Inf2-SEPP: Lecture 13 Part 1: Design Patterns: Command, Singleton

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Previous lecture

- Design patterns
  - Introduction, cautions
  - The MVC Pattern
  - The Observer Pattern (a behavioural pattern)

This lecture

Design patterns continued

- The Command Pattern (a behavioural pattern) and the Singleton Pattern (a creational pattern)
  - The problem
  - Details
  - Benefits
  - Drawbacks

Command pattern: the problem

Context: detailed design

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E.g. Universal remote control being programmable to turn on and off various items in your home like lights, stereo, AC etc. It should be easy to change button and dial controls, and to set buttons and dials to do the same thing.

Command pattern: the problem

Naïve solutions for problem 1):

- Adding to the invoquer's implementation long lists of if-else statements standing for all possible commands, what to do, and for what receiver.
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  E.g. in a Button class: "if required to turn on AC, tell AC object . . . , if required to turn off lights tell Light object".
- Subclassing the invoquer for its use for different commands (to different receivers), interchangeable at runtime.
  E.g. ButtonACOn, ButtonLightsOff inheriting from Button

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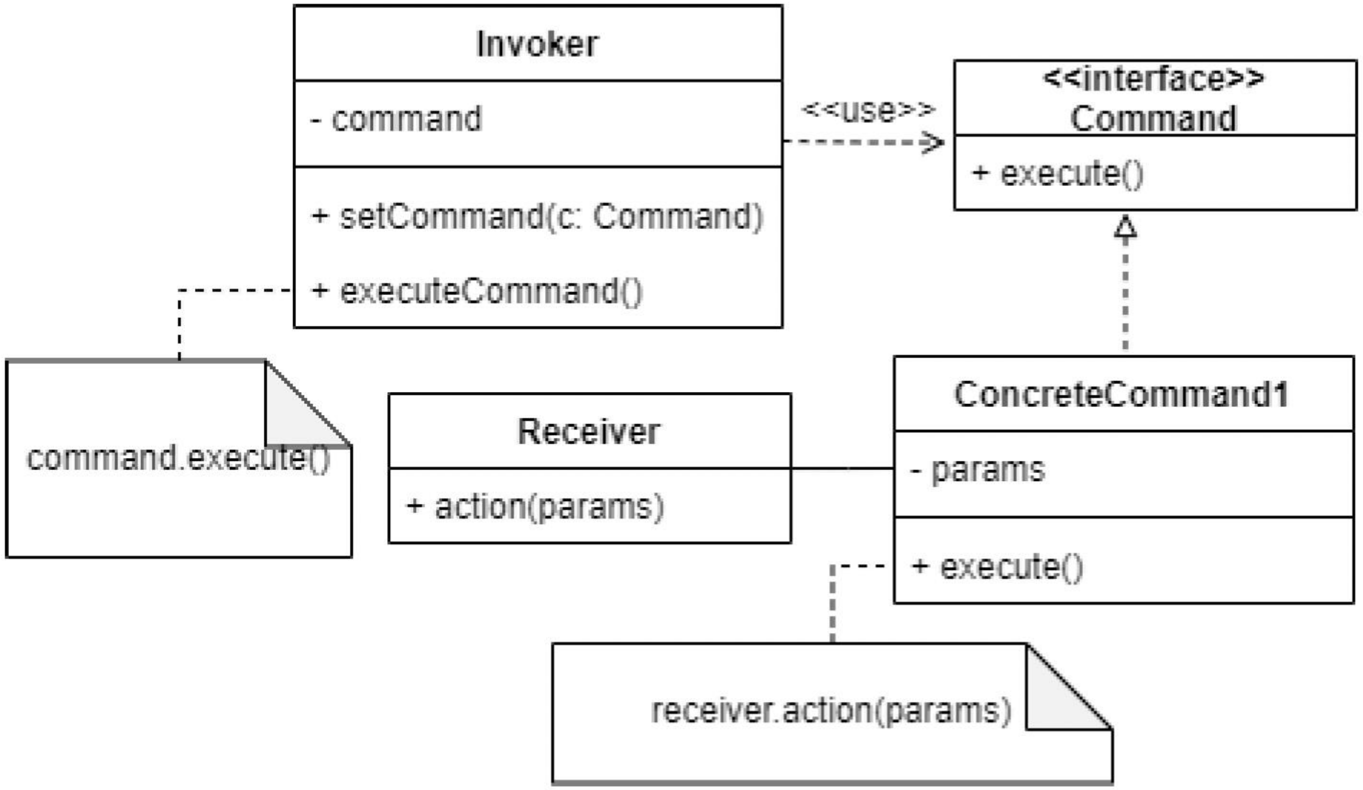
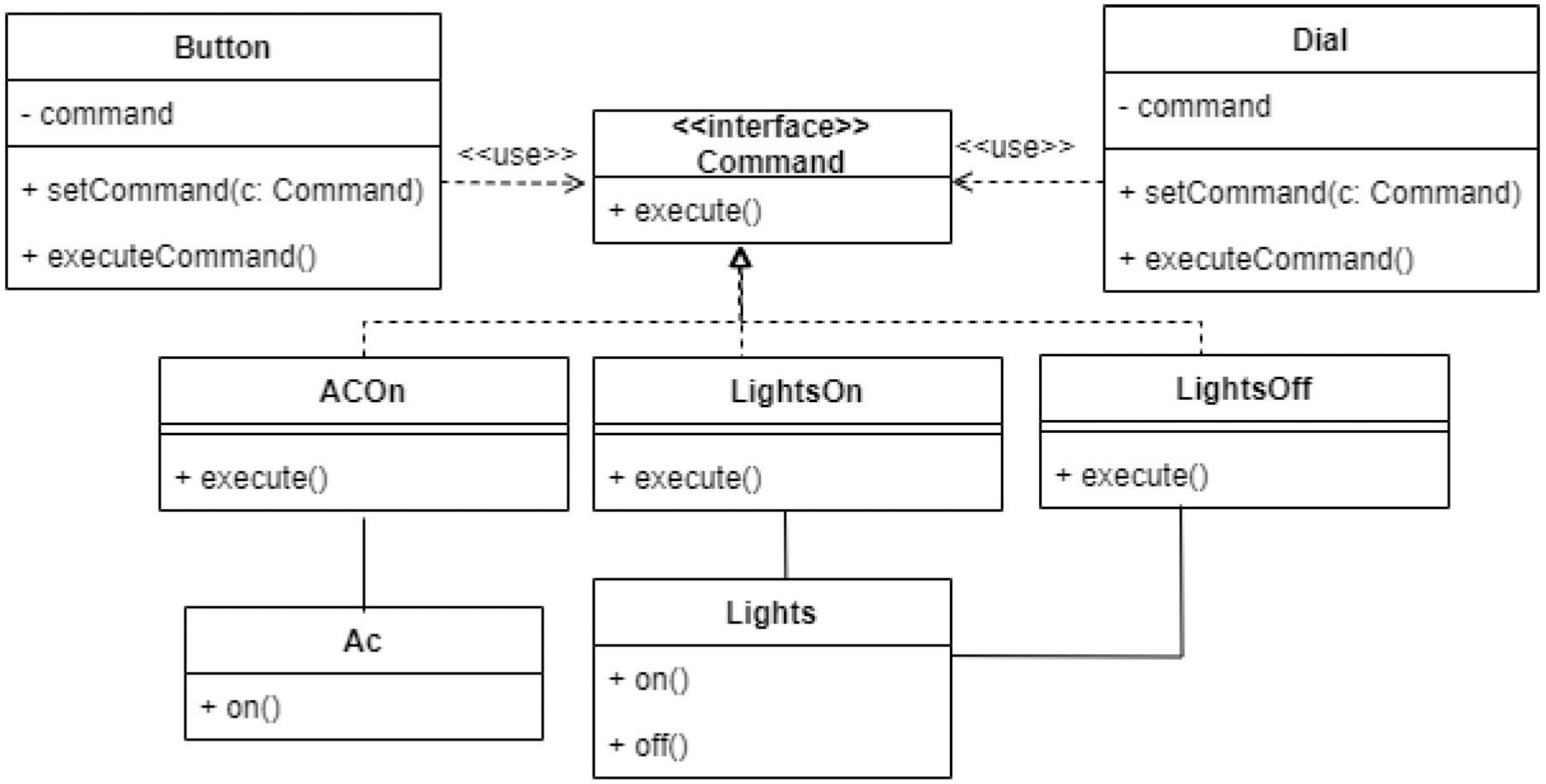
Difficult to understand (1), maintain (1, 2 if many subclasses), error prone (1, 2 especially if updating superclass); Invoquers are tightly coupled with receivers; problem 2 would only be solvable with code duplication or adding class dependencies.

Command pattern: general solution



Command pattern: solution to the example



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Disadvantage: code may become more complex due to extra layer between invoquer and receiver

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There are situations in which we want for a class to:

1. Have a single instance
2. Offer global access to it
3. Protect it from being overwritten

E.g. A single log of all all actions taken by all the entities in the system.

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The Singleton Pattern is used to address this problem. It is often used for logging, driver objects, caching, and in many other patterns.

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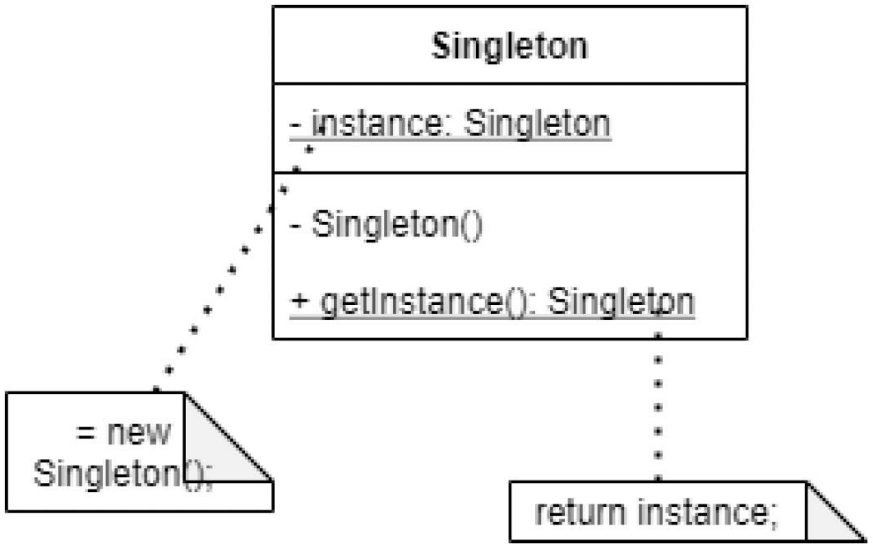
- The class offers a way to access the instance, through a static operation (getInstance()) which returns the sole instance of the class

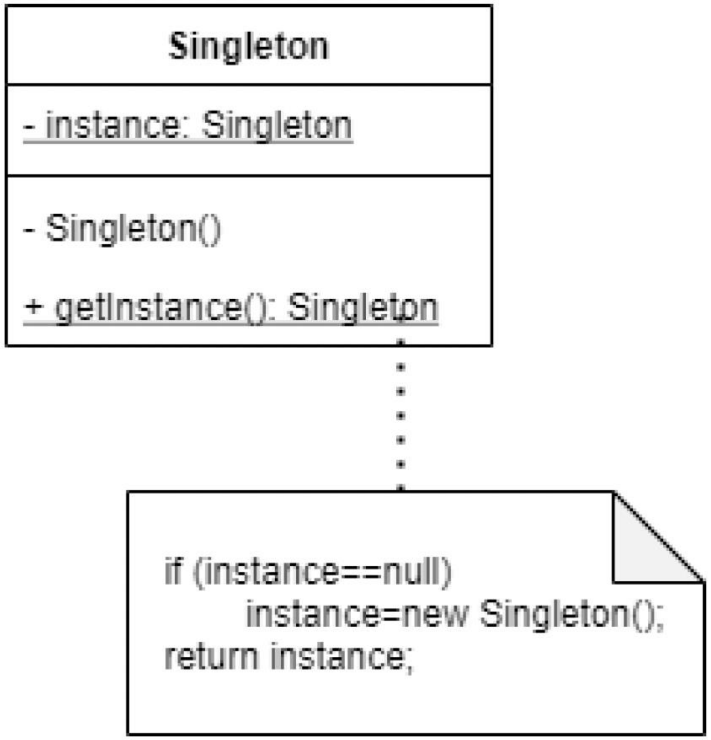
Singleton Pattern: Eager initialisation

The instance is created at first loading of the class (even if not needed).



Singleton Pattern: Lazy initialisation (for single threaded systems)

The instance is created the first time the global creation operation is called.



```
if (instance==null)
        instance=new Singleton();
return instance;
```

Singleton Pattern: Advantages and disadvantages

Advantages:

- Offers controlled global access to a sole instance of a class
- The object is initialised only once
- Preferred over global variables: avoids polluting the name space, permits lazy allocation and initialisation
- Can be easily changed to allow more instances of the class, by editing the getInstance() operation

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Disadvantages (leading some to frame it as an anti-pattern):

- It is frequently misused, adding unnecessary restrictions
- Introduces global state, potentially unsafe
- Leads to tight coupling between classes in your application
- Multiple threads may create multiple objects
- Its private constructor and static operation make it difficult to produce mock objects needed for unit testing

Resources

- **Essential: Read about the Command and Singleton patterns:**
- If you can get a copy of Gamma, E., 1995. Design patterns: elements of reusable object-oriented software. Pearson Education India: p. 263-268 "Command", p. 144-146 "Singleton"
- On the Command pattern: from Refactoring Guru and YouTube
- On the Singleton pattern: from Refactoring Guru and Wikipedia