

CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2005
Doc 7 Singleton
Contents

Singleton	3
Intent.....	3
Motivation	3
Applicability	3
Implementation	5
Java.....	5
C++.....	7
Smalltalk.....	8
Singletons and Static.....	11
Consequences	12
Questions for Thought.....	13

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References

Design Patterns: Elements of Reusable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, 1995, pp. 127-134

The Design Patterns Smalltalk Companion, Alpert, Brown, Woolf, Addison-Wesley, 1998, pp. 91-101

Singleton Intent

Insure 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

Applicability

Use the Singleton pattern when

- 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

Examples of Using a Singleton

Java Security manager

All parts of a program must access the same security manager

Once set a security manager cannot be changed in a program

Logging the activity of a server

All parts of the server should use the same instance of the logging system

The server should not be able to change the instance of the logging system was it has been set

Null Object

If Null object does not have state, only need one instance

Implementation Java

```
// Only one object of this class can be created  
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() { blank; }
```

```
}
```

```
class Program
```

```
{
```

```
    public void aMethod()
```

```
    {
```

```
        X = Singleton.getInstance();
```

```
    }
```

```
}
```

Java Singletons, Classes, Garbage Collection

Classes can be garbage collected in Java

Only happens when there are

- No references to instances of the class
- No references to the class

If a singleton's state is modified and its class is garbage collected, its modified state is lost

To avoid having singletons garbage collected:

- Disable class garbage collection with `-Xnoclassgc` flag
- Insure singleton or class always has a reference

Store singleton or class in system property

Implementation C++

```
// Only one object of this class can be created
class Singleton
{
private:
    static Singleton* _instance;
    void otherOperations();

protected:
    Singleton();

public:
    static Singleton* getInstance();
}
```

```
Singleton* Singleton::_instance = 0;
```

```
Singleton* Singleton::getInstance()
{
    if ( _instance == 0 )
        _instance = new Singleton;
    return _instance;
}
```

Implementation Smalltalk

```
Smalltalk.CS635 defineClass: #SingletonExample
  superclass: #{Core.Object}
  indexedType: #none
  private: false
  instanceVariableNames: "
  classInstanceVariableNames: 'uniqueInstance '
  imports: "
  category: 'Lecture notes'!
```

CS635.SingletonExample class methodsFor: 'instance creation'

current

```
uniqueInstance isNil ifTrue:[uniqueInstance := super new].
^uniqueInstance
```

new

```
self error: 'Use current to get an instance of Class: ', self name
```

One could also use a private constant shared variable to store the unique instance

Overriding new in Smalltalk

Since can control what new returns one might be tempted to use:

```
new
  uniqueInstance isNil ifTrue:[uniqueInstance := super new].
  ^uniqueInstance
```

This can be misleading; user might think they are getting different objects when calling new

Do we have two different windows below or not?

```
| left right |
left := SingleWindow new.
Right := SingleWindow new.
left position: 100@ 100.
right position: 500@100.
```

Naming the Access Method

GOF uses: **instance()**

POSA 1 uses: **getInstance()**

Smalltalk uses **default** and **current**

Selecting names is one of the more difficult problems in object-oriented analysis. No name is perfect¹

¹ Fowler pp. 9, Alpert pp. 98

Singletons and Static

If one needs only one instance of a class why not just implement all methods as static?

- Classes do not inherit Object's protocol
- Hard to modify design if need more than one instance
- Builds bad habits in beginners

Consequences

- Controlled access to sole instance
- Reduced name space
- Permits subclassing
- Permits a variable number of instances
- More flexible than class operations
- Leads to improper use of globals

Questions for Thought

A number of patterns seem to violate basic design principles. For example the Singleton does provide for global access. Most programmers at least will state that one should not use globals. Yet the Singleton allows one to create and use globals in a program.

1. Go through the design patterns and determine which patterns violate which basic design principles.
2. How does one justify the patterns violating the basic design principles?