

CMSC 433 – Programming Language Technologies and Paradigms Spring 2007

Singleton Pattern
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What is it?

- If you need to make sure that there can be one and only one instance of a class.
 - For example, your system can have only one window manager or print spooler, or a single point of access to a database engine.

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Approach 1

- Embed a static variable inside the class that we set on the first instance and check for each time we enter the constructor.
 - A static variable is one for which there is only one instance, no matter how many instances there are of the class.
 - `static boolean instance_flag = false;`

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Disadvantage of Approach 1

- How to find out whether creating an instance was successful or not
 - Remember constructors do not return values.
- One way would be to call a method that checks for the success of creation, and which simply returns some value derived from the static variable.
 - This is inelegant and prone to error
 - because there is nothing to keep you from creating many instances of such non-functional classes and forgetting to check for this error condition.

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Approach 2

- Create a class that throws an Exception when it is instantiated more than once.

– Let's create our own exception class for this case

```
class SingletonException extends RuntimeException
{
    //new exception type for singleton classes
    public SingletonException()
    {
        super();
    }
    //-----
    public SingletonException(String s)
    {
        super(s);
    }
}
```

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Why a New Exception?

- This new exception type doesn't do anything in particular
 - other than calling its parent classes through the super() method.
- However, it is convenient to have our own named exception type so that the compiler will warn us of the type of exception we must catch when we attempt to create an instance

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Lets Implement the Class

```
class PrintSpooler
{
    //this is a prototype for a printer-spooler class
    //such that only one instance can ever exist
    static boolean
        instance_flag=false; //true if 1 instance

    public PrintSpooler() throws SingletonException
    {
        if (instance_flag)
            throw new SingletonException("Only one spooler allowed");
        else
            instance_flag = true; //set flag for 1 instance
            System.out.println("spooler opened");
    }
    //-----
    public void finalize()
    {
        instance_flag = false; //clear if destroyed
    }
}
```

Lets Use it!

```
public class singleSpooler
{
    static public void main(String argv[])
    {
        PrintSpooler pr1, pr2;

        //open one spooler--this should always work
        System.out.println("Opening one spooler");
        try{
            pr1 = new PrintSpooler();
        }
        catch (SingletonException e)
        {System.out.println(e.getMessage());}

        //try to open another spooler --should fail
        System.out.println("Opening two spoolers");
        try{
            pr2 = new PrintSpooler();
        }
        catch (SingletonException e)
        {System.out.println(e.getMessage());}
    }
}
```

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Disadvantage of Approach 2

- Must enclose every method that may throw an exception in a try - catch block.
- And the exception-based solution is not really “transparent”

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Approach 3

- There already is a kind of Singleton class in the standard Java class libraries: the Math class.
 - This is a class that is declared final and all methods are declared static, meaning that the class cannot be extended.
 - The purpose of the Math class is to wrap a number of common mathematical functions such as sin and log in a class-like structure, since the Java language does not support functions that are not methods in a class.
- You can't create any instance of classes like Math, and can only call the static methods directly in the existing final class.
- You can use the same approach to a Singleton pattern, making it a final class.

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Approach 3

```
final class PrintSpooler
{
    //a static class implementation of Singleton pattern
    static public void print(String s)
    {
        System.out.println(s);
    }
}
//=====
public class staticPrint
{
    public static void main(String argv[])
    {
        Printer.print("here it is");
    }
}
```

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Disadvantage of Approach 3

- Difficult to drop the restrictions of Singleton status
 - a lot of reprogramming to do to make the static approach allow multiple instances
- this is easier to do in the exception style class structure

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Approach 4

- Create Singletons using a static method to issue and keep track of instances.
- To prevent instantiating the class more than once, make the constructor private so an instance can only be created from within the static method of the class

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```
class iSpooler
{
    //this is a prototype for a printer-spooler class
    //such that only one instance can ever exist
    static boolean instance_flag = false; //true if 1 instance

    //the constructor is privatized-
    //but need not have any content
    private iSpooler() { }
    //static Instance method returns one instance or null
    static public iSpooler Instance()
    {
        if (! instance_flag)
        {
            instance_flag = true;
            return new iSpooler(); //only callable from within
        }
        else
            return null; //return no further instances
    }
    //-----
    public void finalize()
    {
        instance_flag = false;
    }
}
```

Approach 4

- Don't have to worry about exception handling if the singleton already exists-- you simply get a null return from the Instance method

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Lets Use it!

```
iSpooler pr1, pr2;
//open one spooler--this should always work
System.out.println("Opening one spooler");
pr1 = iSpooler.Instance();
if(pr1 != null)
    System.out.println("got 1 spooler");
//try to open another spooler --should fail
System.out.println("Opening two spoolers");

pr2 = iSpooler.Instance();
if(pr2 == null)
    System.out.println("no instance available");
```

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Compile-time Error Checking

- should you try to create instances of the iSpooler class directly, this will fail at compile time because the constructor has been declared as private.

```
//fails at compile time because constructor is privatized  
iSpooler pr3 = new iSpooler();
```

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Approach 5

```
public class Singleton {  
    // Private constructor suppresses generation  
    // of a (public) default constructor  
    private Singleton() {}  
  
    private static class SingletonHolder {  
        private static Singleton instance = new Singleton();  
    }  
  
    public static Singleton getInstance() {  
        return SingletonHolder.instance;  
    }  
}
```

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Dropping the Singleton Requirement

- Suddenly, we decide that we can allow “n” instances of the (previously) Singleton object
- How would you adapt each of the previous five approaches?
 - Which implementation is “maintainable”?

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