CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2004
Doc 2 Design Pattern Intro
Contents

References

Patterns for Classroom Education, Dana Anthony, pp. 391-406, *Pattern Languages of Program Design 2*, Addison Wesley, 1996

A Pattern Language, Christopher Alexander, 1977

Software Patterns, James Coplien, 1996, 2000, http://www1.bell-labs.com/user/cope/Patterns/WhitePaper/

Design Patterns: Elements of Reusable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, 1995

Reading

Design Patterns chapter 1.

Design Patterns

What is a Pattern?

"Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice"

"Each pattern is a three-part rule, which expresses a relation between a certain context, a problem, and a solution"

Christopher Alexander on architecture patterns

"Patterns are not a complete design method; they capture important practices of existing methods and practices uncodified by conventional methods"

James Coplien

Examples of Patterns
A Place To Wait[1]

The process of waiting has inherent conflicts in it.

Waiting for doctor, airplane etc. requires spending time hanging around doing nothing

Can not enjoy the time since you do not know when you must leave

Classic "waiting room"
- Dreary little room
- People staring at each other
- Reading a few old magazines
- Offers no solution

Fundamental problem
- How to spend time "wholeheartedly" and
- Still be on hand when doctor, airplane etc arrive

Fuse the waiting with other activity that keeps them in earshot
- Playground beside Pediatrics Clinic
- Horseshoe pit next to terrace where people waited

Allow the person to become still meditative
- A window seat that looks down on a street
- A protected seat in a garden
- A dark place and a glass of beer
- A private seat by a fish tank

[1] Alexander 1977, pp. 707-711

A Place To Wait

Therefore:

"In places where people end up waiting create a situation which makes the waiting positive. Fuse the waiting with some other activity - newspaper, coffee, pool tables, horseshoes; something which draws people in who are not simple waiting. And also the opposite: make a place which can draw a person waiting into a reverie; quiet; a positive silence"

Chicken And Egg[2]

Problem

Two concepts are each a prerequisite of the other

To understand A one must understand B

To understand B one must understand A

A "chicken and egg" situation

Constraints and Forces

First explain A then B

- Everyone would be confused by the end

Simplify each concept to the point of incorrectness to explain the other one

- People don't like being lied to

Solution

Explain A & B correctly by superficially

Iterate your explanations with more detail each iteration

[2] Anthony 1996

Benefits of Software Patterns

By providing domain expertise patterns

- Reduce time to find solutions
- Avoid problems from inexpert design decisions

Patterns reduce time to design applications

- Patterns are design chunks larger than objects

Patterns reduce the time needed to understand a design

Common Forms For Writing Design Patterns

Alexander - Originated pattern literature

GOF (Gang of Four) - Style used in Design Patterns text

Portland Form -Form used in on-line Portland Pattern Repository

http://c2.com/cgi/wiki?PortlandPatternRepository

Coplien

Design Principle 1

Program to an interface, not an implementation

Use abstract classes (and/or interfaces in Java) to define common interfaces for a set of classes

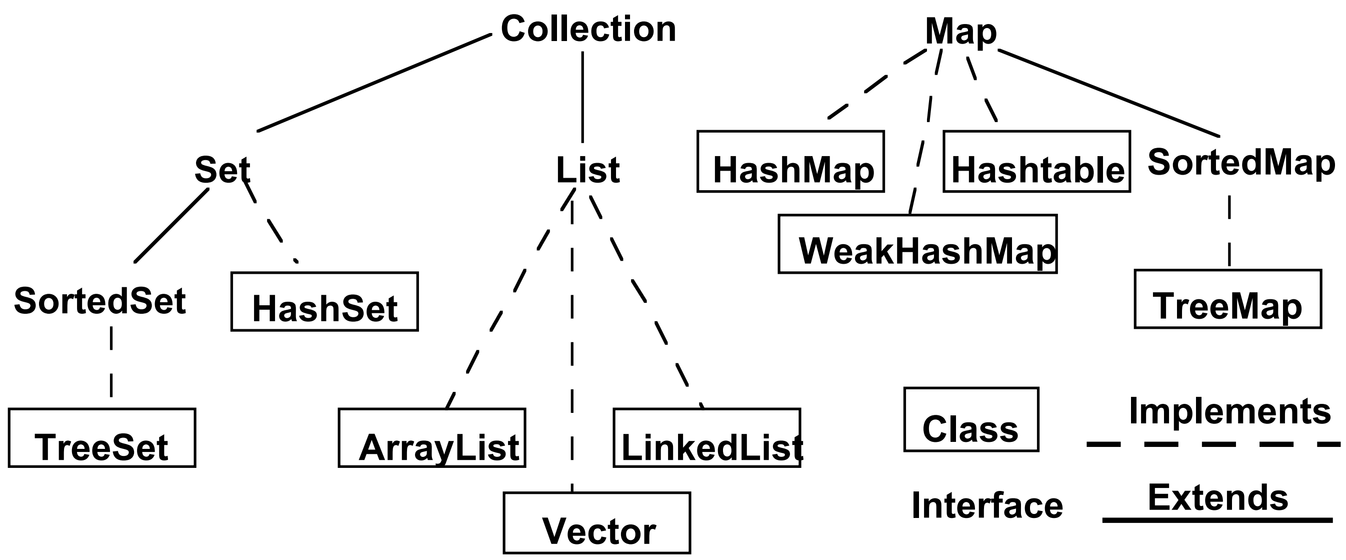
Declare variables to be instances of the abstract class not instances of particular classes

Benefits of programming to an interface

Client classes/objects remain unaware of the classes of objects they use, as long as the objects adhere to the interface the client expects

Client classes/objects remain unaware of the classes that implement these objects. Clients only know about the abstract classes (or interfaces) that define the interface.

Programming to an Interface
Java Collections



```
Collection students = new XXX;
students.add( aStudent);
```

students can be any collection type

We can change our mind on what type to use

Design Principle 2

Favor object composition over class inheritance

Composition
- Allows behavior changes at run time
- Helps keep classes encapsulated and focused on one task
- Reduce implementation dependencies

Inheritance

```
class A {
   Foo x
   public int complexOperation() { blah }
}

class B extends A {
   public void bar() { blah}
}
```

Composition

```
class B {
   A myA;
   public int complexOperation() {
      return myA.complexOperation()
   }

   public void bar() { blah}
}
```

Parameterized Types

Generics in Ada, Eiffel, Java (jdk 1.5)
Templates in C++

Allows you to make a type as a parameter to a method or class

```
template <class TypeX>
TypeX min(  TypeX a, Type b )
   {
   return a < b ? a  :  b;
   }
```

Parameterized types give a third way to compose behavior in an object-oriented system

Designing for Change

Some common design problems that GoF patterns that address

• Creating an object by specifying a class explicitly

Abstract factory, Factory Method, Prototype

• Dependence on specific operations

Chain of Responsibility, Command

• Dependence on hardware and software platforms

Abstract factory, Bridge

• Dependence on object representations or implementations

Abstract factory, Bridge, Memento, Proxy

• Algorithmic dependencies

Builder, Iterator, Strategy, Template Method, Visitor

• Tight Coupling

Abstract factory, Bridge, Chain of Responsibility, Command, Facade, Mediator, Observer

• Extending functionality by subclassing

Bridge, Chain of Responsibility, Composite, Decorator, Observer, Strategy

• Inability to alter classes conveniently

Adapter, Decorator, Visitor