

Design Patterns



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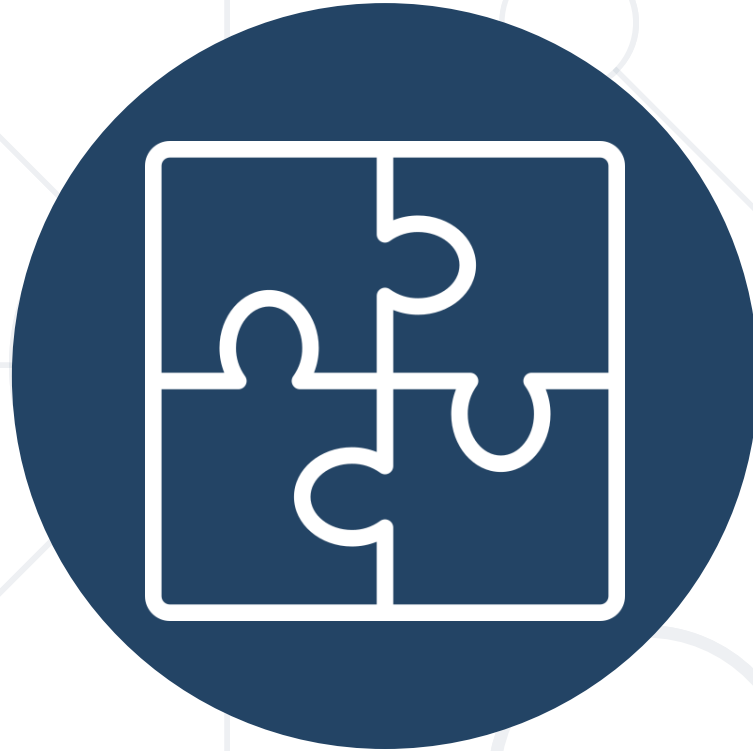
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1. Definition of Design Patterns
2. Benefits and Drawbacks
3. Types of Design Patterns
 - Creational
 - Structural
 - Behavioral



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Definition, Solutions and Elements

Design Patterns

What Are Design Patterns?

- **General** and **reusable solutions** to common problems in software design
- A **template** for solving given problems
- Add additional layers of **abstraction** in order to reach flexibility



What Do Design Patterns Solve?

- Patterns solve **software structural problems** like:
 - Abstraction
 - Encapsulation
 - Separation of concerns
 - Coupling and cohesion
 - Separation of interface and implementation



Elements of a Design Pattern

- Pattern name - Increases **vocabulary** of designers
- Problem - **Intent**, context and when to apply
- Solution - **Abstract** code
- Consequences - **Results** and trade-offs





Benefits and Drawbacks

Why Design Patterns?

- Names form a common vocabulary
- Enable large-scale **reuse** of software architectures
- Help improve developer **communication**
- Can **speed-up** the development

- Do not lead to a direct code reuse
- Deceptively simple
- Developers may suffer from **pattern overload** and **overdesign**
- Validated by **experience** and discussion, not by automated testing
- Should be used only if **understood well**



Types of Design Patterns

- Creational patterns
 - Deal with **initialization and configuration** of classes and objects
- Structural patterns
 - Describe ways to **assemble** objects to implement **new functionality**
 - **Composition** of classes and objects
- Behavioral patterns
 - Deal with dynamic **interactions** among societies of classes
 - Distribute **responsibility**



Creational Patterns

Purposes

- Deal with **object creation** mechanisms
- Trying to create objects in a **manner suitable** to the **situation**
- Two main ideas
 - **Encapsulating** knowledge about which classes the system uses
 - **Hiding** how instances of these classes are created



List of Creational Patterns

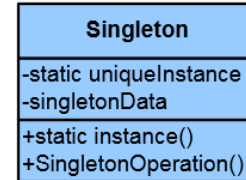
- Singleton
- Simple Factory
- Factory Method
- Abstract Factory
- Builder
- Prototype
- Fluent Interface
- Object Pool
- Lazy Initialization

Singleton

Type: Creational

What it is:

Ensure a class only has one instance and provide a global point of access to it.

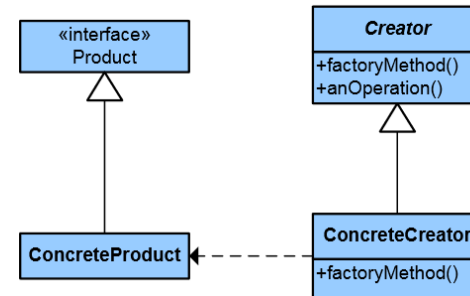


Factory Method

Type: Creational

What it is:

Define an interface for creating an object, but let subclasses decide which class to instantiate. Lets a class defer instantiation to subclasses.

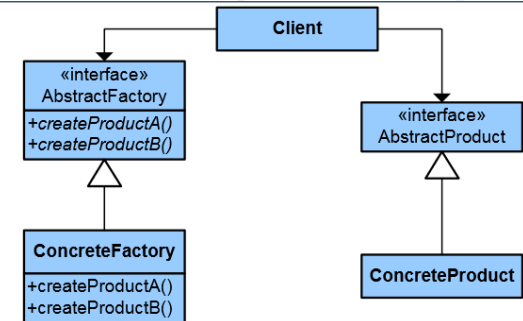


Abstract Factory

Type: Creational

What it is:

Provides an interface for creating families of related or dependent objects without specifying their concrete class.

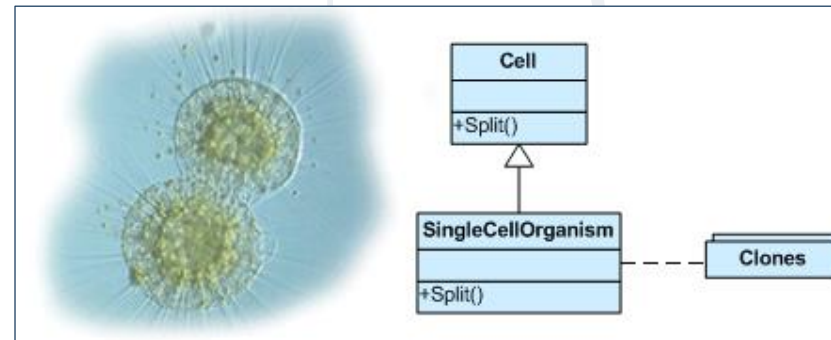
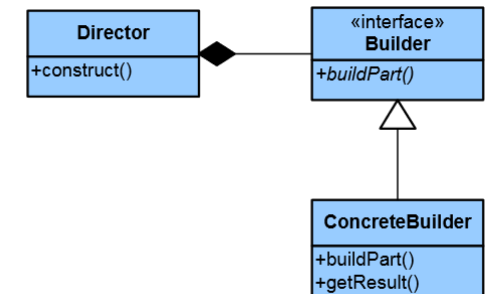


Builder

Type: Creational

What it is:

Separate the construction of a complex object from its representing so that the same construction process can create different representations.



- The most often used creational design pattern
- A Singleton class is supposed to have **only one instance**
- It is **not a global variable**
- Possible problems
 - Lazy loading
 - Thread-safe

Singleton

Type: Creational

What it is:

Ensure a class only has one instance and provide a global point of access to it.

Singleton

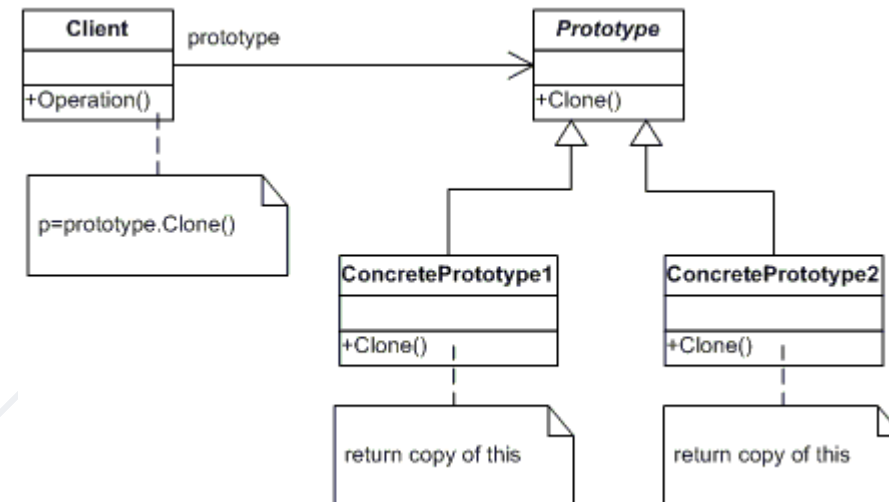
-static uniqueInstance
-singletonData

+static instance()
+SingletonOperation()

Double-Check Singleton Example

```
public sealed class Singleton {  
    private static Singleton instance;  
    private static readonly object padlock = new object();  
    private Singleton() { }  
    public static Singleton Instance {  
        get {  
            if (instance == null) {  
                lock (padlock) {  
                    if (instance == null)  
                        instance = new Singleton(); }  
                return instance; } } }  
}
```

- Factory for **cloning** new instances from a prototype
 - Create new objects by copying this prototype
 - Instead of using the "new" keyword
- **ICloneable** interface acts as Prototype



The Prototype Abstract Class

```
abstract class Prototype {  
    private string _id;  
  
    public Prototype(string id) {  
        this._id = id; }  
  
    public string Id => this._id;  
  
    public abstract Prototype Clone();  
}
```

A Concrete Prototype Class

```
class ConcretePrototype : Prototype
{
    public ConcretePrototype(string id) : base(id) { }

    public override Prototype Clone()
        => return (Prototype)this.MemberwiseClone();
}
```



Structural Patterns

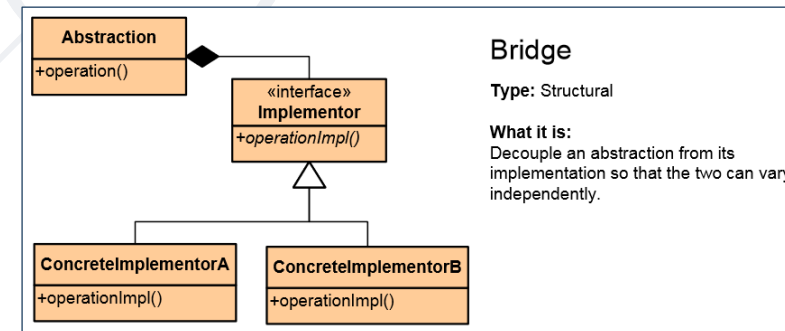
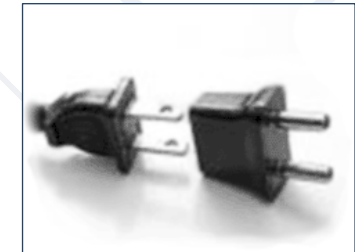
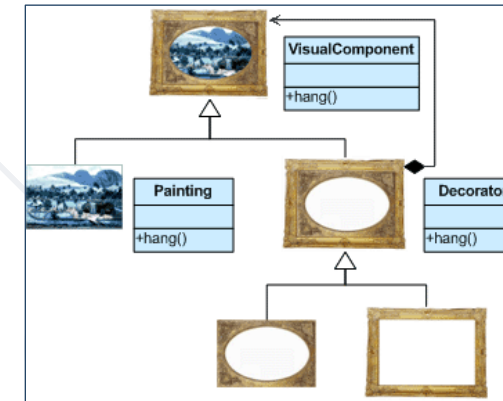
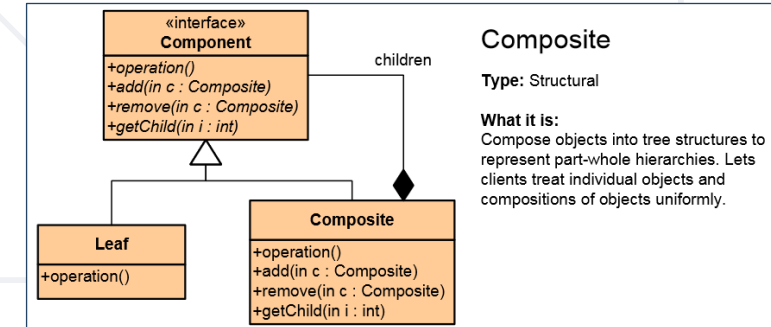
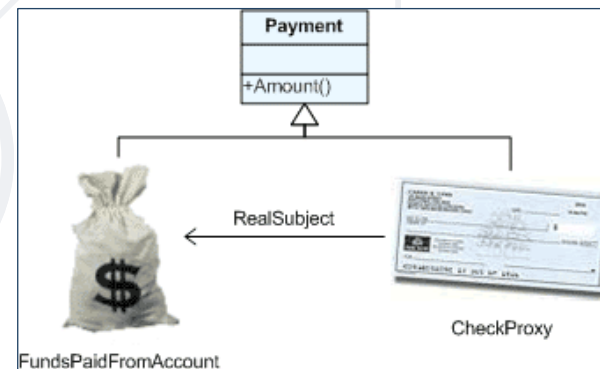
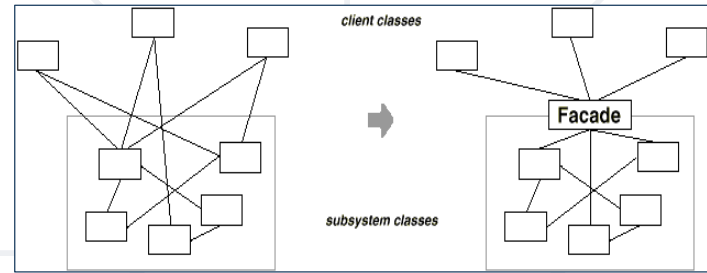
Purposes

- Describe ways to assemble **objects** to implement a **new functionality**
- Ease the design by identifying a simple way to realize **relationship** between entities
- All about Class and Object composition
 - **Inheritance** to compose interfaces
 - Ways to compose objects to obtain **new functionality**



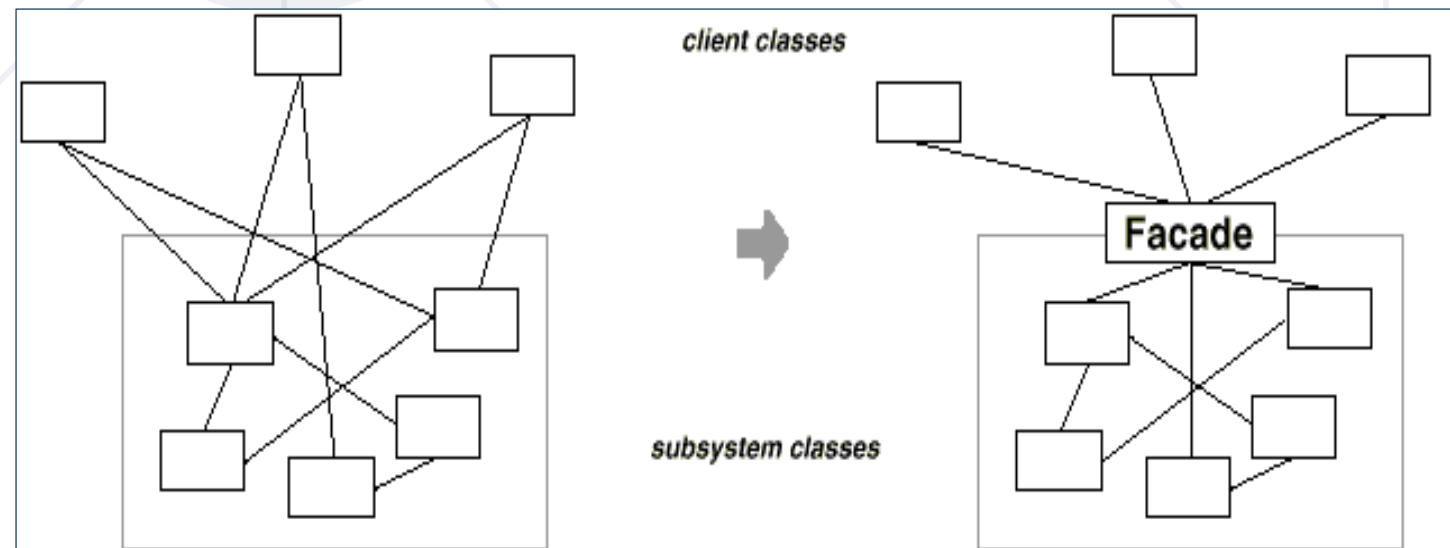
List of Structural Patterns

- Facade
- Composite
- Flyweight
- Proxy
- Decorator
- Adapter
- Bridge



Facade Pattern

- Provides a **unified interface** to a set of interfaces in a subsystem
- Defines a **higher-level interface** that makes the subsystem easier to use



The Facade Class (1)

```
class Facade
{
    private SubSystemOne _one;
    private SubSystemTwo _two;

    public Facade()
    {
        _one = new SubSystemOne();
        _two = new SubSystemTwo();
    }
}
```

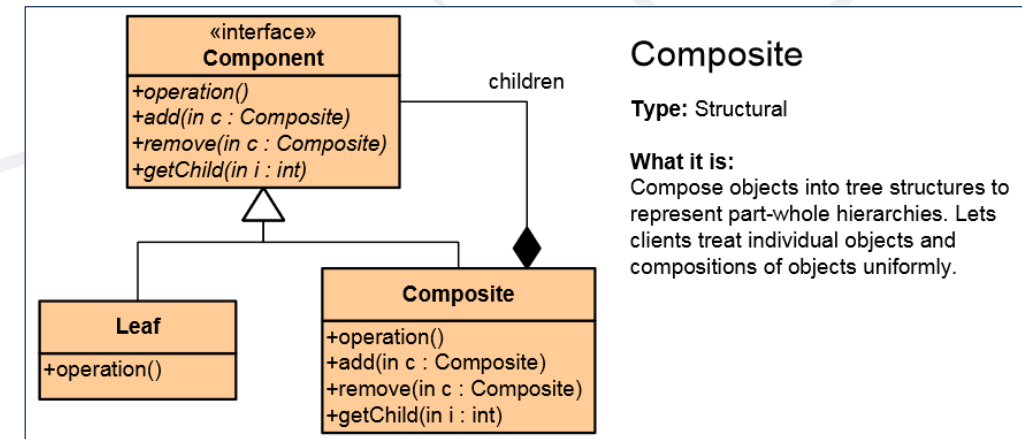
The Facade Class (2)

```
public void MethodA() {  
    Console.WriteLine("\nMethodA() ---- ");  
    _one.MethodOne();  
    _two.MethodTwo(); }  
  
public void MethodB() {  
    Console.WriteLine("\nMethodB() ---- ");  
    _two.MethodTwo(); }  
}
```

```
class SubSystemOne
{
    public void MethodOne()
        => Console.WriteLine(" SubSystemOne Method");
}
```

```
class SubSystemTwo
{
    public void MethodTwo()
        => Console.WriteLine(" SubSystemTwo Method");
}
```

- Allows to **combine** different types of objects in tree structures
- Gives the possibility to treat the **same object(s)**
- Used when
 - You have different objects that you want to **treat the same way**
 - You want to present **hierarchy** of objects



The Component Abstract Class

```
abstract class Component {  
    protected string name;  
  
    public Component(string name) {  
        this.name = name; }  
  
    public abstract void Add(Component c);  
    public abstract void Remove(Component c);  
    public abstract void Display(int depth);  
}
```

The Composite Class (1)

```
class Composite : Component {  
    private List<Component> _children = new List<Component>();  
  
    public Composite(string name) : base(name) { }  
  
    public override void Add(Component component)  
        => _children.Add(component);  
  
    public override void Remove(Component component)  
        => _children.Remove(component);  
}
```

The Composite Class (2)

```
public override void Display(int depth)
{
    Console.WriteLine(new String('-', depth) + name);

    foreach (Component component in _children)
    {
        component.Display(depth + 2);
    }
}
}
```

```
class Leaf : Component {  
    public Leaf(string name) : base(name) { }  
  
    public override void Add(Component c)  
        => Console.WriteLine("Cannot add to a leaf");  
    public override void Remove(Component c)  
        => Console.WriteLine("Cannot remove from a leaf");  
    public override void Display(int depth)  
        => Console.WriteLine(new String('-', depth) + name);  
}
```




Behavioral Patterns

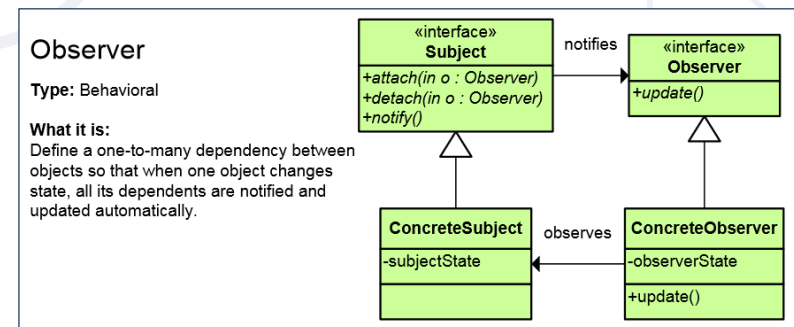
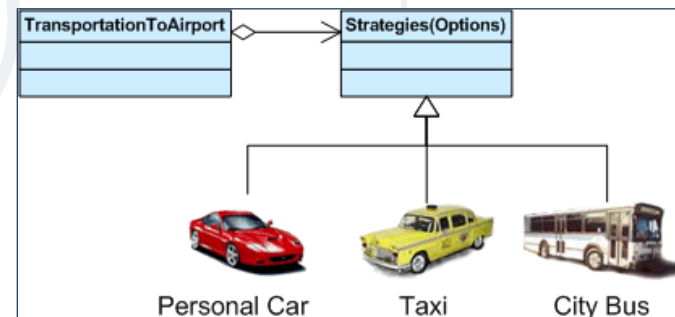
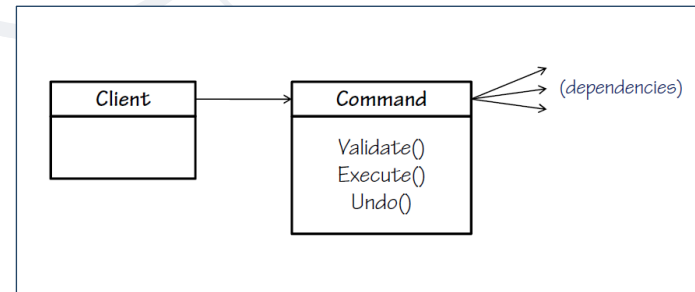
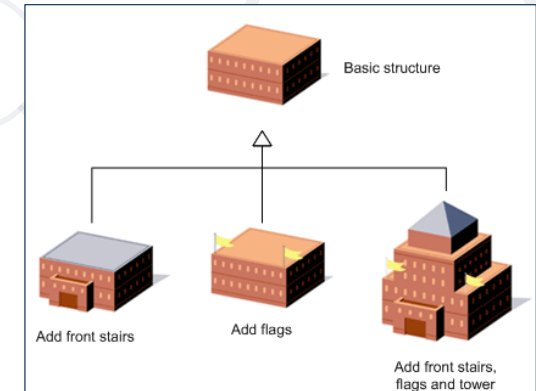
Purposes

- Concerned with **interaction** between objects
 - Either with the **assignment of responsibilities** between objects
 - Or **encapsulating behavior** in an object and delegating requests to it
- Increases **flexibility** in carrying out cross-classes communication



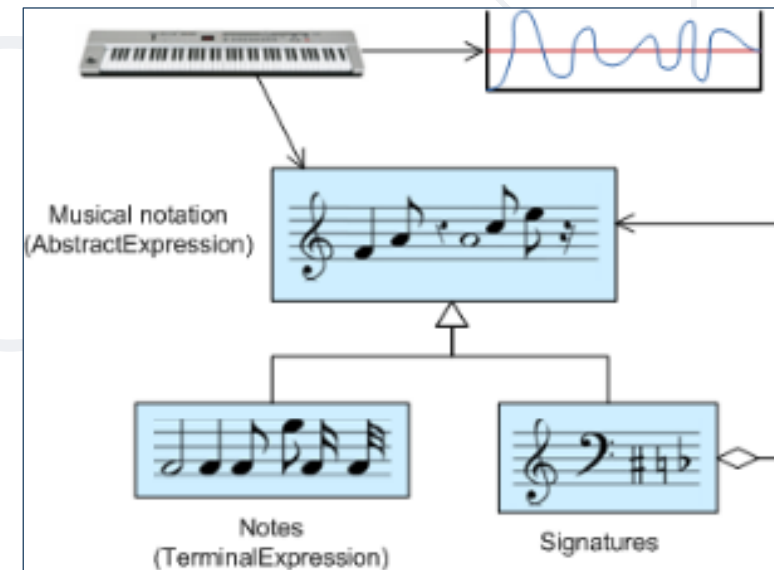
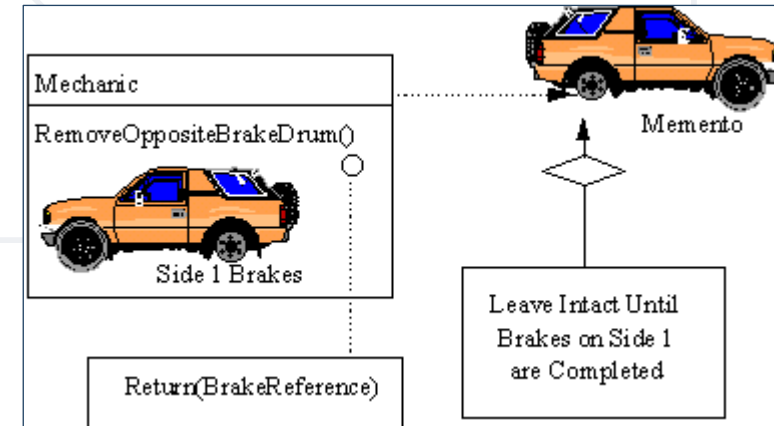
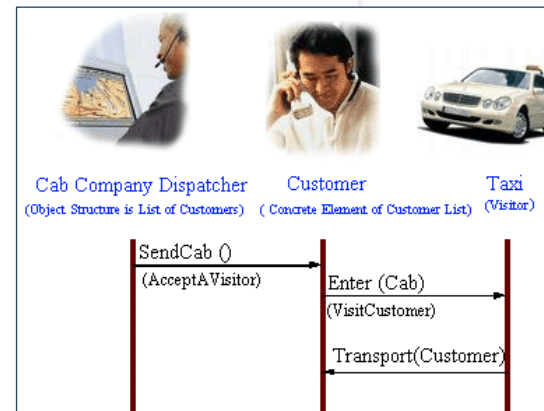
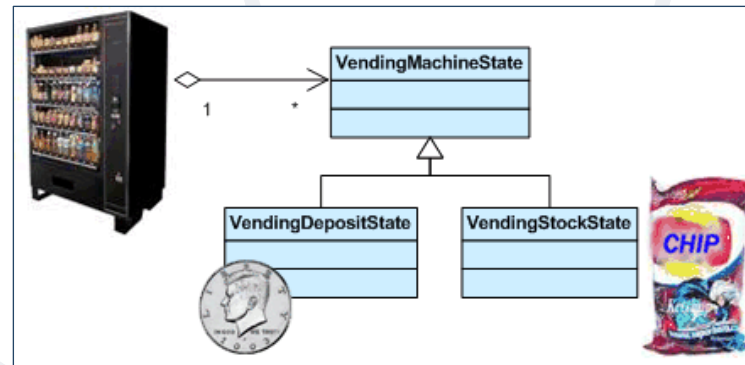
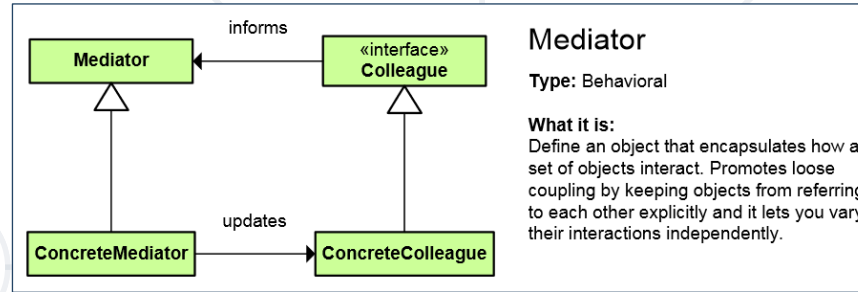
List of Behavioral Patterns (1)

- Chain of Responsibility
- Iterator
- Command
- Template Method
- Strategy
- Observer

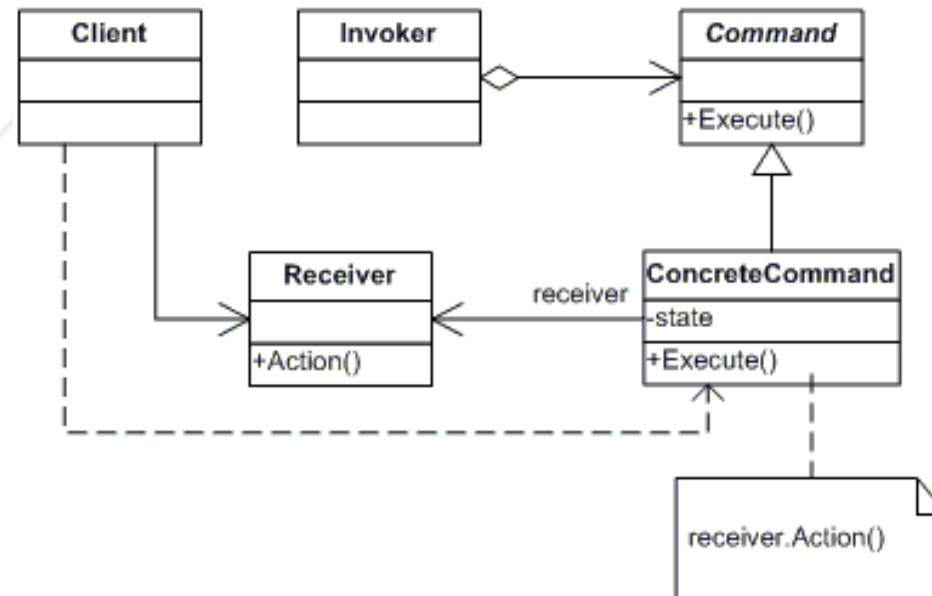


List of Behavioral Patterns (2)

- Mediator
- Memento
- State
- Interpreter
- Visitor



- An object **encapsulates** all the information needed to call a method at a later time
- Lets you **parameterize** clients with different requests, queue or log requests, and support undoable operations



The Command Abstract Class

```
abstract class Command
{
    protected Receiver receiver;

    public Command(Receiver receiver) {
        this.receiver = receiver; }

    public abstract void Execute();
}
```

```
class ConcreteCommand : Command
{
    public ConcreteCommand(Receiver receiver)
        : base(receiver) { }

    public override void Execute()
        => receiver.Action();
}
```

```
class Receiver
{
    public void Action()
    {
        Console.WriteLine("Called Receiver.Action()");
    }
}
```


The Invoker Class

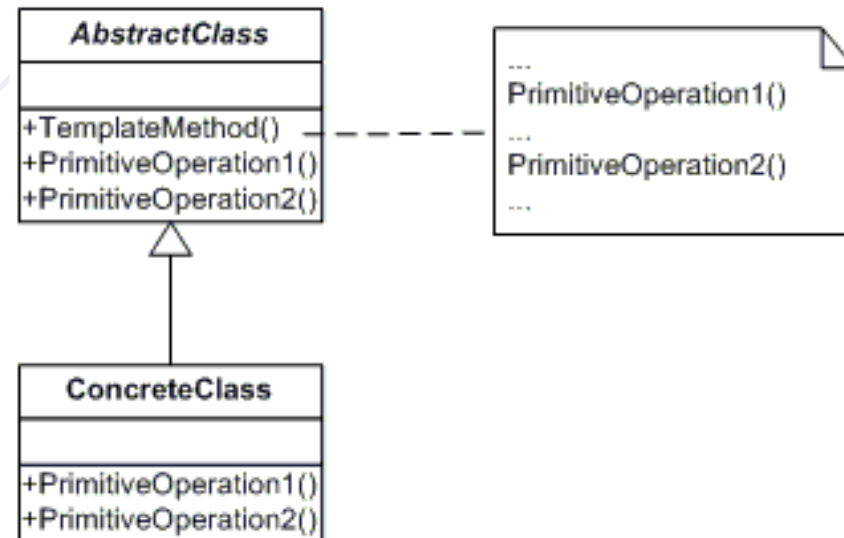
```
class Invoker
{
    private Command _command;

    public void SetCommand(Command command)
        => this._command = command;

    public void ExecuteCommand()
        => _command.Execute();
}
```

Template Method Pattern

- Define the **skeleton** of an algorithm in a method, leaving some implementation to its subclasses
- Allows the subclasses to **redefine** the implementation of some of the **parts** of the algorithm, but not its structure



```
abstract class AbstractClass
{
    public abstract void PrimitiveOperation1();
    public abstract void PrimitiveOperation2();

    public void TemplateMethod() {
        PrimitiveOperation1();
        PrimitiveOperation2();
        Console.WriteLine(""); }
}
```

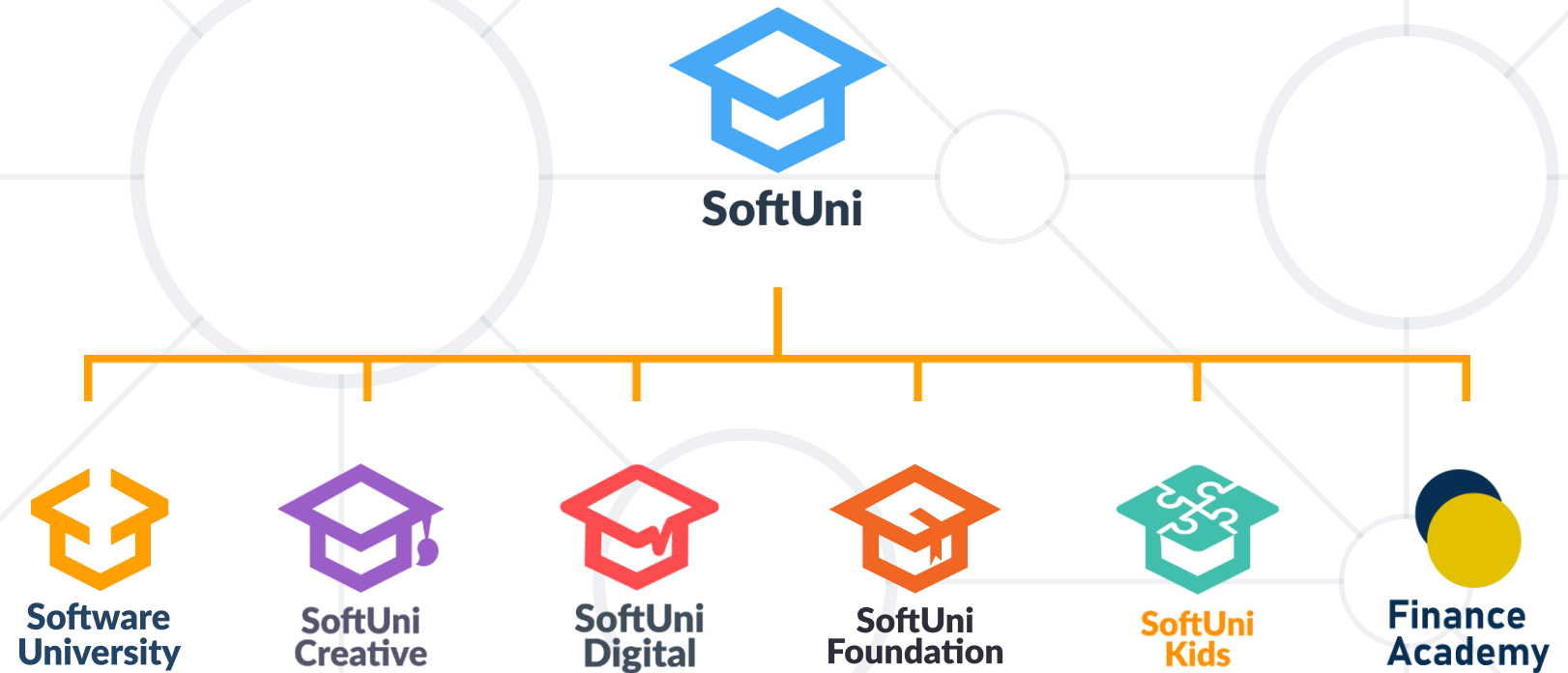
```
class ConcreteClassA : AbstractClass
{
    public override void PrimitiveOperation1()
        => Console.WriteLine("ConcreteClassA.
        PrimitiveOperation1()");

    public override void PrimitiveOperation2()
        => Console.WriteLine("ConcreteClassA
        .PrimitiveOperation2()");
}
```

- **Design Patterns**
 - Provide solution to common problems
 - Add additional layers of abstraction
- Three main types of Design Patterns
 - **Creational**
 - **Structural**
 - **Behavioral**



Questions?



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