CS 351
Design of Large Programs
Singleton Pattern

September 29, 2021

Global State??

The Notion of a Singleton

There are many objects we only need one of:

- Thread pools, caches, dialog boxes, logging objects, device drivers, etc.
- In many cases, instantiating more than one of such objects creates all kinds of problems
  - incorrect program behavior
  - resource overuse
  - inconsistent results

The Notion of a Singleton

- We could just use global (static) variables
- The Singleton pattern gives all of the upsides without the downsides
  e.g., object isn't forced to be created when the application starts
- Basically, the Singleton is used anytime you want a set of objects in the application to use the same global resource

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public class MyClass {
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- Who can use such a private constructor?
  Only code within `MyClass`

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- How would you fill out the implementation to make sure that only a single instance of `MyClass` is ever created?

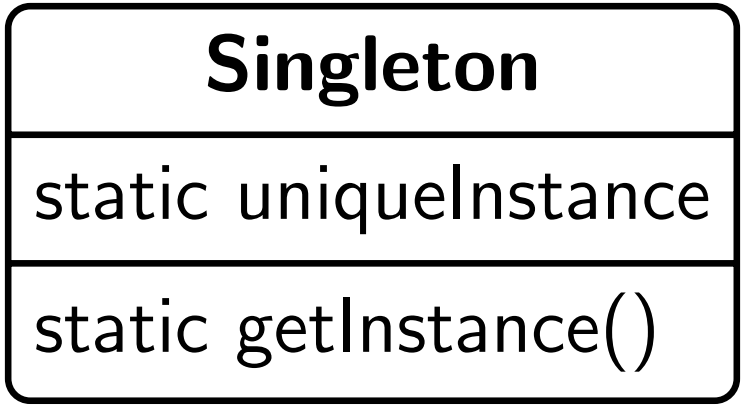
The Classic Singleton

```
public class Singleton {
  private static Singleton uniqueInstance;

  // additional instance variables

  private Singleton() {}

  public static Singleton getInstance() {
    if (uniqueInstance == null) {
      uniqueInstance = new Singleton();
    }
    return uniqueInstance;
  }

  // additional methods

}
```

The Singleton Pattern

The Singleton Pattern ensures a class has only one instance and provides a global point of access to that instance.

The Singleton Class Diagram



We have a problem...

- The Singleton pattern, as we have implemented it, is not *thread safe*
- When multiple threads invoke the `getInstance()` method, multiple instances of the object may be created!

Possible solution

- One simple solution is to use eager instantiation instead of lazy instantiation

```
public class Singleton {
  private static Singleton uniqueInstance =
      new Singleton();

  private Singleton() {}
  public static Singleton getInstance() {
    return uniqueInstance;
  }
}
```

- We will need to return to this when we study concurrent programming!

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  - Using the Singleton pattern instead allows for complex initialization (especially if that initialization involves other classes and objects)
  - Without the Singleton pattern, you can still implement these things, but the result are common "order of initialization" bugs that are hard to pin down
- Why can't you subclass a Singleton?
  - You can't extend a class with a private constructor
  - All of the derived classes share the same static variable "instance"

When To Use a Singleton?

Very few problems warrant the use of singletons If your problem has the following three properties then you MAY want to use singletons

1. There can only be one object
2. Object controls concurrent access to a shared resource (i.e. database)
3. Access to the resource will be necessary in seperate parts of the system

Another good rule of thumb is if you are only sending data to a shared object and no data is coming back out then a singleton might be appropriate (i.e. logging)