

SOFT2201/COMP9201: Software Design and Construction 1

Singleton, Decorator, and
Façade

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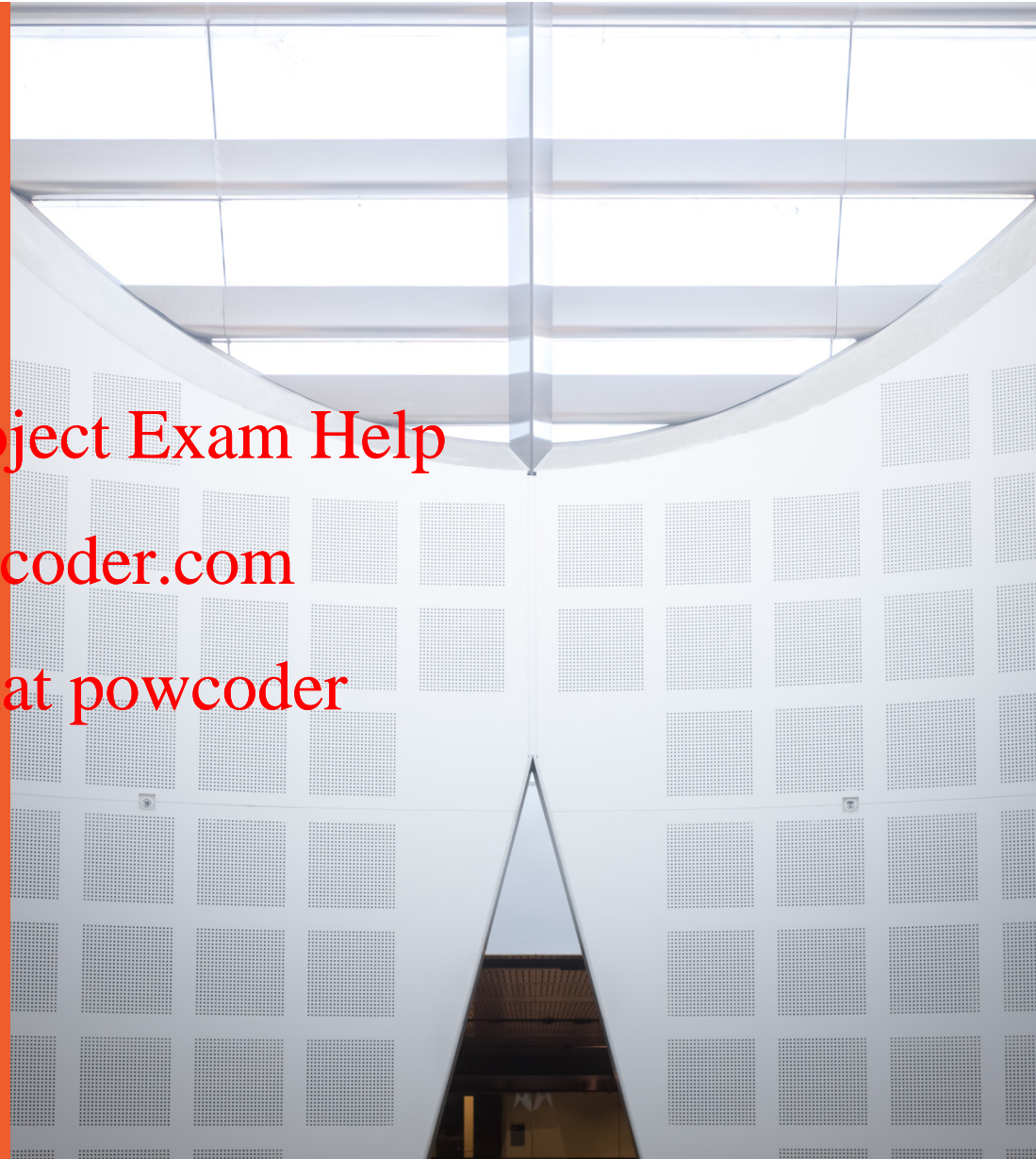
School of Computer Science



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Agenda

- Creational Design Pattern
 - Singleton

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- Structural Design Pattern
 - Decorator and Facade

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Singleton Pattern

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Object Creational



Creational Patterns (GoF)

Pattern Name	Description
Factory Method	Define an interface for creating an object, but let sub-class decide which class to instantiate (class instantiation deferred to subclasses)
Builder	Separate the construction of a complex object from its representation so that the same construction process can create different representations
Prototype	Specify the kinds of objects to create using a prototype instance, and create new objects by copying this prototype
Singleton	Ensure a class only has one instance, and provide global point of access to it

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Singleton

- Intent
 - Ensure a class only has one instance, and provide a global point of access to it.
- Motivation
 - Make the class itself responsible for keeping track of its sole instance (intercept requests to create new objects and provide a way to access its instance)
 - There can be many printers in a system, but there should be only one printer queue

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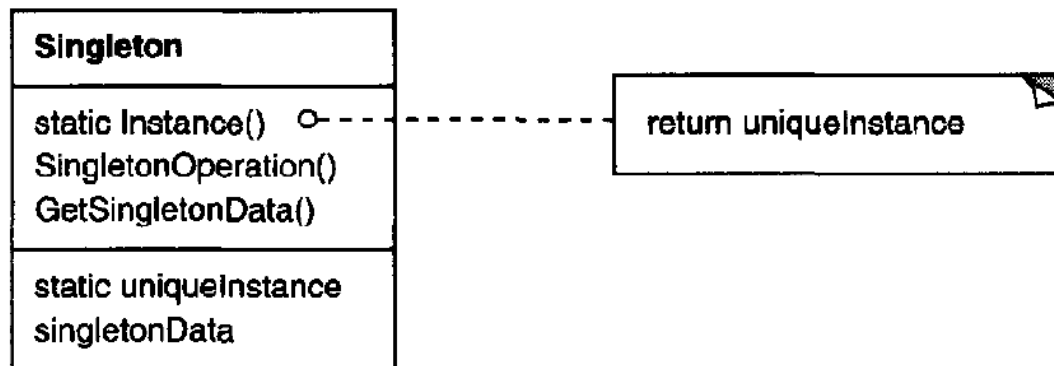
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Singleton

- Applicability

- There must be exactly one instance of a class, and it must be accessible to clients from a well-known access point
- The sole instance should be extensible by subclassing, and clients should be able to use an extended instance without modifying their code

- Structure



Singleton

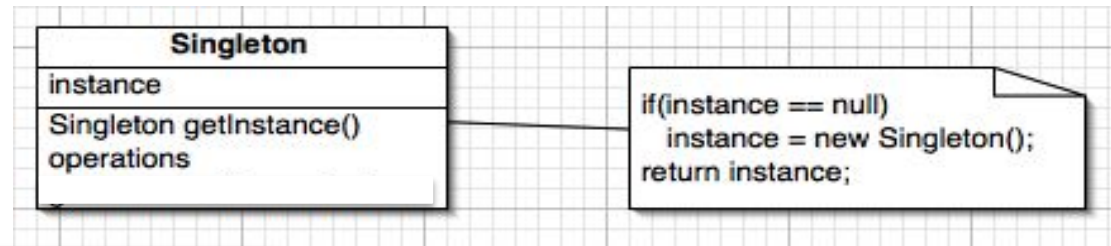
- **Participants**

- Defines an instance() operation that lets clients access its unique instance. instance() is a class operation.
- May be responsible for creating its own unique instance

- **Collaboration** <https://powcoder.com>

- Clients access a Singleton instance solely through Singleton's instance() operation.

Singleton Implementation



```
public class Singleton {  
    private static Singleton instance = null;  
    // Private constructor to prevent direct  
    initialisation.  
    private Singleton() {  
    }  
    public static Singleton getInstance() {  
        if (instance == null) {  
            instance = new Singleton();  
        }  
        return instance;  
    }  
}  
  
public class Client {  
    ...  
    Singleton single = Singleton.getInstance();  
}
```

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Decorator Pattern

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Object Structural



Structural Patterns (GoF)

Pattern Name	Description
Adapter	Allow classes of incompatible interfaces to work together. Convert the interface of a class into another interface clients expect.
Decorator	Attach additional responsibilities to an object dynamically (flexible alternative to subclassing for extending functionality)
Façade	Provides a unified interface to a set of interfaces in a subsystem. Defines a higher-level interface that simplifies subsystem use.

Decorator Pattern

– Intent

- Attach additional responsibilities to an object dynamically. Decorators provide a flexible alternative to sub-classing for extending functionality

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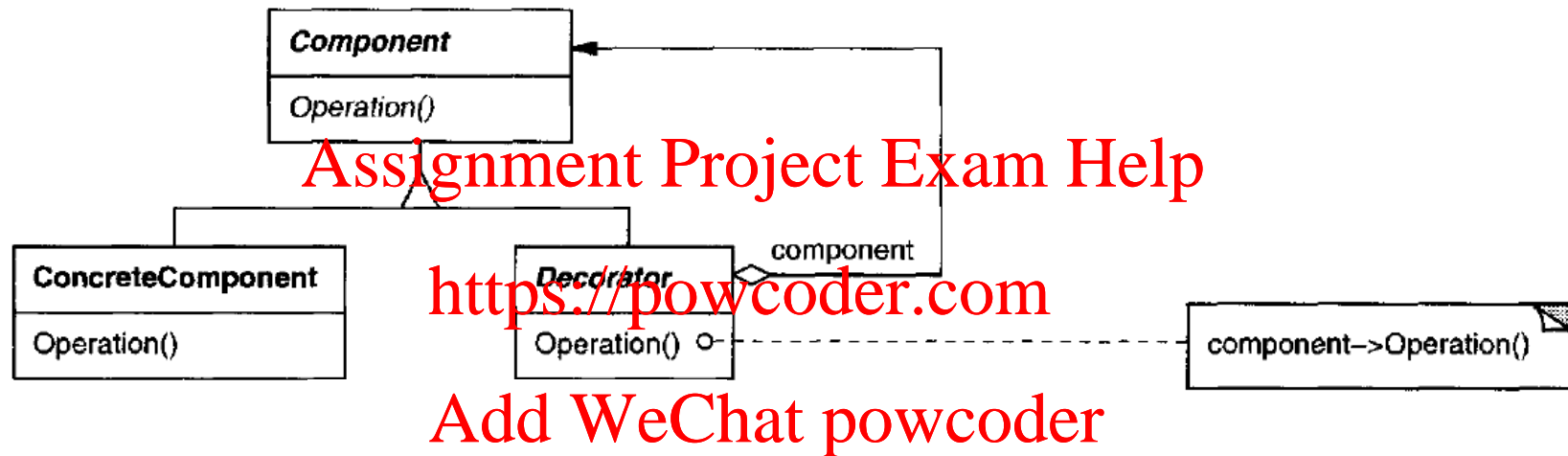
– Applicability

- to add responsibilities to individual objects dynamically and transparently, without affecting other objects
- For responsibilities that can be withdrawn
- When extension by sub-classing is impractical
 - Sometimes a large number of independent extensions are possible and would produce an explosion of subclasses to support every combination.

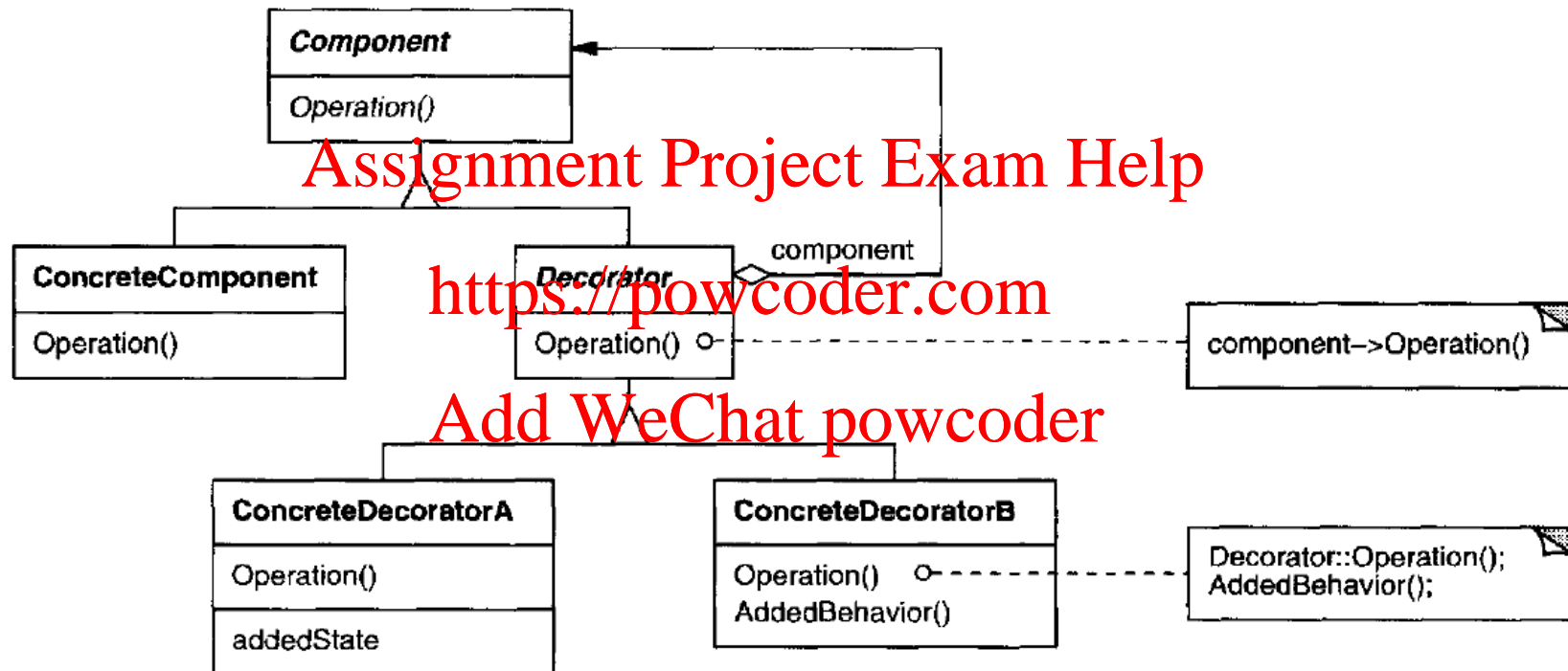
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Decorator – Structure



Decorator – Structure



Decorator Pattern – Why Not Inheritance?

- We want to add responsibilities to individual objects, not an entire class
 - E.g., A GUI toolkit should let you add properties like borders or behaviors like scrolling to any user interface component
- Is adding responsibilities using inheritance a good design? For example, inheriting a border class puts a border every subclass instance
 - Why, why not?

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Decorator Pattern – Why Not Inheritance?

- Adding responsibilities using inheritance restricts runtime change, and requires an implementation for every decoration.
- This design is inflexible
 - The choice of border is made statically; a client cannot control how and when to decorate the component with a border
 - More flexible design is to enclose the component in another object that adds the border

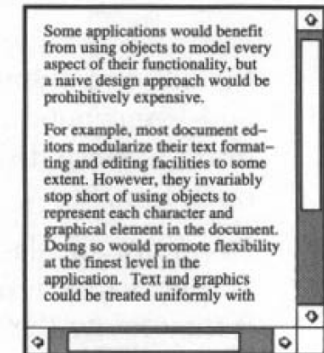
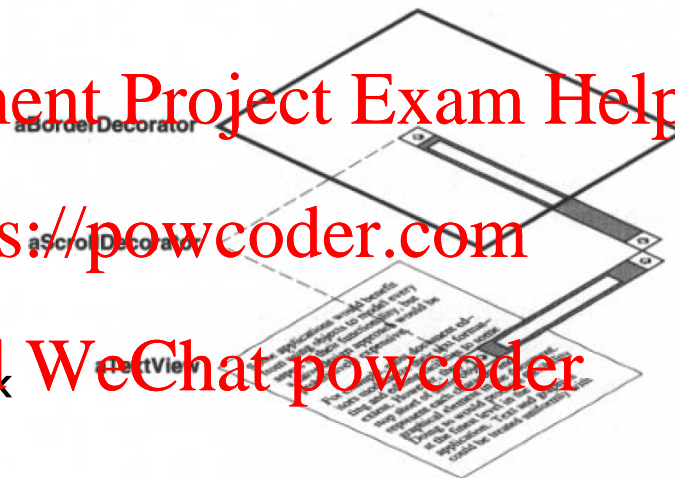
Decorator Pattern – Text Viewer Example

- TextView object has no scroll bars and border by default (not always needed)
- ScrollDecorator to add them
- BorderDecorator to add a thick black border around the TextView

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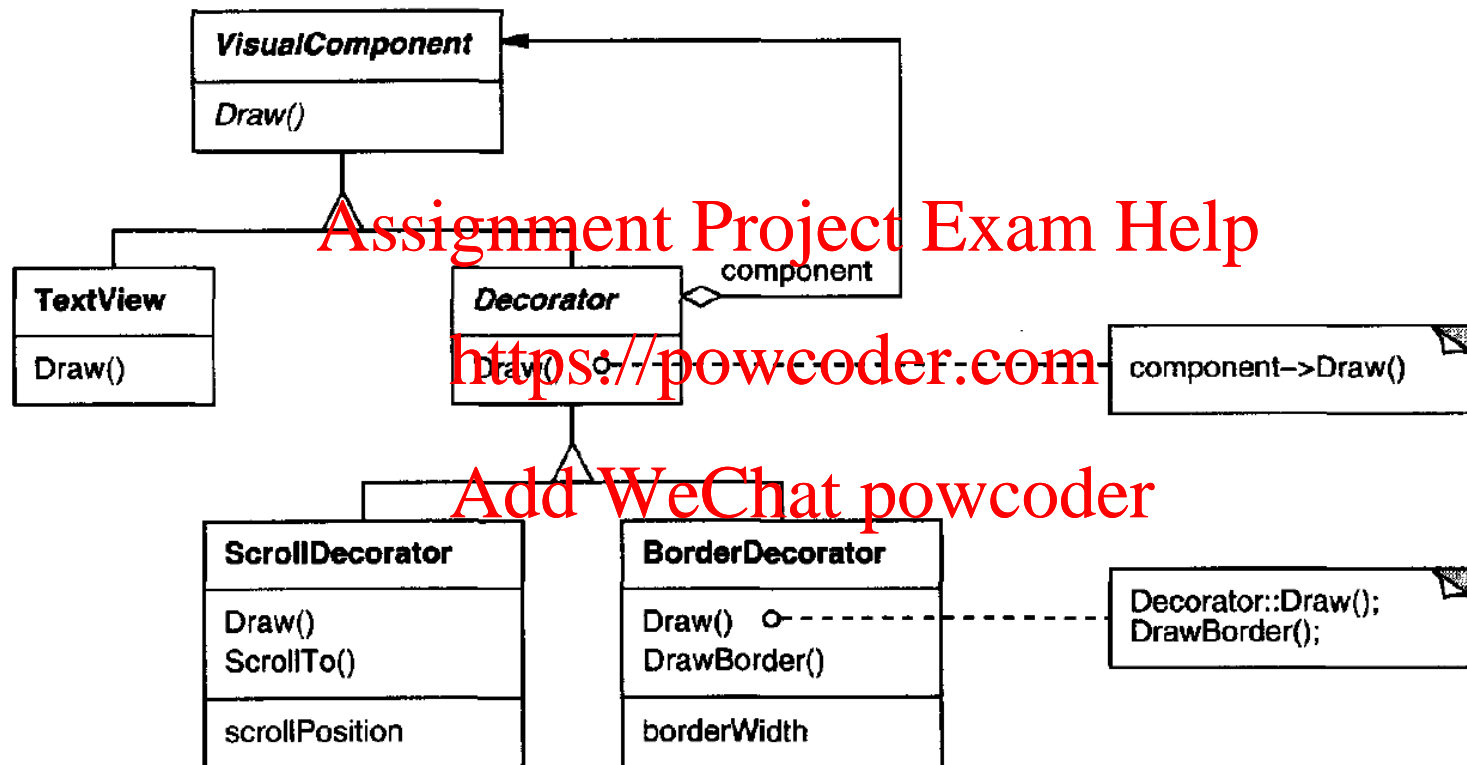


Decorator Pattern – Text Viewer Example

- Compose the decorators with the TextView to produce both the border and the scroll behaviours for the TextView



Decorator Pattern – Text Viewer Example



Decorator – Text Viewer Example

- VisualComponent is the abstract class for visual objects
 - It defines their drawing and event handling interface
- Decorator is an abstract class for visual components that decorate the other visual components
 - It simply forwards draw requests to its component; Decorator subclasses can extend this operation
- The ScrollDecorator and BorderDecorator classes are subclasses of Decorator
 - Can add operations for specific functionality (e.g., ScrollTo)

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Decorator – Participants

- **Component** (*VisualComponent*)
 - Defines the interface for objects that can have responsibilities added to them dynamically
- **ConcreteComponent** (*TextView*)
 - Defines an object to which additional responsibilities can be attached
- **Decorator**
 - Maintains a reference to a Component object and defines an interface that conforms to Component's interface.
- **ConcreteDecorator** (*BorderDecorator, ScrollDecorator*)
 - Adds responsibilities to the component

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Decorator – Collaborations

- **Collaborations**

- Decorator forwards requests to its Component object. It may optionally perform additional operations before and after forwarding the request.

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Consequences (1)

- More flexibility and less complexity than static inheritance
 - Can add and remove responsibilities to objects at run-time
 - Inheritance requires adding new class for each responsibility (increase complexity)

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- Avoids feature-laden (heavily loaded) classes high up in the hierarchy
 - Defines a simple class and add functionality incrementally with Decorator objects – applications do not need to have un-needed features
 - You can define new kinds of Decorators independently from the classes of objects they extend, even for unforeseen extensions

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Consequences (2)

- Decorator and its component are not identical
 - Decorated component is not identical to the component itself - you shouldn't rely on object identity when you use decorator
- Many little objects <https://powcoder.com>
 - Can become hard to learn and debug when lots of little objects that look alike
 - Still not difficult to customize by those who understand them

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Façade Pattern

Object Structural

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Structural Patterns (GoF)

Pattern Name	Description
Adapter	Allow classes of incompatible interfaces to work together. Convert the interface of a class into another interface clients expect.
Decorator	Attach additional responsibilities to an object dynamically (flexible alternative to subclassing for extending functionality)
Façade	Provides a unified interface to a set of interfaces in a subsystem. Defines a higher level interface that simplifies subsystem use.

Façade Pattern

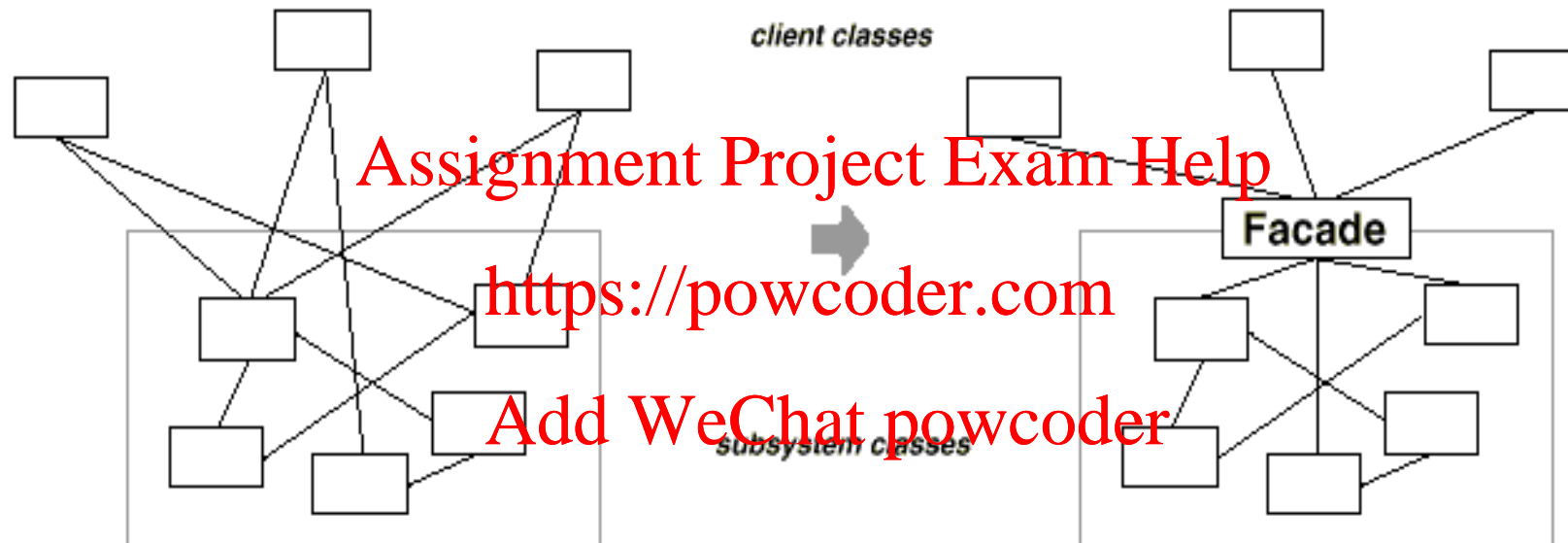
- Intent
 - Provide a unified interface to a set of interfaces in a subsystem. It defines a higher-level interface that makes the subsystem easier to use
- Applicability
 - You want to provide a simple interface to a complex subsystem
 - There are many dependencies between clients and the implementation classes of an abstraction
 - You want to layer your subsystem. Façade would define an entry point to each subsystem level

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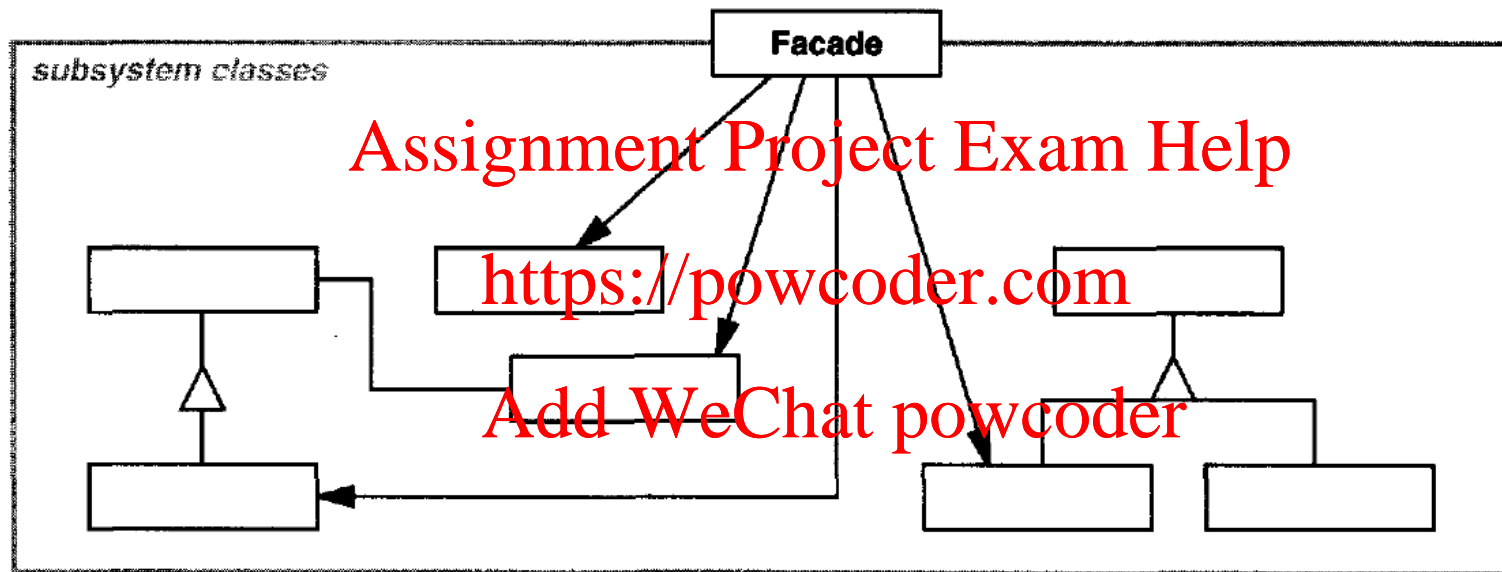
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Façade Motivation



A **facade** object provides a single, simplified interface to the more general facilities of a subsystem

Façade – Structure



Façade Pattern - Example

```
class subClass1 {  
    public void method1() {  
        // method body  
    }  
  
class subSystem2 {  
    public void method2() {  
        // method body  
    }  
}
```

```
class Façade {  
    subClass1 s1;  
    subClass2 s2;  
  
    public Façade() {  
        s1 = new subClass1();  
        s2 = new subClass2();  
    }  
  
    public void methodA() {  
        s1.method1();  
        s2.method2();  
    }  
}
```

How about Client?

```
Façade façade = new Façade();  
façade.methodA();
```

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Façade – Participants

- **Facade**
 - Knows which subsystem classes are responsible for a request.
 - Delegates client requests to appropriate subsystem objects.
- **Subsystem classes**
 - Implement subsystem functionality.
 - Handle work assigned by the Façade object
 - Have no knowledge of the facade; they keep no references to it.
- **Collaborations**
 - Clients communicate with the subsystem by sending requests to Façade, which forwards them to the appropriate subsystem object(s).
 - Although the subsystem objects perform the actual work, the façade may have to do work of its own to translate its interface to subsystem interfaces
 - Clients that use the facade don't have to access its subsystem objects directly

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Consequences

- Simplify the usage of an existing subsystem by defining your own interface
- Shields clients from subsystem components, reduce the number of objects that clients deal with and make the subsystem easier to use.
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- Promote weak coupling between the subsystem and the clients
 - Vary the components of the subsystem without affecting its clients
 - Reduce compilation dependencies (esp. large systems) – when subsystem classes change
- Does not prevent applications from using subsystem classes if they need to. Choice between ease of use and flexibility.

Façade Pattern

- Façades can simplify using a series of complicated method calls and interactions
- Façades can wrap a complex set of packages with a simpler interface
 - Easier to use
 - Easier to maintain
- Promote weak coupling with the complex system
- Doesn't prevent using the complex system directly if needed

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Task for Week 11

- Submit weekly exercise on canvas before 23.59pm Sunday
- Well organize time for assignment 3
- Attend Helpdesk session if you have any questions/difficulties on implementation perspective

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What are we going to learn on week 12?

- Unit Review

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References

- Craig Larman. 2004. *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development (3rd Edition)*. Prentice Hall PTR, Upper Saddle River, NJ, USA.
- Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides. 1995. *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.

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