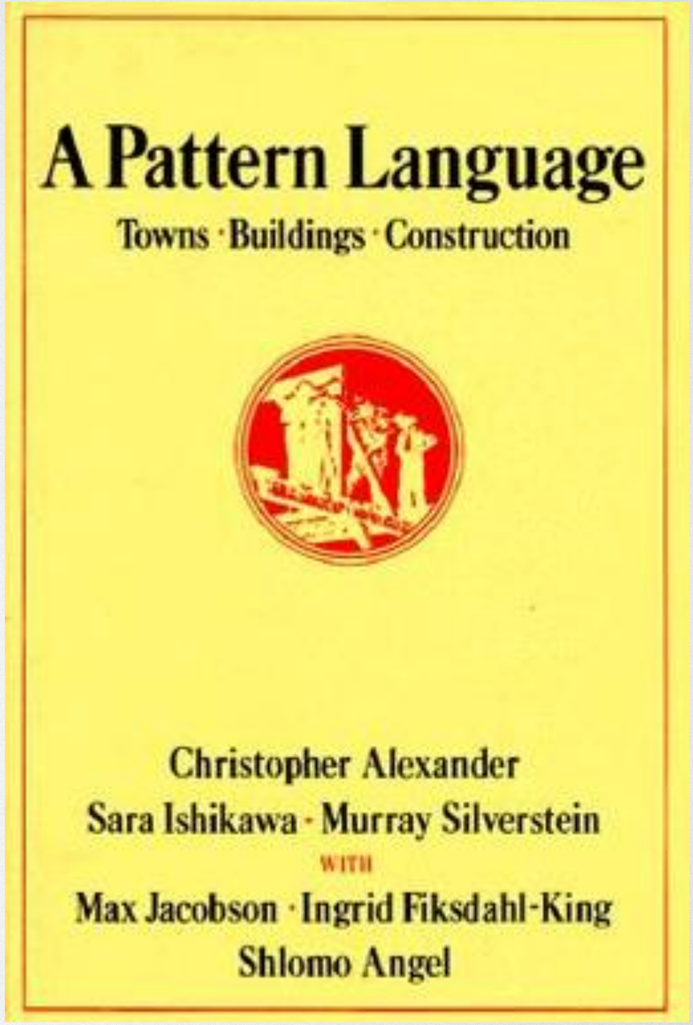
Design Patterns (1)

Patterns

- Often, the same problem arises in multiple contexts
- "A Pattern Language" describes 253 patterns for architects: "All 253 patterns together form a language."
- "each pattern represents our current best guess as to what arrangement of the physical environment will work to solve the problem presented. The empirical questions center on the problem—does it occur and is it felt in the way we describe it? —and the solution—does the arrangement we propose solve the problem? "



A Pattern Language Example

- "When they have a choice, people will always gravitate to those rooms which have light on two sides, and leave the rooms which are lit only from one side unused and empty."

- "Locate each room so that it has outdoor space outside it on at least two sides, and then place windows in these outdoor walls so that natural light falls into every room from more than one direction."

https://www.patternlanguage.com/apl/aplsample/aplsample.htm

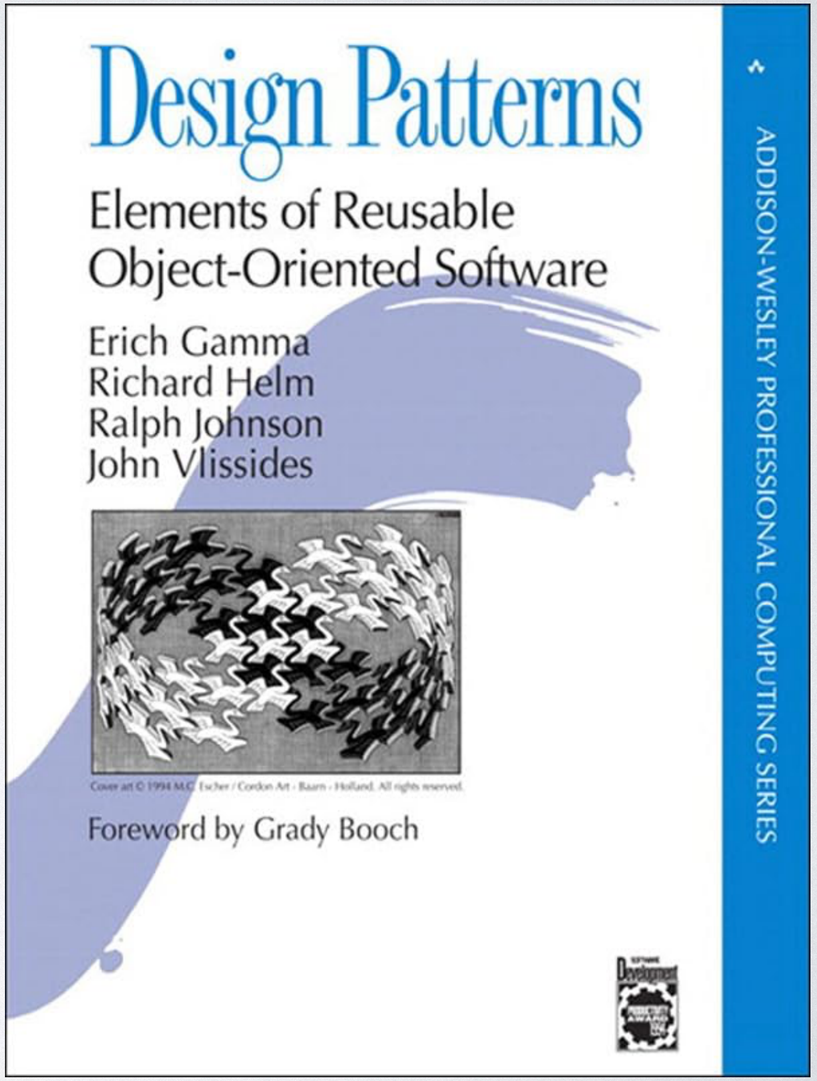
Lighting: Two Sides vs One Side

Wrinkle the Edge

- "Wrinkling the edge" of a building enables natural light from more than one side of each room

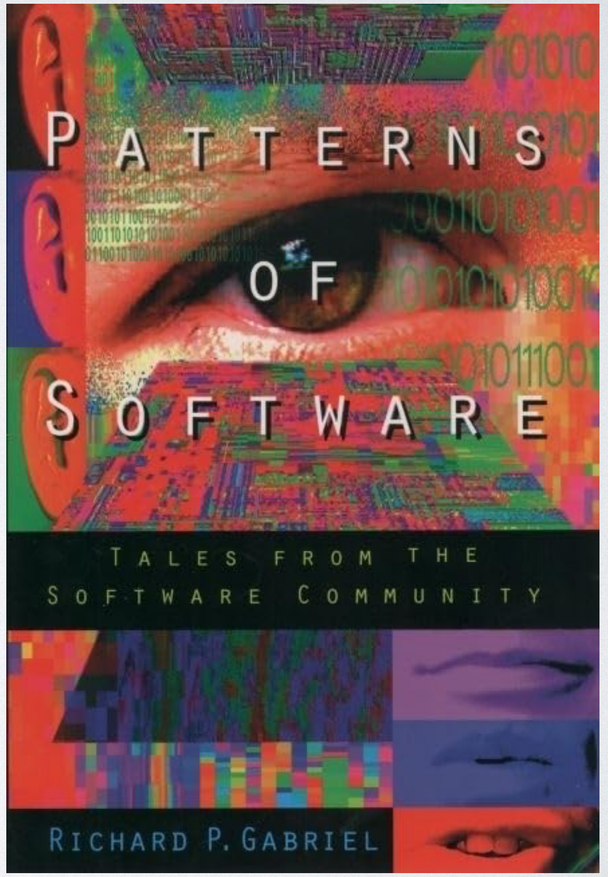
Object-Oriented Patterns

- The "Gang of Four" book (1994) describes 23 patterns
- The problems they address are still common — and so are the patterns!
- Some patterns solve multiple different problems



Software Patterns

- "Programs live and grow, and their inhabitants—the programmers—need to work with that program the way the farmer works with the homestead." (Richard P. Gabriel)



Each Pattern Solves Certain Problems

- With practice, you will see those problems and think "aha! I need THIS pattern!"
- Not every problem has a pattern-based solution.
  - At least, not a named pattern in the book.
- But when you now might think "now what?" eventually you'll think "the usual way to do this is…".

Factory Pattern

- Sometimes object creation is complicated
  - Object needs to be "hooked up" or which object to create depends on something
  - Putting this logic everywhere would violate DRY
- Solution: put complicated logic in a "factory"

Example

```
class Month {
  private int month;

  public String monthName() {…}
}
```

- How many different Month instances do we need to allocate?
- No need to ever have more than 12!

Want To Re-Use Month Objects

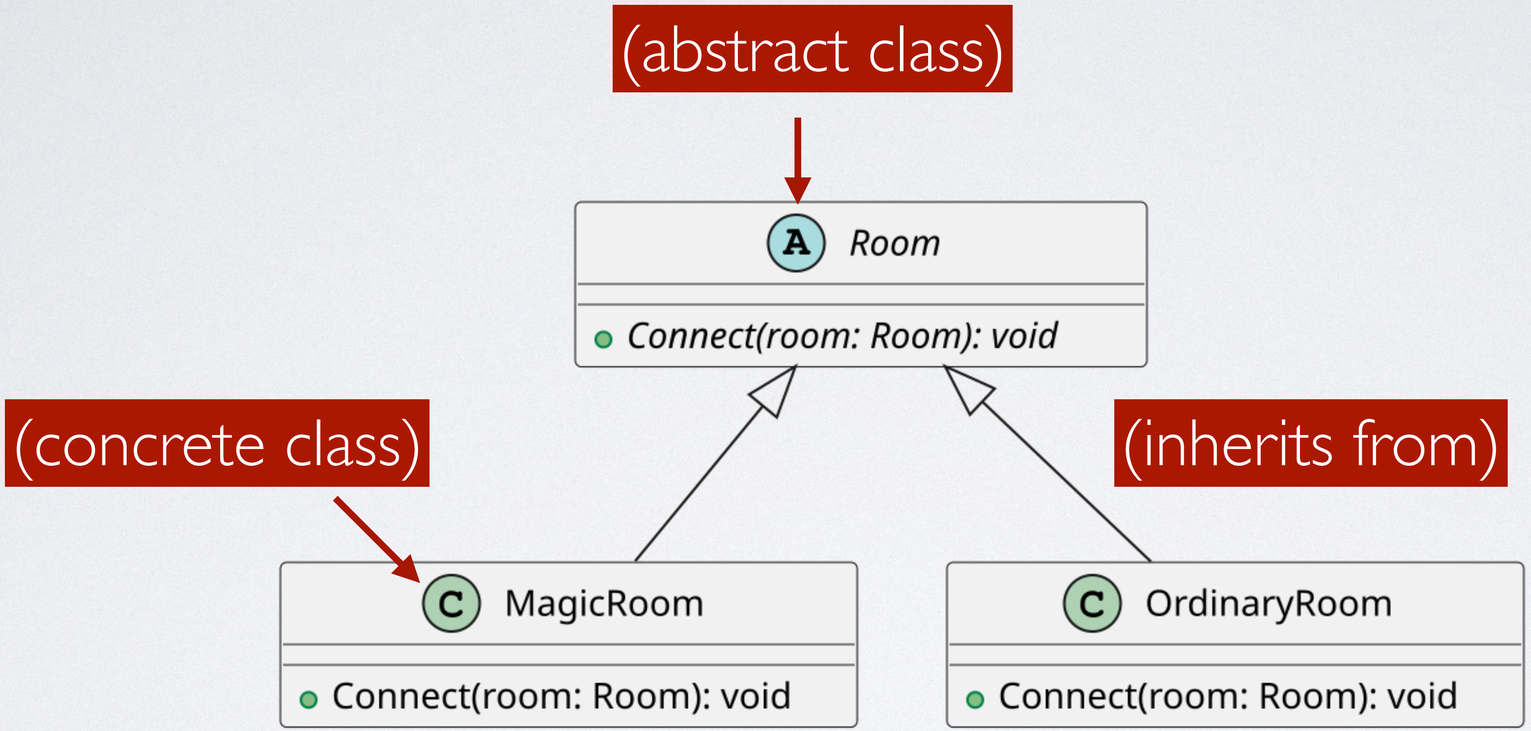
```
class MonthFactory {
  Month[] allMonths;

  public static Month createMonth(int month) {
    if (month >= 0 && month <= 11) {
      return allMonths[month];
    }
    else {
       // throw…
    }
}
```

Another Example

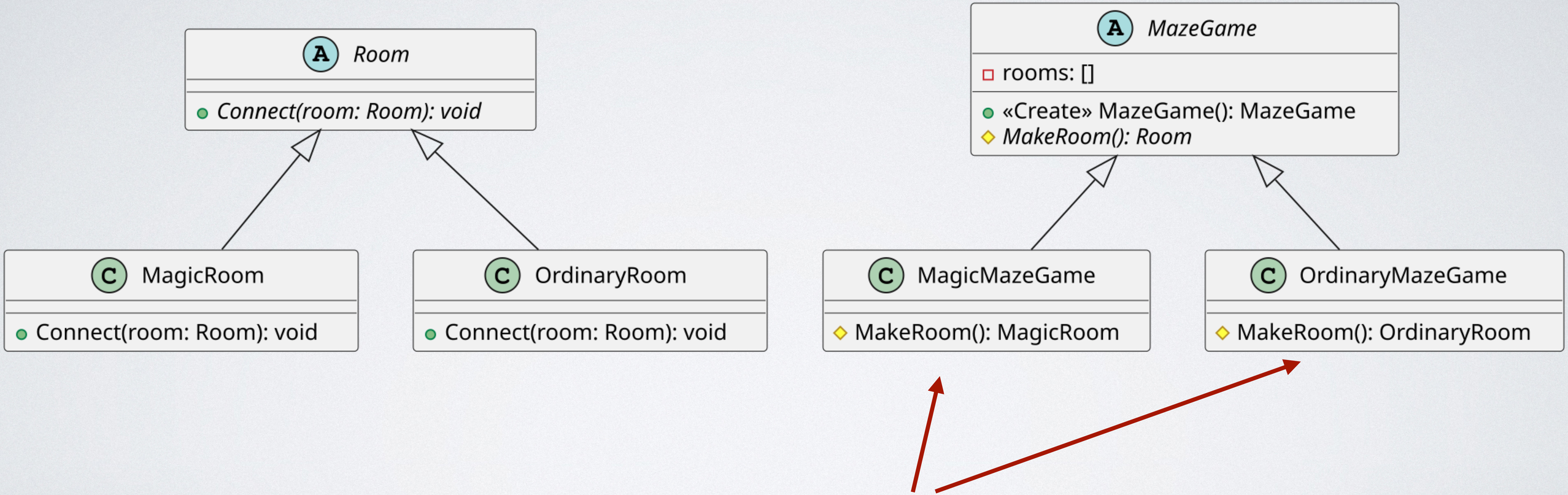
- Two varieties of maze games
  - OrdinaryMazeGame uses OrdinaryRoom instances
  - MagicMazeGame uses MagicMazeRoom instances
- Want to re-use the rest of the game logic (don't want two game implementations)

source: Wikipedia, based on Design Patterns book

Rooms


(abstract class)
A
Room
Connect(room: Room): void
(concrete class)
(inherits from)
C
MagicRoom
Connect(room: Room): void
C
OrdinaryRoom
Connect(room: Room): void

MazeGame



MakeRoom() is a factory method: it always makes a new room of the right type

Singleton Pattern

- Sometimes there should be only ONE of something.
- Often, you only want one factory!
- Other examples: logger; cache; thread pool
- Use *sparingly*
  - *Singletons* smell an awful lot like *global variables*

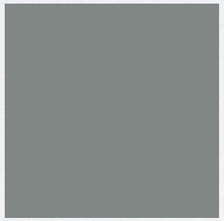
Singleton in Java

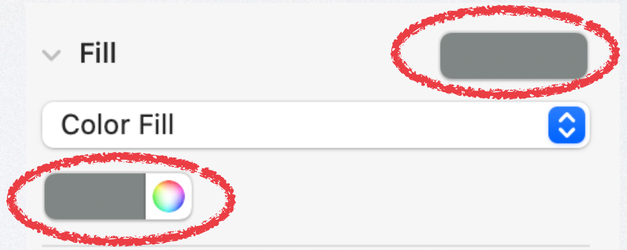
```
class ThreadPool {
  static ThreadPool instance;

  private ThreadPool() {}

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

  // Instance methods go here
}
```

Private constructor forces singleton access

Not thread-safe!

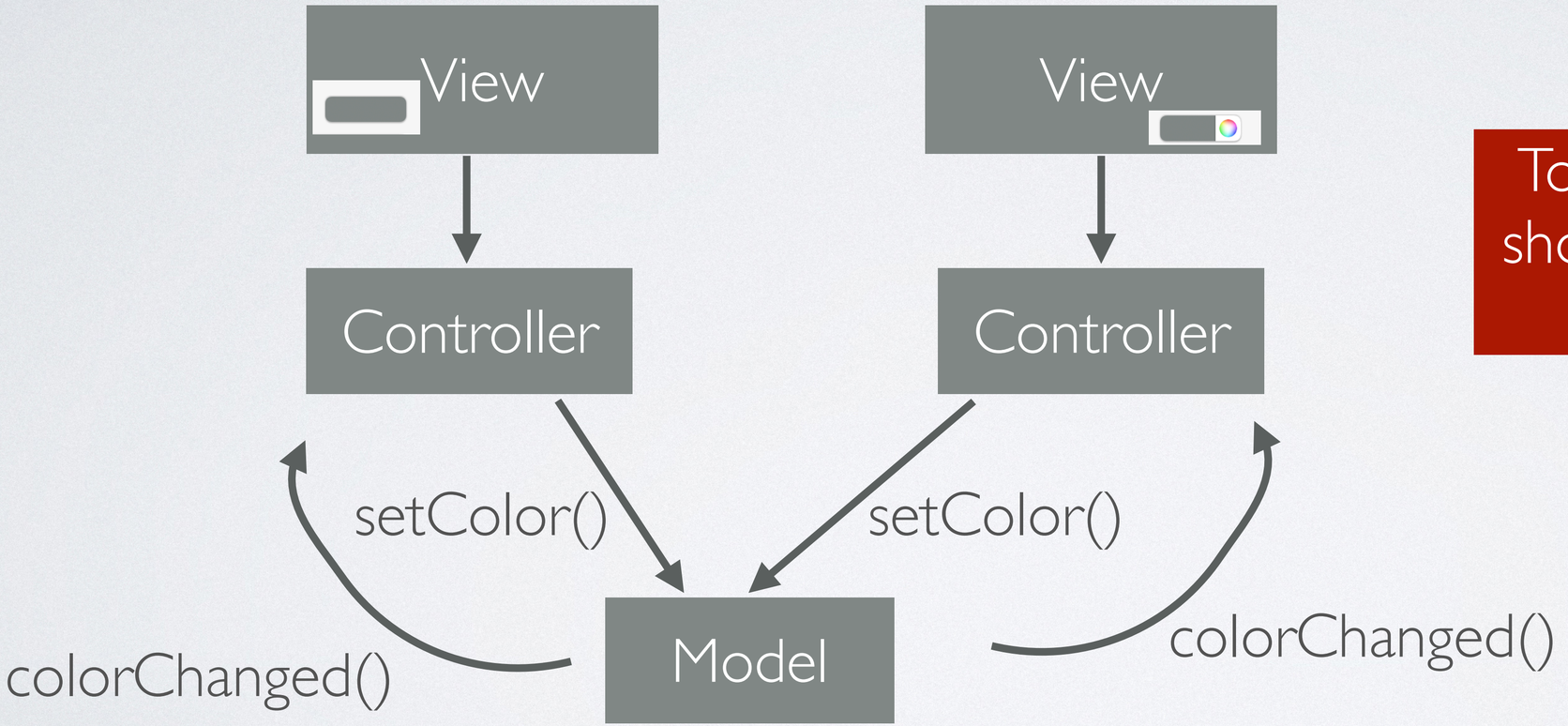
Observer Pattern

- Suppose you have a slideshow application (like this one)
- You can draw shapes 
- and you can set their colors:



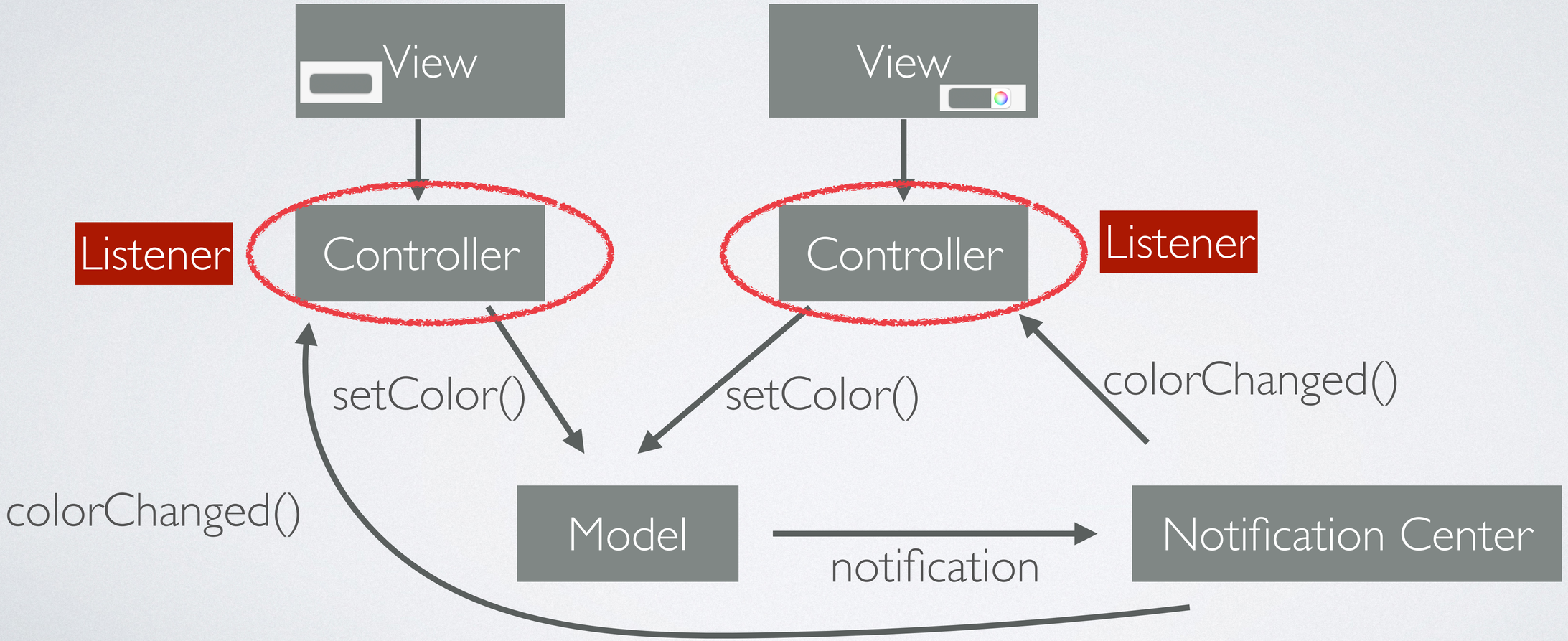
- Changing the color with either affordance updates both.

A First Try



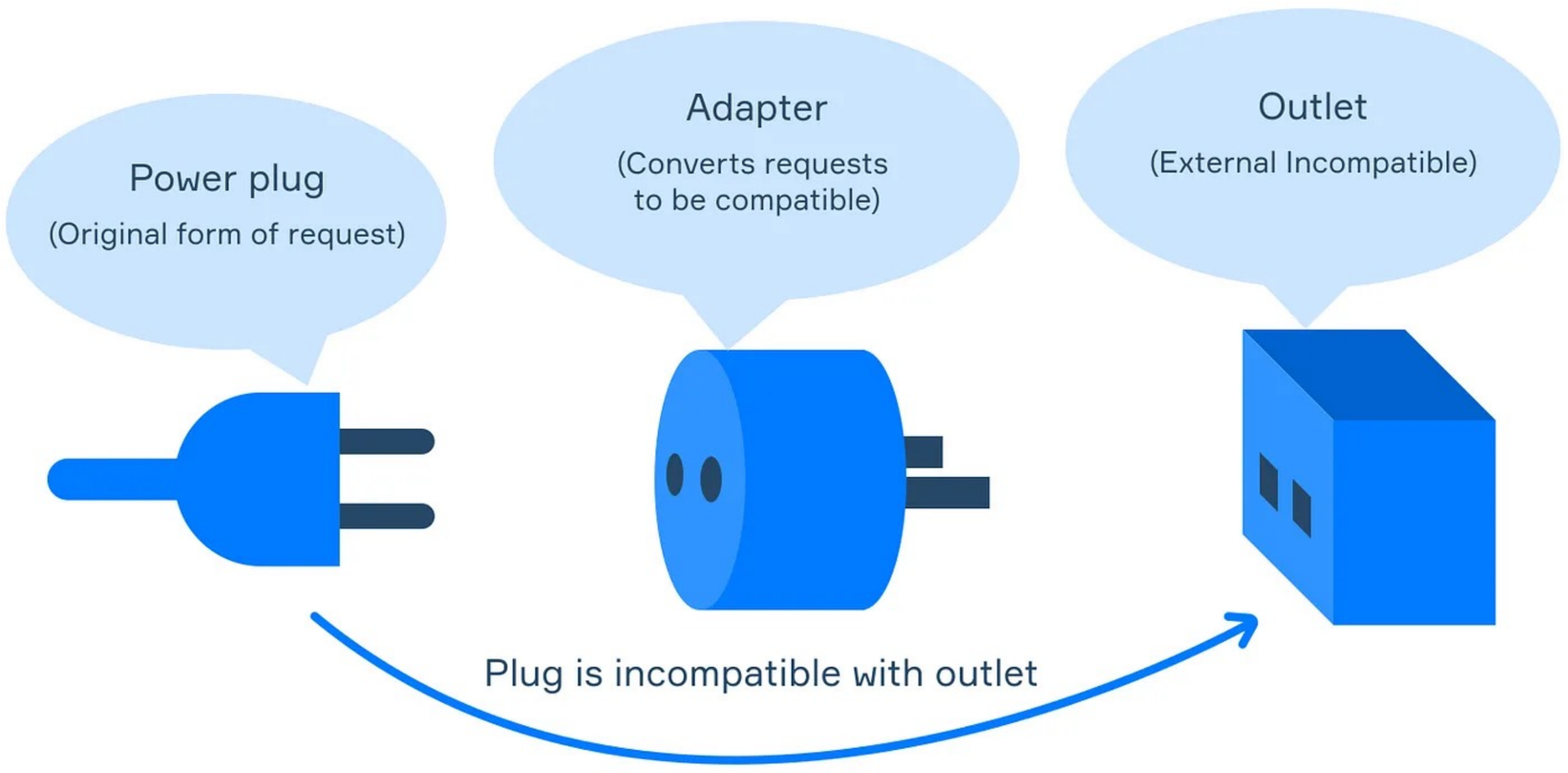
Too much coupling! Model shouldn' t know about each controller.

Observer


View
View
Listener
Controller
Controller
Listener
setColor()
setColor()
colorChanged()
colorChanged()
Model
notification
Notification Center

Adapter Pattern

- Goal: re-use existing component in a new context
- Problem: new context assumes a different interface
- Solution: Adapter



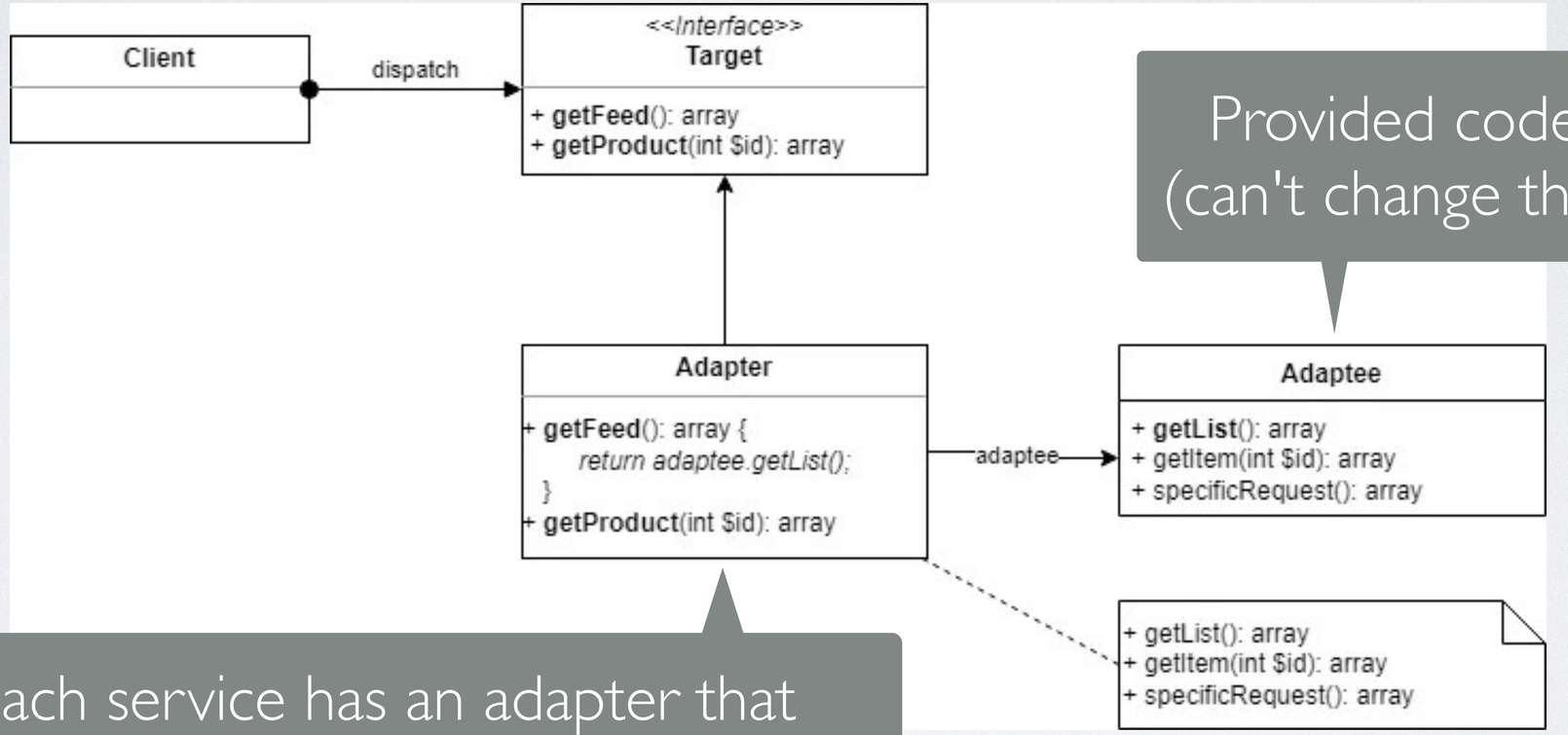
https://medium.com/@erlandmuchasaj/adapter-design-pattern-eddc3fa6f33d

Example

- Building a shopping app that aggregates data from different sources (Shopify, BigCommerce, etc.)
- Problem: different sources have different APIs
- Solution: define a common API; wrap each source in an adapter

Existing code (don't want to change this)

Generic interface



Provided code (can't change this)

Each service has an adapter that implements the generic interface

Conclusion

- Design patterns succinctly describe good solutions to common problems
- But not every problem can be solved with a design pattern!
- Very useful as vocabulary. Not as useful as a catalog of solutions until you internalize them.