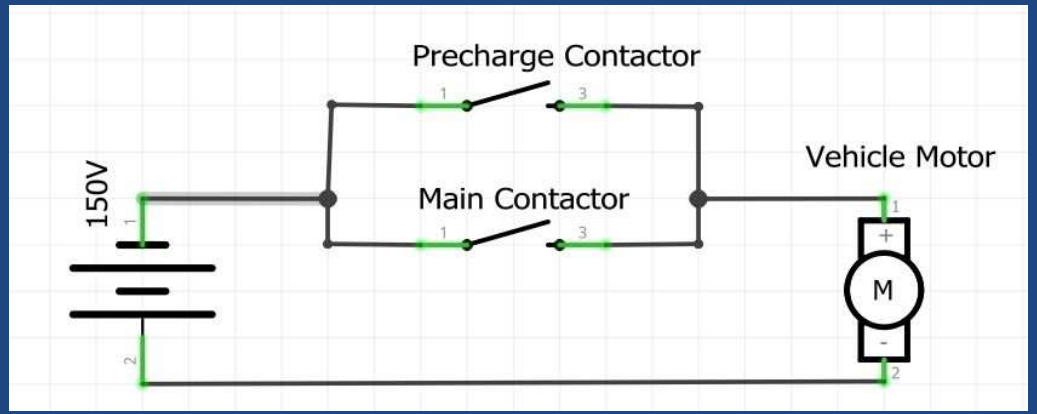
Pattern / Anti-pattern: Singleton

Topics

1) How can we:
   a) Create just one instance of a class?
   b) Allow all the code to share access to an object?
   c) Allow lazy initialization?
   d) Tightly couple all our code to one class

Motivation

- Sometimes, it's critical that only one instance of a class exists
  - Ex: Logger, DB Connector, Thread pool, Launch control timer...
- Ex: Battery Contactor Controller (BCC)
  - Hardware to control power to an electric vehicle's motor
  - Software must control hardware carefully



Battery Contactor Controller (BCC)

Constructor
- check hardware connection & turn off (open) contactor
- *requires hardware sub-system to initialize first.*

StartPreCharge()
- Precharge contactor on for 10s, then turn on main contactor;
- Prevents voltage spike frying the system.

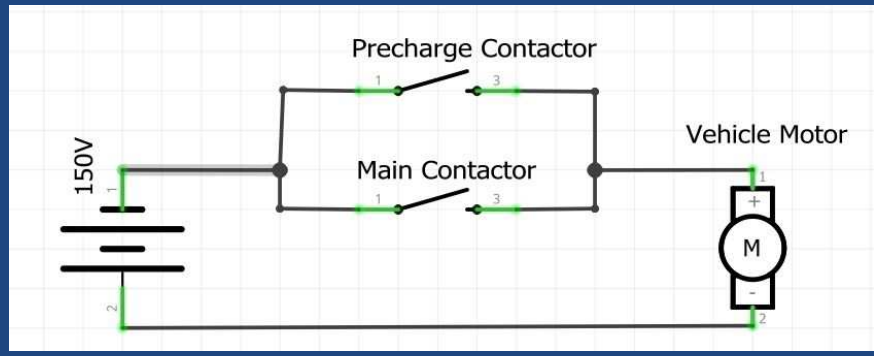
- turnOn() closes main contactor;
- turnOff() opens both contactors

Safety mode
- Disables (opens) both contactors

```
class BCC {

    public BCC() {
        // Check HW
        // Set to Off
    }

    .. startPreCharge();
    .. turnOn();
    .. turnOff();
    .. activateSaftey();
}
```



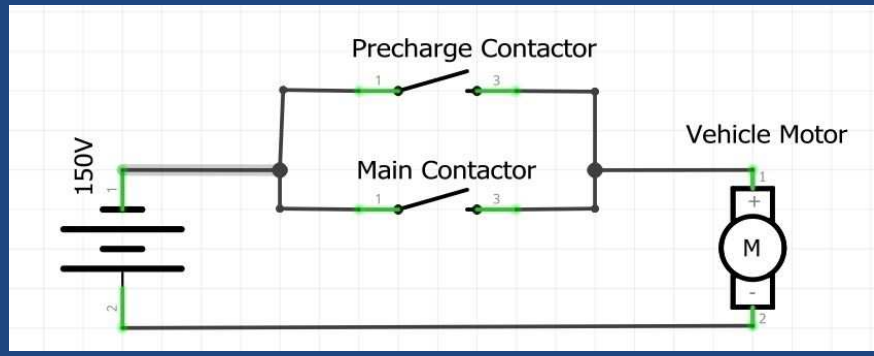
Analysis of BCC

- What happen if more >1 BCC?
  - Constructor of 2nd would turn off contactors, interrupting whatever was happening 1st
  - Turing 1st "on" while 2nd pre-charging could damage hardware
  - Activating safety mode on 1st object irrelevant with 2nd!
- ..

```
class BCC {

    public BCC() {
        // Check HW
        // Set to Off
    }

    .. startPreCharge();
    .. turnOn();
    .. turnOff();
    .. activateSaftey();
}
```



Requirements of BCC

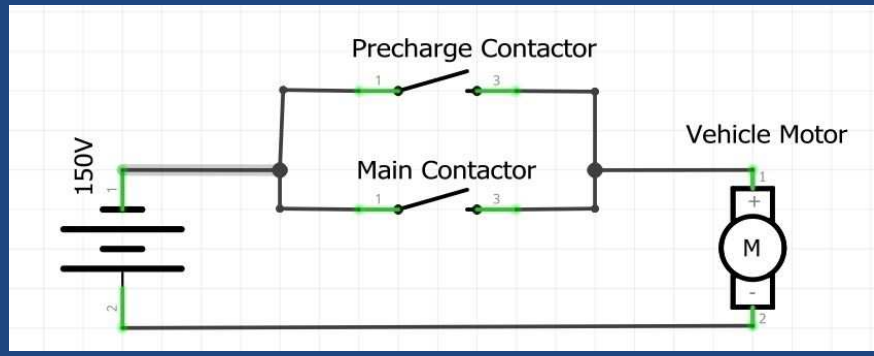
- Requirement
  - ..
  - ..
  - ..

Global access to the BCC a bad design?

```
class BCC {

    public BCC() {
        // Check HW
        // Set to Off
    }

    .. startPreCharge();
    .. turnOn();
    .. turnOff();
    .. activateSaftey();
}
```



Ideas that Don’t Work

Easy things that don’t work

- Bad idea 1: ..
  - gives everyone access to BCC
  - but..
- Bad idea 2: ..
  - everything static (static class w/ static member functions and variables)
  - ..

Requirement

1) At most one copy of BCC
2) Construction *after* other subsystems initialized
3) Any code can get access to the BCC

Singleton

Limit Construction

- new executes a constructor; ..
  - Can instantiate an object from inside the class
- Create a..

```
public class BCC {
    private static BCC instance;

    private BCC() {
        // Check HW
        // Set to Off
    }

    public static BCC getInstance() {
        if (instance == null) {
            instance = new BCC();
        }
        return instance;
    }
    public void startPreCharge() {}
    public void turnOn() {}
    public void turnOff() {}
    public void activateSaftey(){}
}
```

Singleton Pattern

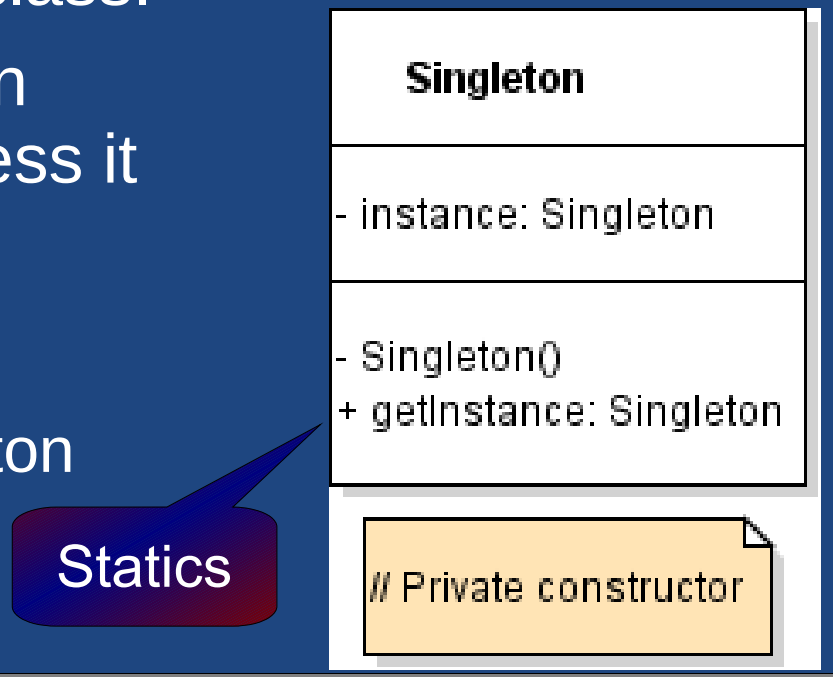
- Singleton Pattern

  ..

  - To get an instance of this class, you have to go through this class.
  - Public static method to get an instance so anyone can access it
  - Allows lazy initialization.

- Exercise

  Changed RedHeadDuck into singleton HeadFirst sample code.
  (Would not **want** to, though!)



Multi-Threaded

- What if singleton used in multithreaded application?
  - two threads enter the ==null check at once; instantiating two BCC's.
  - 1st one through gets an orphaned copy of the BCC, thus causing havoc!

```
public static BCC getInstance() {
    if (instance == null) {
        instance = new BCC();
    }
    return instance;
}
```

- Solution
  - ..
- Poor Solution
  - If not needing lazy / late initialization:
    private static instance = new BCC();
    ... getInstance() { return instance; }
  - hard to track down bugs: construction happens at application launch; and initialization order dependency.

Problems with Singletons

- Inheriting from a singleton class is problematic
  - have to make constructor protected, and then can end up with multiple of them!
- ..
  - GS makes it hard to understand the system because ..
    -- things happen outside normal flow of execution.
  - Components accessing GS ..
    (mock and driver objects)
- Google code talk on global state
  https://www.youtube.com/watch?v=-FRm3VPhseI

How to avoid globals?

- What design principle/technique can we use to avoid this?
- ..

  pass it a reference to the required “global” object(s)
  - ..
  - Testable: Client code able to select which objects it wants other code to use (good for mock’ing)
  - Explicitly force the initialization order at compile time.

Guideline

- When to use dependency injection (DI)?
  - ..
    (things that don't store the data, but process it)
    - should use Dependency Injection
  - ..
    (store data; things you'd save)
    - need not use dependency injection;
      just intantiate the object as needed

Summary

- Singleton Pattern for
  - Limit instantiation of a class to 1
  - Global access to that object
- Supports lazy initialization
- Anti-pattern: It creates global state
  - cannot test with it
  - tight coupling to all classes that use it
  - hidden dependencies