CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2009
Doc 18 Singleton & Abstract Factory
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References

Design Patterns: Elements of Resuable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, Addison-Wesley, 1995, pp. 87-96, 107-116, 127-134

When is a Singleton not a Singleton, Joshua Fox, January 2001, http://java.sun.com/developer/technicalArticles/Programming/singletons/

http://en.wikipedia.org/wiki/Abstract_factory_pattern

http://en.wikipedia.org/wiki/Singleton_pattern

The "Double-Checked Locking is Broken" Declaration, http://www.cs.umd.edu/~pugh/java/memoryModel/DoubleCheckedLocking.html

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Singleton

```
public class Counter {
      private int count = 0;
      private static Counter instance;
      private Counter() { }

      public static Counter instance() {
            if (instance == null)
                  instance = new Counter();
            return instance();
      }

      public int increase()  {return ++count;}
}
```

One instance

Global access

This version does not work correctly all the time. See later slides

Globals are Evil

Some Uses

Java Security Manager

Logging a Server

Null Object

Why Not Use This?

```
public class Counter {
        private static int count = 0;

        public static int increase()  {return ++count;}
}
```

Why Not Use This?

```
public class Counter {
        private int count = 0;
        private Counter() { }

        public static Counter instance = new Counter();

        public int increase()  {return ++count;}
}
```


Very subtle the error here

Recommended Implementation

```
public class Counter {
        private int count = 0;
        protected Counter() { }

        private static class SingletonHolder {
           private final static Counter INSTANCE = new Counter();
        }

        public static Counter instance() {
                return SingletonHolder.INSTANCE;
        }

        public int increase()  {return ++count;}
}
```


Implementation due to Bill Pugh, found in Wikipedia, http://en.wikipedia.org/wiki/Singleton_pattern. It is thread-safe, lazy and works with all know versions of Java

Correct but not Lazy

```
public class Counter {
        private int count = 0;
        protected Counter() { }

        private final static Counter INSTANCE = new Counter();

        public static Counter instance() {
                return INSTANCE;
        }

        public int increase()  {return ++count;}
}
```

Lazy, Threadsafe with Overhead

```
public class Counter {
        private int count = 0;
        private static Counter instance;
        private Counter() { }

        public static synchronized Counter instance() {
                if (instance == null)
                        instance = new Counter();
                return instance();
        }

        public int increase()  {return ++count;}
}
```

Double-Checked Locking does not work

```
public class Counter {
        private int count = 0;
        private static Counter instance;
        private Counter() { }

        public static Counter instance() {
                if (instance == null)
                        synchronize(this) {
                                if (instance == null)
                                        instance = new Counter();
                        }
                return instance();
        }

        public int increase()  {return ++count;}
}
```


See http://www.cs.umd.edu/~pugh/java/memoryModel/DoubleCheckedLocking.html

Ruby Singleton

```
class Counter
    private_class_method :new
    @@instance = nil

    def Counter.instance
        @@instance = new unless @@instance
        @@instance
    end

    def increase
        @count = 0 unless @count
        @count = @count + 1
        @count
    end
end
```

```
require 'singleton'

class Counter
   include Singleton

    def increase
        @count = 0 unless @count
        @count = @count + 1
        @count
    end
end
```

Why Not Use This?

```
class Counter
    @@instance = nil

    def Counter.new()
        if @@instance.nil?
            @@instance = super
        end
        @@instance
    end

    def increase
        @count = 0 unless @count
        @count = @count + 1
        @count
    end
end
```

```
x = Counter.new();
puts x.increase
puts x.increase
y = Counter.new()
puts y.increase
```

Output

```
1
2
3
```

When is a Singleton not a Singleton?

When Java Garbage Collects Classes

Singleton class can be garbage collected
Singleton loses any value it had

Solution

Turn off garbage collection of classes (-Xnoclassgc)

Make sure there is always a reference to the class/instance

When Multiple Java Class Loaders are Used

When loaded by two different class loaders there will be two versions of the class

Some servlet engines use different class loader for each servlet

Using custom class loaders can cause this

Purposely Reloading a Java Class

Servlet engines can force a class to be reloaded

Serialize and Deserialize Singleton Object

Serialize the singleton

Deserialize the singleton

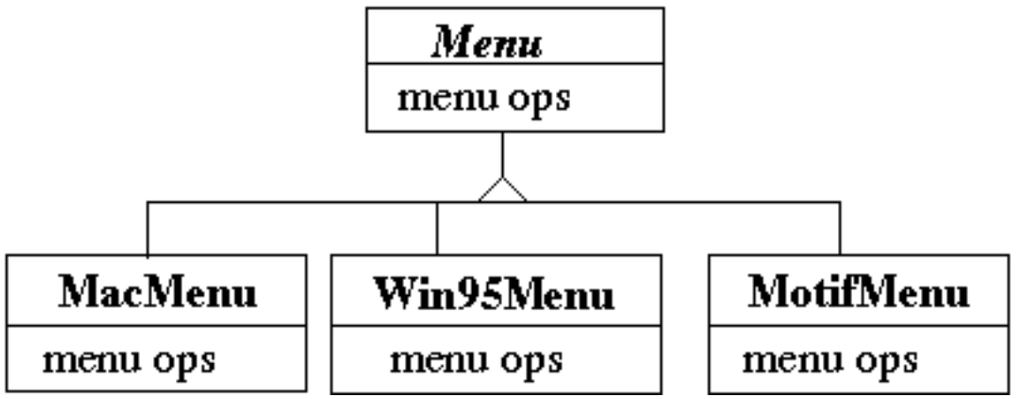
You now have two copies

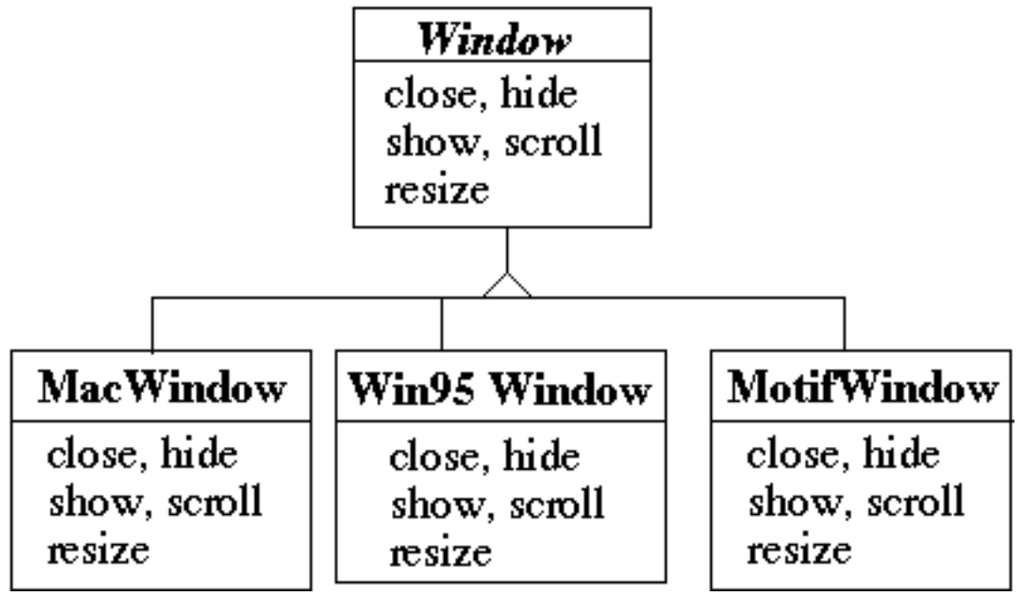
One way to serialize a Java object is using ObjectOutputStream

Ruby Marshal.dump() will not marshal a singleton

Abstract Factory

Write a cross platform window toolkit





Bad Code Dependencies

```
public void installDisneyMenu()
        {
        Menu disney = new MacMenu();
        disney.addItem( "Disney World" );
        disney.addItem( "Donald Duck" );
        disney.addItem( "Mickey Mouse" );
        disney.addGrayBar( );
        disney.addItem( "Minnie Mouse" );
        disney.addItem( "Pluto" );
        etc.
        }
```

Use Abstract Factory

```
abstract class WidgetFactory {
        public Window createWindow();
        public Menu createMenu();
        public Button createButton();
        }
```

```
class MacWidgetFactory extends WidgetFactory {
        public Window createWindow()
                { code to create a mac window }

        public Menu createMenu()
                { code to create a mac Menu }

        public Button createButton()
                { code to create a mac button }
}

class Win95WidgetFactory extends WidgetFactory {
        public Window createWindow()
                { code to create a Win95 window }

        public Menu createMenu()
                { code to create a Win95 Menu }

        public Button createButton()
                { code to create a Win95 button }
}
```

Use one Factory per Application

```
public void installDisneyMenu(WidgetFactory myFactory)
      {
      Menu disney = myFactory.createMenu();
      disney.addItem( "Disney World" );
      disney.addItem( "Donald Duck" );
      disney.addItem( "Mickey Mouse" );
      disney.addGrayBar( );
      disney.addItem( "Minnie Mouse" );
      disney.addItem( "Pluto" );
      etc.
      }
```

Abstract Factory

Encapsulate a group of individual factories that have a common theme

Separates the details of implementation of a set of objects from its general usage

How Do Abstract Factories create Things?

Use Subclass Factory Method

```
abstract class WidgetFactory
        {
        public Window createWindow();
        public Menu createMenu();
        public Button createButton();
        }

class MacWidgetFactory extends WidgetFactory
        {
        public Window createWindow()
                { return new MacWidow() }

        public Menu createMenu()
                { return new MacMenu() }

        public Button createButton()
                { return new MacButton()  }
        }
```

Use Widget Factory Method

```
abstract class WidgetFactory {
        private Window windowFactory;
        private Menu menuFactory;
        private Button buttonFactory;

        public Window createWindow()
                { return windowFactory.createWindow() }

        public Menu createMenu();
                { return menuFactory.createMenu() }

        public Button createButton()
                { return buttonFactory.createMenu() }
}
```

```
class MacWidgetFactory extends WidgetFactory {
        public MacWidgetFactory() {
                windowFactory = new MacWindow();
                menuFactory = new MacMenu();
                buttonFactory = new MacButton();
        }
}
```

```
class MacWindow extends Window {
        public Window createWindow() { blah }
        etc.
```

Why Widget Factory Method?

```
abstract class WidgetFactory {
        private Window windowFactory;
        private Menu menuFactory;
        private Button buttonFactory;

        public Window createWindow()
                { return windowFactory.createWindow() }

        public Window createWindow( Rectangle size)
                { return windowFactory.createWindow( size ) }

        public Window createWindow( Rectangle size, String title)
                { return windowFactory.createWindow( size, title) }

        public Window createFancyWindow()
                { return windowFactory.createFancyWindow() }

        public Window createPlainWindow()
                { return windowFactory.createPlainWindow() }
```

Multiple ways to create Widget

Use Prototype

```
class WidgetFactory{
        private Window windowPrototype;
        private Menu menuPrototype;
        private Button buttonPrototype;

        public WidgetFactory( Window windowPrototype,
                                        Menu menuPrototype,
                                        Button buttonPrototype)
                {
                this.windowPrototype = windowPrototype;
                this.menuPrototype = menuPrototype;
                this.buttonPrototype = buttonPrototype;
                }

public Window createWindow()
        { return windowPrototype.createWindow() }

public Window createWindow( Rectangle size)
        { return windowPrototype.createWindow( size ) }

public Window createMenu()
        { return menuPrototype.createMenu() }
etc.
```

How to prevent Cheating?

```
public void installDisneyMenu(WidgetFactory myFactory)
    {
    // We ship next week, I can't get the stupid generic Menu
    // to do the fancy Mac menu stuff
    // Windows version won't ship for 6 months
    // Will fix this later

    MacMenu disney = (MacMenu) myFactory.createMenu();
    disney.addItem( "Disney World" );
    disney.addItem( "Donald Duck" );
    disney.addItem( "Mickey Mouse" );
    disney.addMacGrayBar( );
    disney.addItem( "Minnie Mouse" );
    disney.addItem( "Pluto" );
    etc.
    }
```