Intro to Design Patterns / Singleton

Comp-304 : Intro to Design Patterns / Singleton
Lecture 21

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Origins of Design Patterns

- In the 1970, an architect named Christopher Alexander started to question himself about design.
  - How do I now if an architecture design is good?
- Alexander proposed that there was an objective way of measuring quality of design.
- He studied the architecture of many cities (buildings, streets, parks, etc).
- He discovered that, although each architecture is different, they can still be considered high quality.

Front Porch

A solution to a problem

- Two porches may appear structurally different, and yet they may still be considered of high quality.
  - One porch might be a simple transition from the front yard to the front door.
  - Another might also be a resting area.
- However, they both solve of common problem of transition.
- By comparing two items that solve a common problem, on can identify similarities between the designs that are of high quality.
- Alexander called these similarities Patterns.

Gang of Four

- In 1987, Kent Beck and Ward Cunningham began experimenting with Design Patterns.
- They believed that this idea of patterns as solutions to common problems could be used with software.
- In 1994, Erich Gamme, Richard Helm, Ralph Johnson and John Vlissides published Design Patterns: Elements of Reusable Object-Oriented Software.
- This book, also known as the Design Pattern bible, helped Design Patterns gain popularity with the Computer Science community.
- In recognition for their important work, the four authors are known as the gang of four.

What are Patterns?

"A pattern for software architecture describes a particular recurring design problem that arises in specific design contexts and presents a well-proven generic scheme for its solution. The solution scheme is specified by describing its constituent components, their responsibilities and relationships, and the ways in which they collaborate." [Buschmann].

- Patterns are a solution to a problem in a context.
- Patterns are not invented, they are derived from practical experience.
- Patterns are construction blocks, to be used to solve complex problems.
- Patterns can be used as a vocabulary to communicate.

Why use Patterns?

- Because Patterns are well tested and well proven solution to common problems.
  - They have been successfully used in the past.
  - They are a form of code reuse.
- Patterns are to Design what Libraries are to Software.

Components of a Design Pattern

- Name
  - Each pattern has an assigned name so it can be easily recognized.
  - This gives us the vocabulary we can use to discuss design.
- Problem
  - Each pattern is design to address to a specific problem.
  - Some also have conditions before the pattern can be used.
- Solution
  - Each pattern provides a solution to a problem.
  - Components of that solution are also known as Participants.
- Consequence
  - They are the results and trade-off of using design patterns.

Types of Design Patterns

- Creational Patterns
  - These patterns abstract the instantiation process.
  - They make the system independent of how objects are created, composed and represented.
- Structural Patterns
  - These patterns are concerned with how classes and objects are composed to form larger structures.
  - These structures are use to provide new functionalities
- Behavioral Patterns
  - These patterns are concerned with algorithms and the assignment of responsibility between objects.
  - They describe the communication between objects.

The Book

- The Design Patterns book is a catalog of design patterns.
- When faced with a design pattern, one should:
  - Browse the catalog to determine if a particular design pattern solves this pattern.
  - If so, before implementing the solution,
    - Carefully identify the various participants of the problems.
    - Study thoroughly the appropriate section in the book, particularity the consequence and implementation section.

Didn't I do this before?

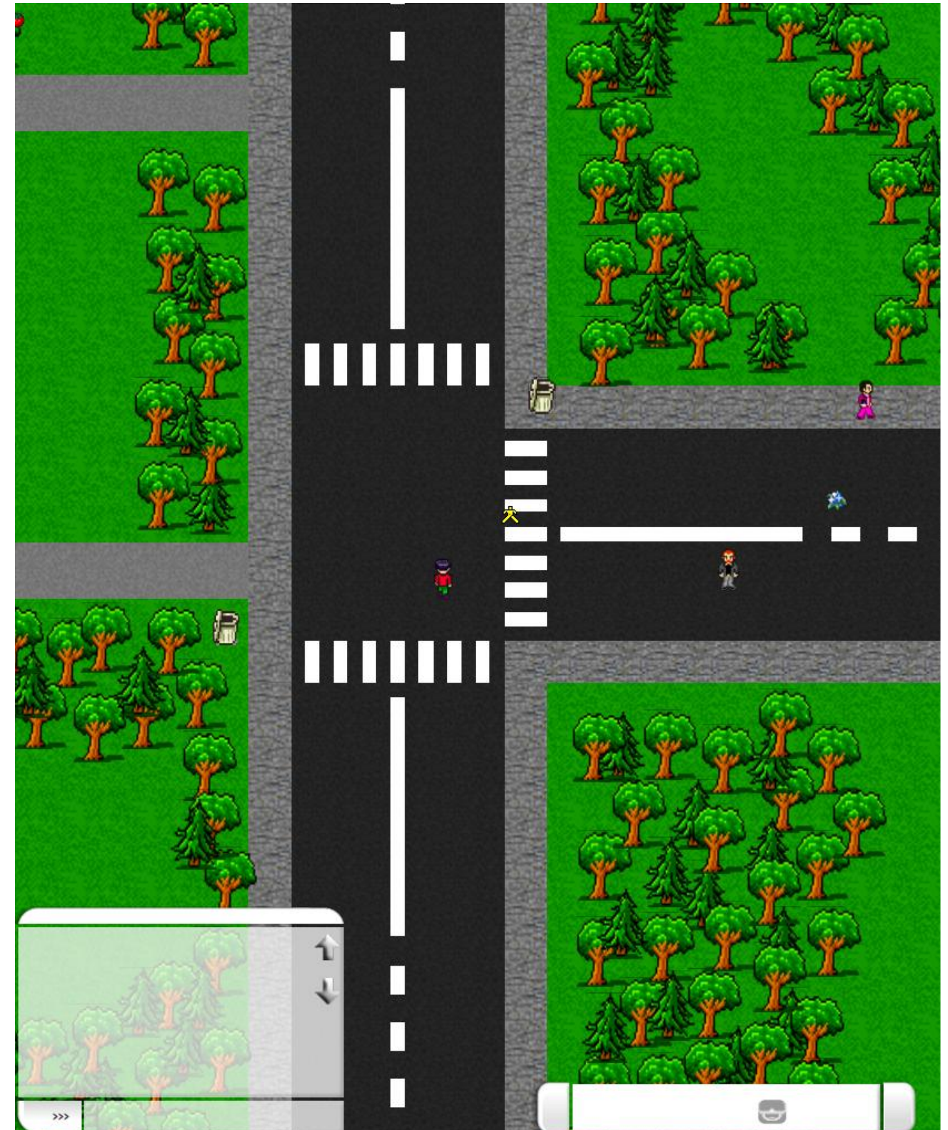
- The material you will see in Design Patterns is not new.
- Some of you might have been using this stuff for years.
- That's the whole point.
- It's a catalog of good design.
- If you have already been using a Pattern, then
  - You now have an official name for it.
  - You know it good design.
  - You might gain a few new incites on how to use it.

Just a few example?

- Command
- Adapter
- Proxy
- Composite
- Observer
- Template Method
- Visitor
- Factory

Mammoth

- Mammoth is a massively multiplayer game research framework.
- The world of Mammoth is a 2D environment viewed from a 2D perspective.
- The world contains a fixed number of game objects, some of which can be controlled by humans (players).
- A player can move around in the game, examine objects, pick them up, and drop them again.



IDs?

- Each object in the world (player, items, grass, etc) has a unique Id associated to it.
- How do I distribute Ids, making sure that I never distribute a duplicate one?

ID Distributor

- Mammoth uses unique identifiers (ID) to identify all the Game objects in the world.
- These IDs are distributed by a single object.
  - If more than one distributor were used, duplicate IDs could be distributed.
- The application needs global access to this distributor.
  - It would be very complicated/ugly to pass around the reference to the distributor all around the application.

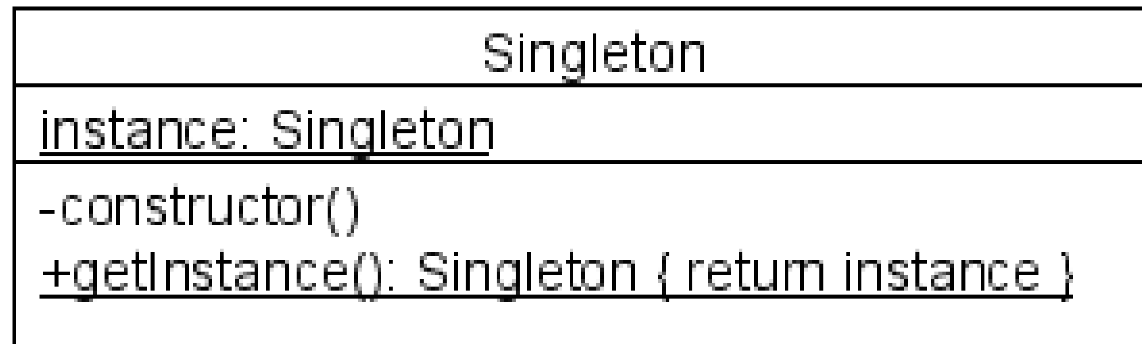
Problem

- We need to make sure that only <u>one</u> instance of a class can be created.
- We want that instance to be easy to access anywhere in the application.

Singleton

- Ensure a class only has one instance, and provide a global point of access to it.

Class Diagram



Code Structure

```
public class Singleton {

   private static Singleton instance = new Singleton();

   private Singleton() { }

   public static Singleton getInstance() {
      return Singleton.instance;
   }
}
```

Consequences

- You are assured that only one instance can be created.
  - Global access to that instance without the use of a global variable (less pollution)
- Can be modified to allow a fix number of instances.
- Singletons can be sub-classed.

ID Distributor Example

```
public class IdDistributor {

    private static IdDistributor instance = new
        IdDistributor();
    private long lastId;

    private IdDistributor() {
        this.lastId = -1;
    }

    public static IdDistributor getInstance() {
        return IdDistributor.instance;
    }

    public long getId() {
        this.lastId++;
        return this.lastId;
    }
}
```

Lazy Initialization

```
public class Singleton {

    private static Singleton instance;

    private Singleton() { }

    public static Singleton getInstance() {
        if (Singleton.instance == null) {
            Singleton.instance = new Singleton()
        }

        return Singleton.instance;
    }
}
```

Lazy Initialization (Better)

```
public class Singleton {

   private static Singleton instance;

   private Singleton() { }

   public static synchronized Singleton getInstance() {
      if (Singleton.instance == null) {
         Singleton.instance = new Singleton()
      }

      return Singleton.instance;
   }
}
```