Design Patterns

Agenda - Design Patterns

- What is a design pattern
- Motivation for patterns
- Pattern Categories
- Pattern Examples

Patterns Overview

- Patterns support reuse of software architecture and design.
- Patterns capture the static and dynamic structures and collaborations of successful solutions to problems that arise when building applications.

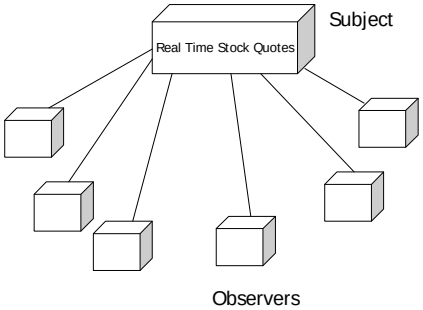
Motivation for Patterns

- Developing software is hard
- Developing reusable software is even harder
- Patterns provide proven solutions
- Patterns can be reused in design

Becoming a software designer

- First learn the rules
  - Algorithms, data structures and languages
- Then learn the principles
  - Structured design, OO design
- However to truly master software design, you must study the design of masters
  - These designs have patterns to be understood, remembered and re-used

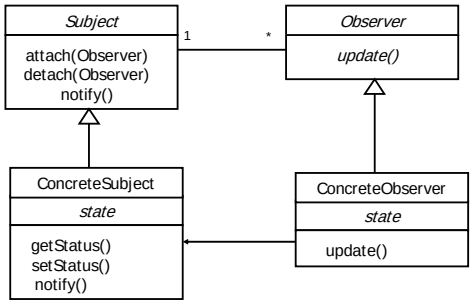
Design Pattern – example stock quote service



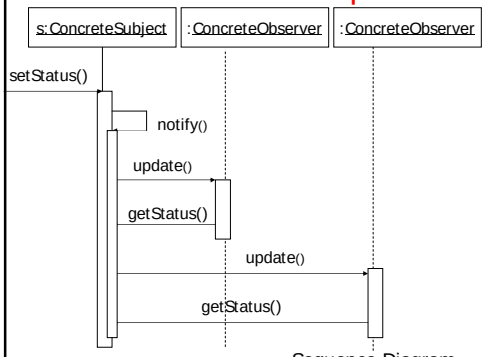
Observer Pattern

- Intent
  - Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically.
- Key forces
  - There may be many observers
  - Each observer may react differently to same notification
  - Subjects should be decoupled as much as possible from the observer to allow observers to change independently.

Observer Pattern – Class diagram



Observer Pattern – sequence diagram



Sequence Diagram

Pattern Template

- Pattern Name and Classification
  - A good , concise name for the pattern and the pattern's type
- Intent
  - Short statement about what the pattern does
- Also Known As
  - Other names for the pattern
- Motivation
  - A scenario that illustrates where the pattern would be useful
- Applicability
  - Situations where the pattern can be used

Pattern Template (cont'd)

- Structure
  - A graphical representation of the pattern
- Participants
  - The classes and objects participating in the pattern
- Collaborations
  - How to do the participants interact to carry out their responsibilities?
- Consequences
  - What are the pros and cons of using the pattern?
- Implementation
  - Hints and techniques for implementing the pattern

Pattern Template (cont'd)

- Sample Code
  - Code fragments for a sample implementation
- Known Uses
  - Examples of the pattern in real systems
- Related Patterns
  - Other patterns that are closely related to the pattern

Pattern Types

- Creational Patterns
  - Deal with initializing and configuring classes and objects.
- Structural Patterns
  - Deal with decoupling interface and implementation of classes and objects.
- Behavioural Patterns
  - Deal with dynamic interactions among societies of classes and objects.

Creational Patterns

- Singleton
  - Factory for a singular (sole) instance
- Factory Method
  - Method in a derived class creates associates
- Builder
  - Factory for building complex objects incrementally.
- Prototype
  - Factory for cloning new instances from a prototype

Singleton

- Pattern Name and Classification
  - Singleton
- Intent
  - Ensure a class only has one instance, and provide a global point of access to it.
- Motivation
  - There are times when a class can only have one instance.

Singleton

- Applicability
  - there must be only one instance of a class, and it must be accessible to clients from a well-known access point
  - when the sole instance should be extensible by subclassing, and clients should be able to use an extended instance without modifying their code.

Singleton

```
class Singleton {
      private static Singleton _instance = null;
      private Singleton()     {
              //fill in the blank
      }

      public static Singleton getInstance() {
           if ( _instance == null )
                _instance = new Singleton();
           return _instance;
      }
      public void otherOperations() {    }
}
```


Singleton

```
class TestSingleton {

    public void method1(){
              X = Singleton.getInstance();
    }


    public void method2(){
              Y = Singleton.getInstance();
    }

}
```

Structural Patterns

- Adapter
  - Translator adapts a server interface for a client
- Bridge
  - Abstraction for binding one of many implementations
- Composite
  - Structure for building recursive aggregations
- Decorator
  - Decorator extends an object transparently

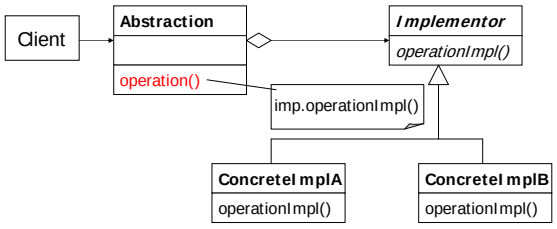
Bridge

- Pattern Name and Classification
  - Bridge
- Intent
  - Decoupling the interface from implementation
- Motivation
  - Used to hide the implementation from the client. Avoid permanent binding between the client and implementation.

Bridge

- Applicability
  - Avoid a permanent binding between an abstraction and its implementation
  - both the abstractions and their implementations should be independently extensible by subclassing
  - changes in the implementation of an abstraction should have no impact on the clients; that is, their code should not have to be recompiled
  - you want to hide the implementation of an abstraction completely from clients (users)

Bridge



Behavioural Patterns

- State
  - An object whose behaviour depends on state
- Observer
  - Dependents update automatically when a subject changes
- Iterator
  - Aggregate elements are accessed sequentially

When to use patterns

- Solutions to problems that recur with variations.
  - No need to reuse if the problem occurs only once.
- Solutions that require several steps.
  - Not all problems need all steps
  - Patterns can be an overkill is problems have simple solutions.