SOFT2201/COMP9201: Software Design and Construction 1

Singleton, Decorator, and Façade

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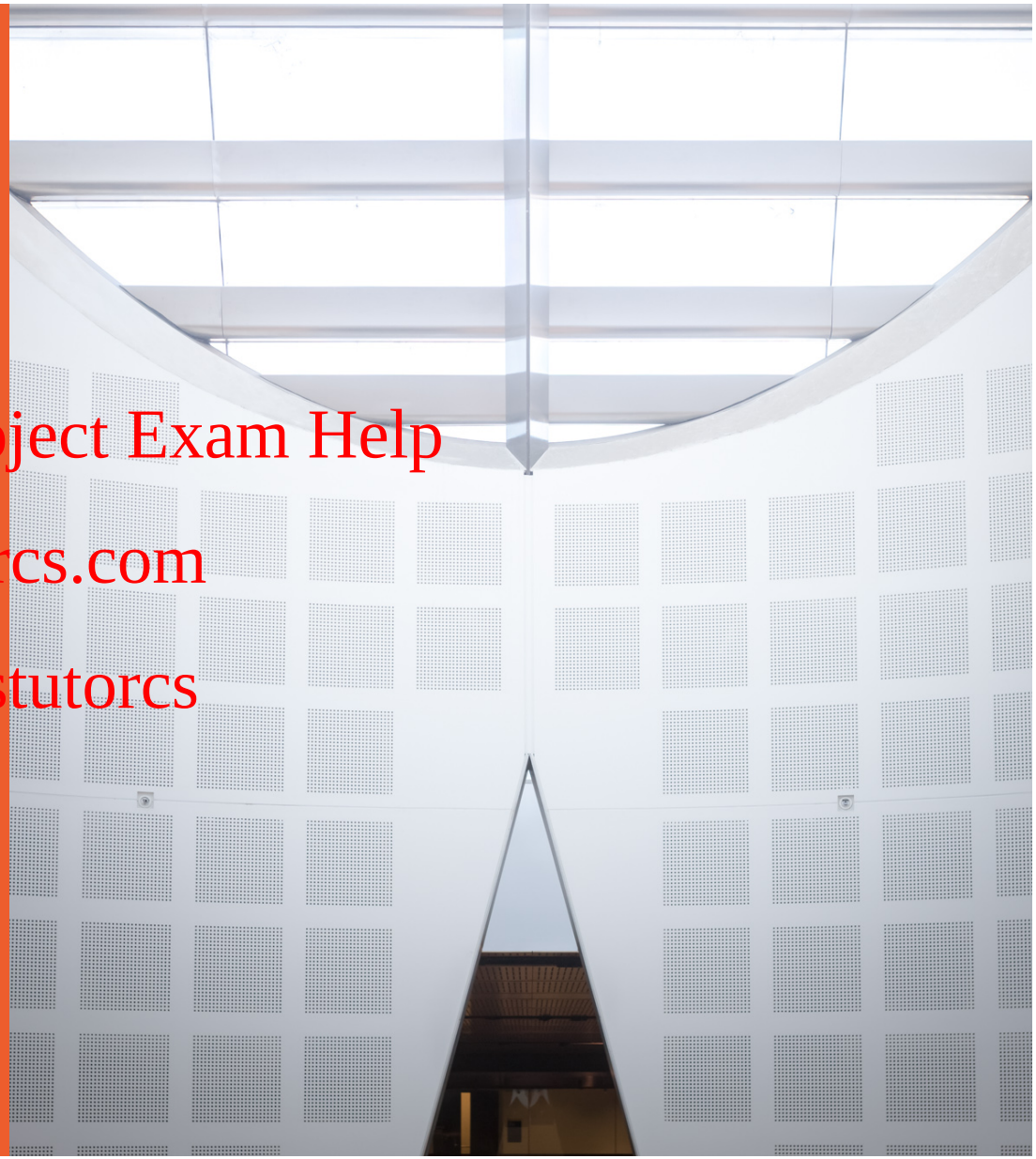

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Agenda

- Creational Design Pattern
  - Singleton
- Structural Design Pattern
  - Decorator and Façade

Singleton Pattern

Object Creational

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Creational Patterns (GoF)

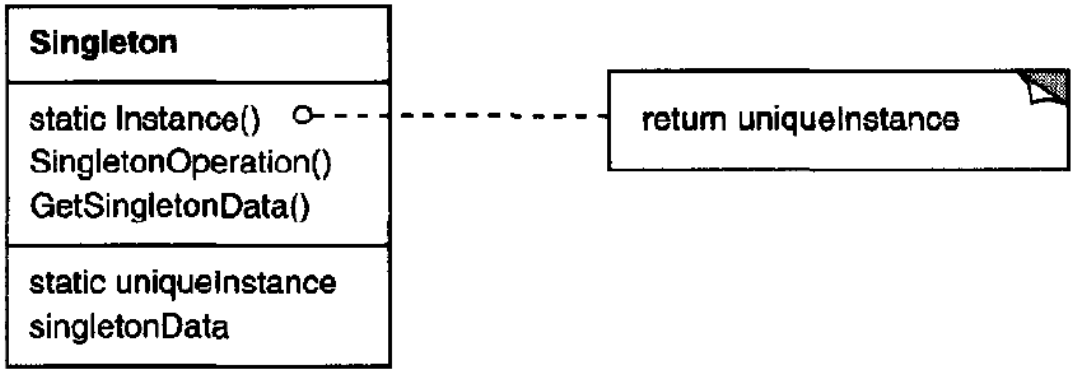
Pattern Name	Description
Factory Method	Define an interface for creating an object, but let sub-class decide which class to instantiate (class instantiation deferred to subclasses)
Builder	Separate the construction of a complex object from its representation so that the same construction process can 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**

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

Singleton

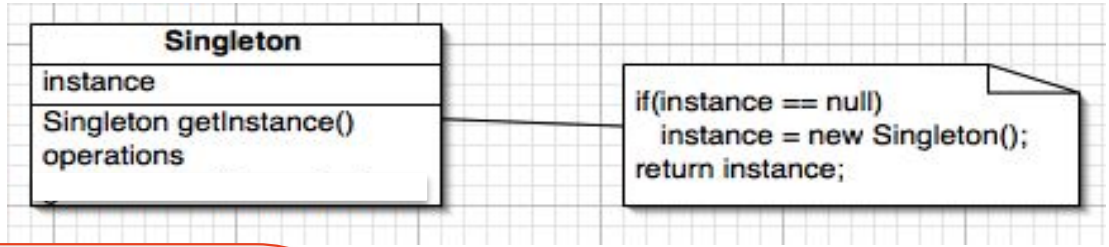
- Applicability
  - There must be exactly one instance of a class, and it must be accessible to clients from a well-known access point
  - The sole instance should be extensible by subclassing, and clients should be able to use an extended instance without modifying their code
- Structure



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**
  - 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();
}
```

Decorator Pattern

Object Structural

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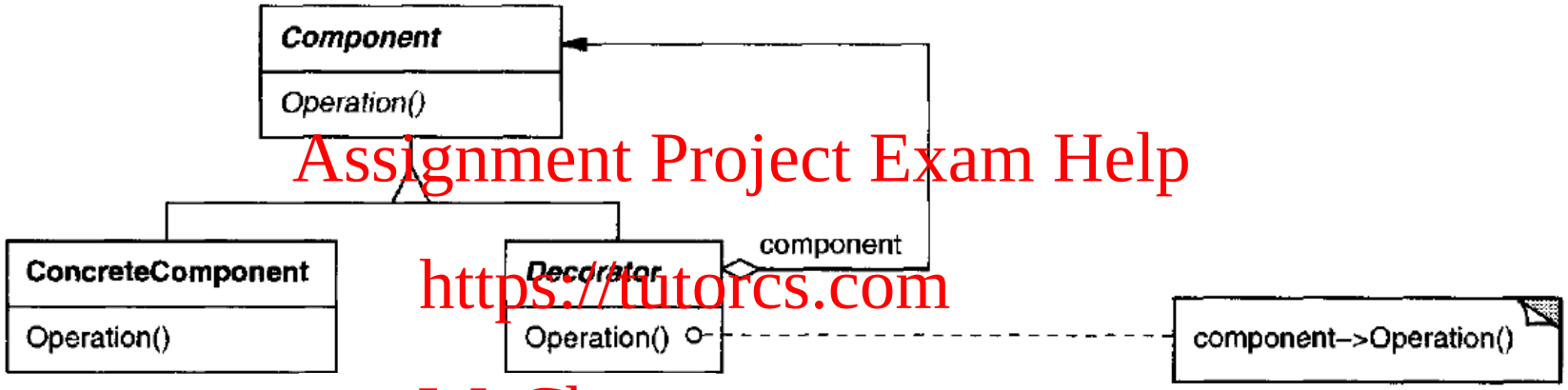
Structural Patterns (GoF)

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.

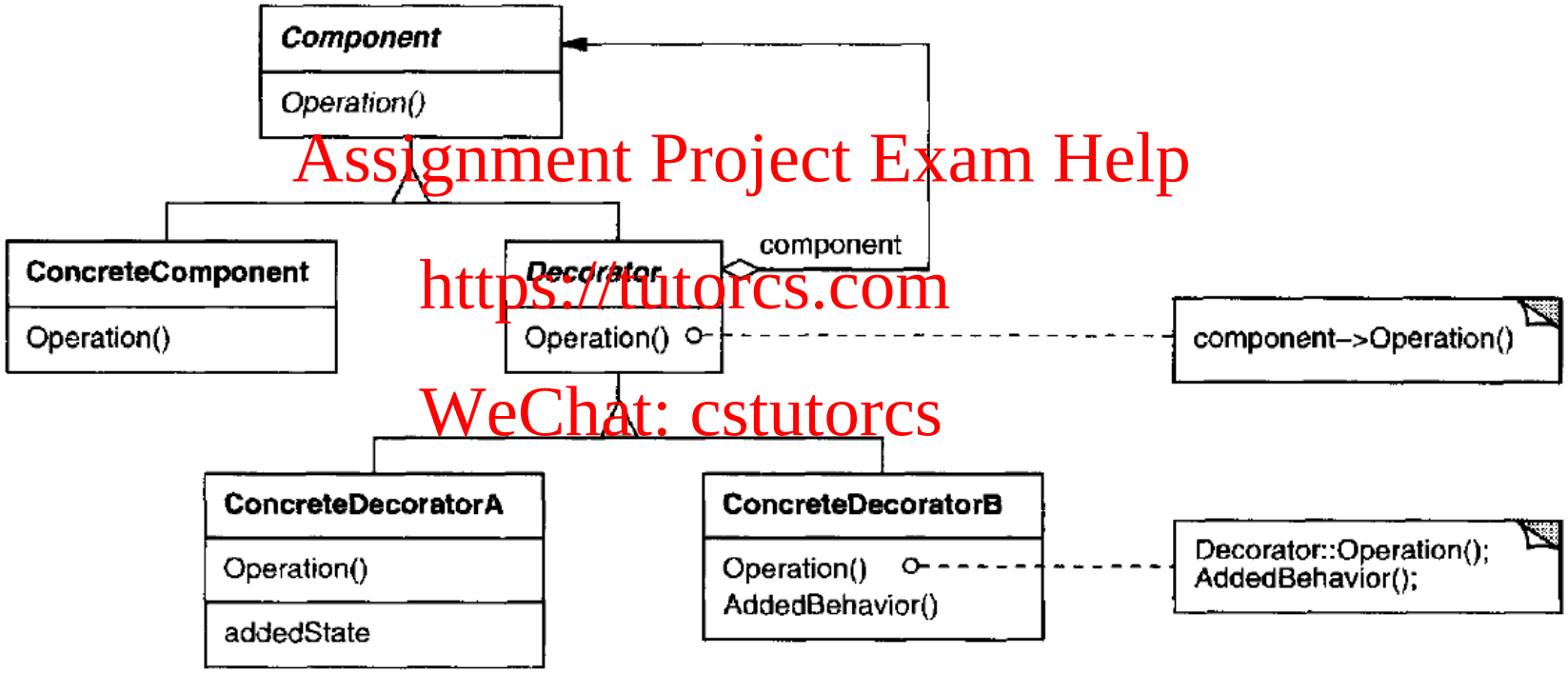
Decorator Pattern

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

Decorator – Structure



Decorator – Structure



Decorator Pattern – Why Not Inheritance?

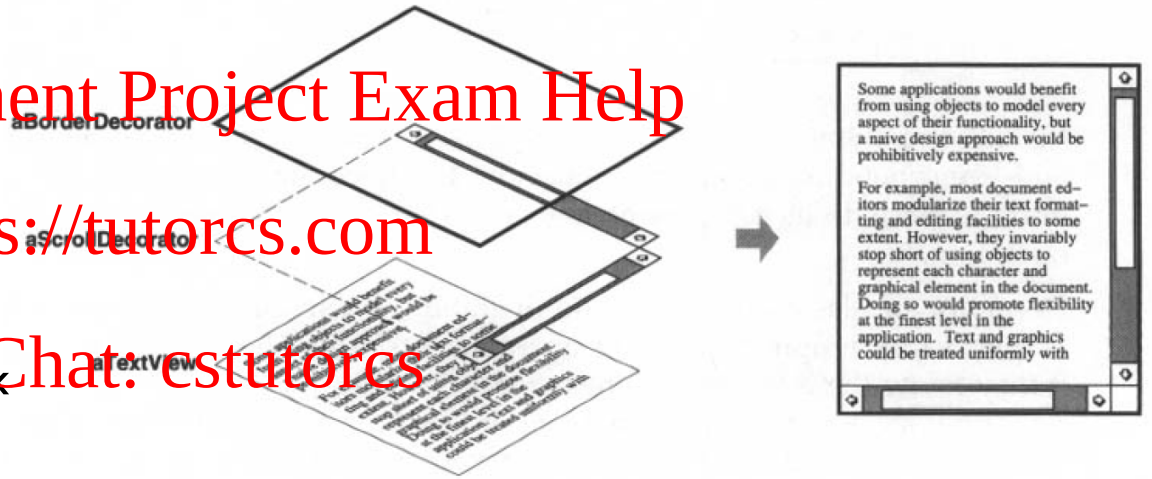
- We want to add responsibilities to individual objects, not an entire class
  - E.g., A GUI toolkit should let you add properties like borders or behaviors like scrolling to any user interface component
- Is adding responsibilities using inheritance a good design? For example, inheriting a border class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

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

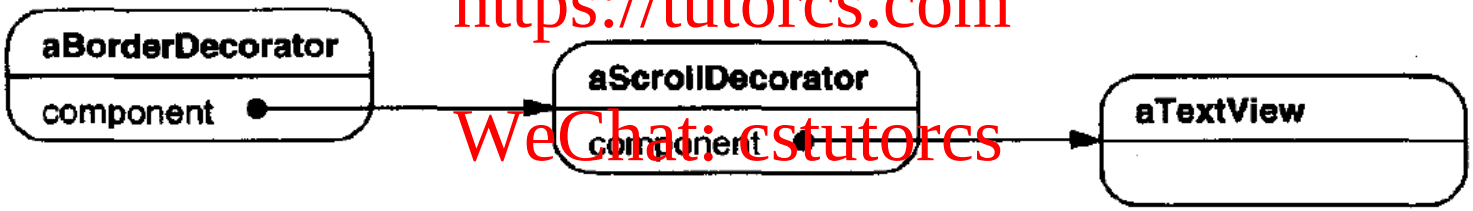
Decorator Pattern – Text Viewer Example

- 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

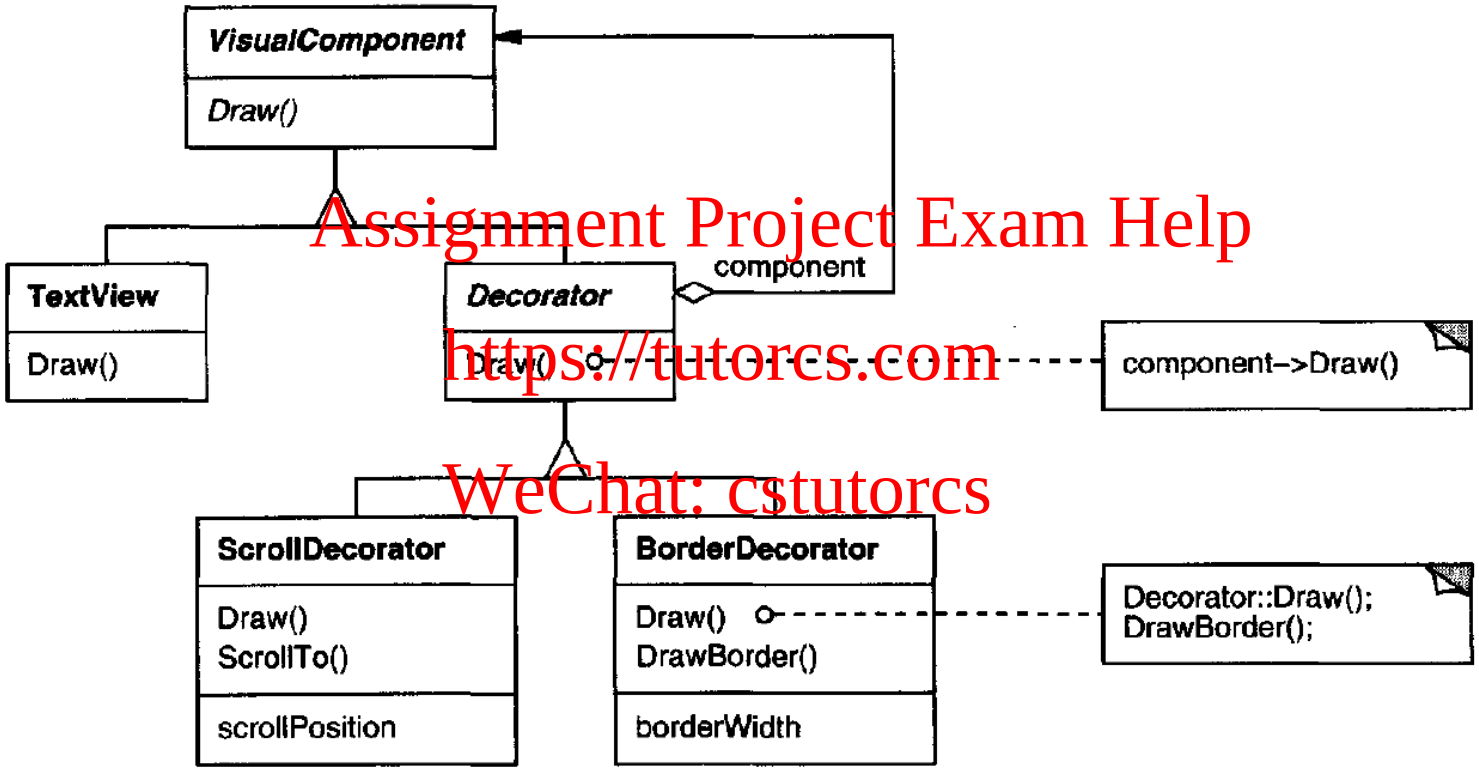


Decorator Pattern – Text Viewer Example

- 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)

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

Decorator – Collaborations

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

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)
- 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

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
  - 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

Façade Pattern

Object Structural

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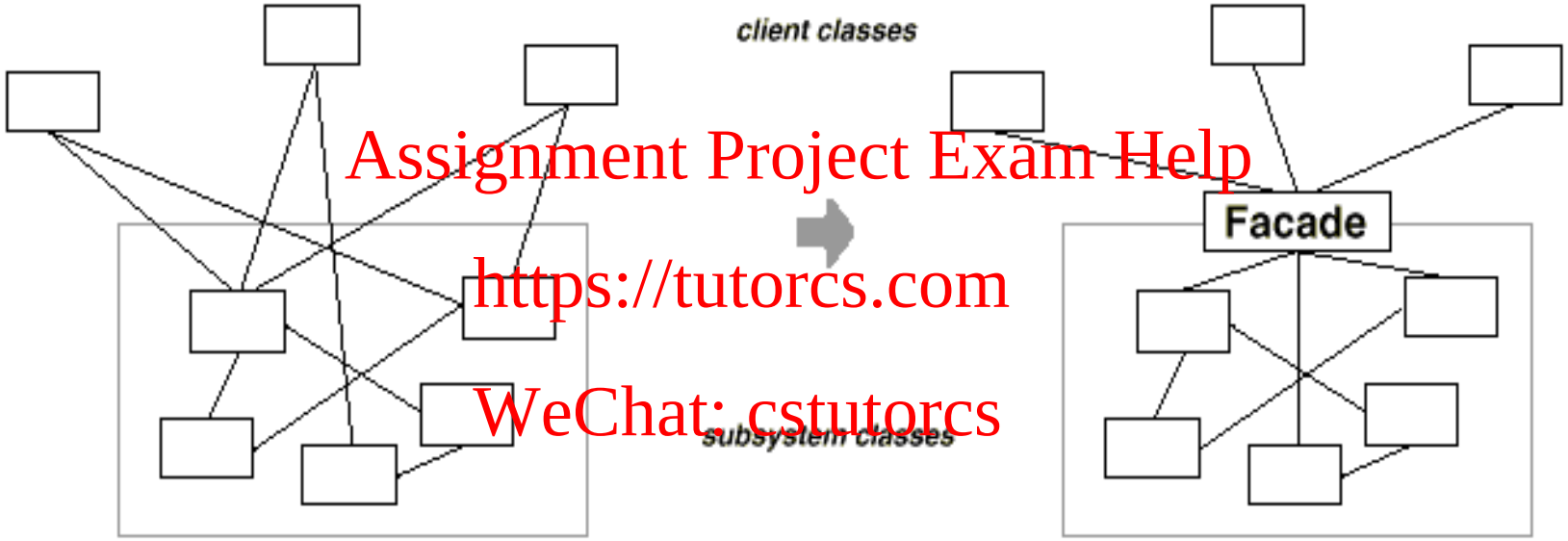
Structural Patterns (GoF)

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

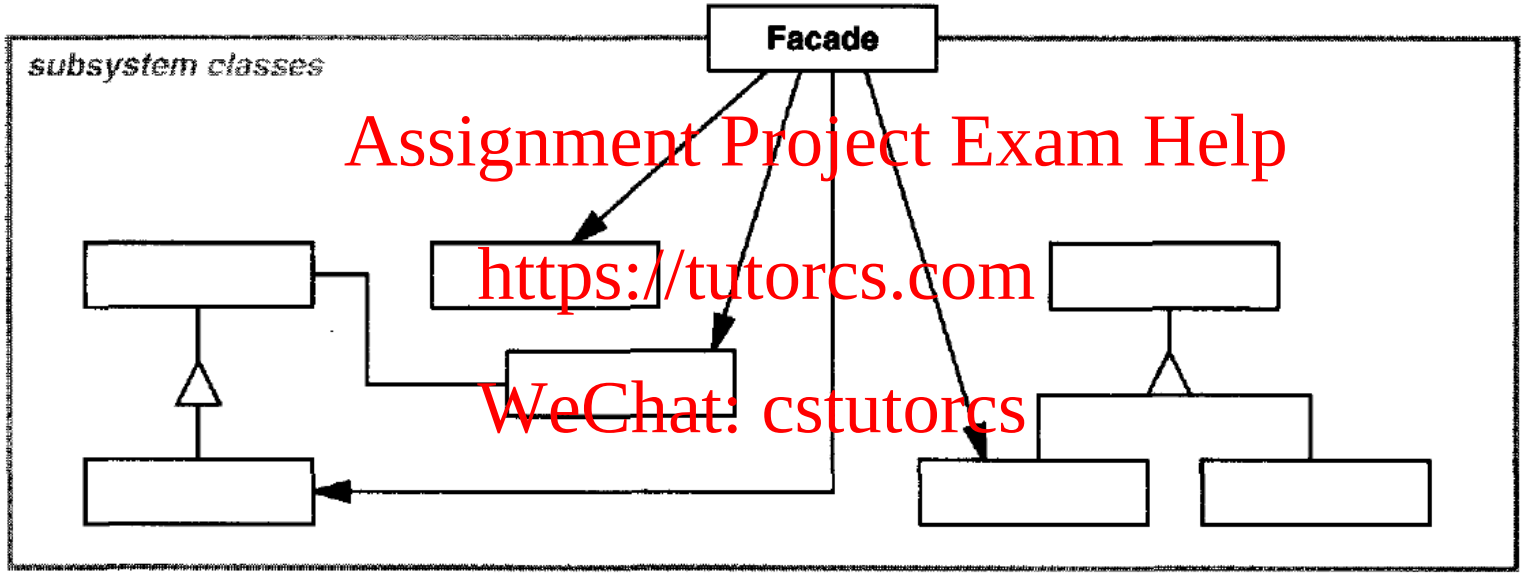
- Intent
  - Provide a unified interface to a set of interfaces in a subsystem. It defines a higher-level interface that makes the subsystem easier to use
- Applicability
  - You want to provide a simple interface to a complex subsystem
  - There are many dependencies between clients and the implementation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

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();
```

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

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.
- 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

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

What are we going to learn on week 12?

- Unit Review

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.