  - How to construct software

"Good programmers know what to write. Great ones know what to rewrite (and reuse)."

- How to convince someone that guns are a good idea? Put this sign up:

- THIS HOME IS A GUN-FREE ZONE