Design Patterns

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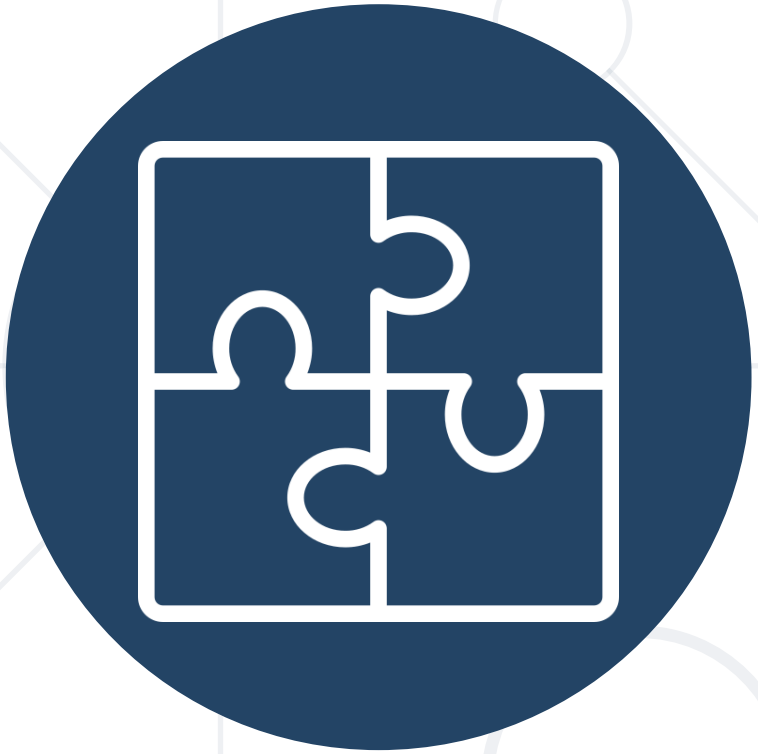
#csharp-advanced



Design Patterns

Definition, Solutions and Elements

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
  - Divide and conquer

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

Why Design Patterns?

Benefits and Drawbacks

Benefits

- Names form a common vocabulary
- Enable large-scale **reuse** of software architectures
- Help improve developer **communication**
- Help ease the **transition** to Object Oriented technology
- Can **speed-up** the development

Drawbacks

- 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 of **understood well**

Types of Design Patterns

Main Types

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- 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

Singleton Pattern

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- 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

Double-Check Singleton Example

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

Prototype Pattern

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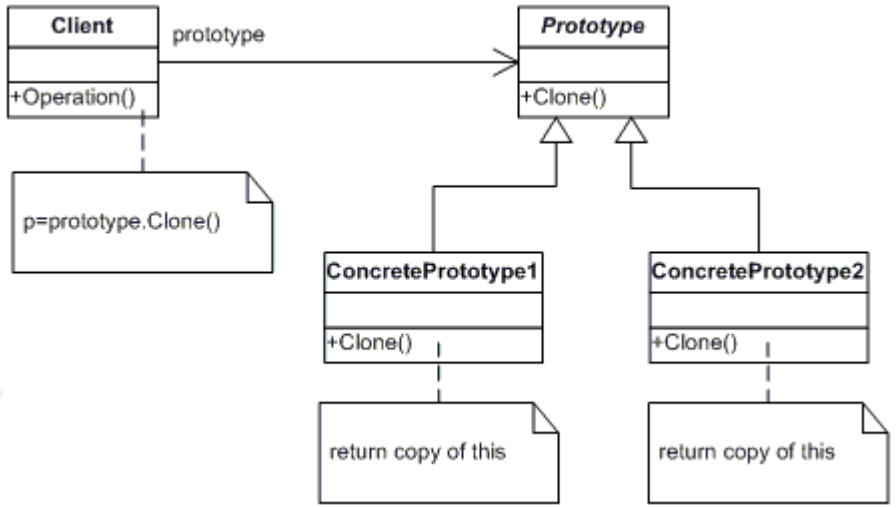
- Factory for **cloning** new instances from a prototype
  - Create new objects by copying this prototype
  - Instead if using the "new" keyword
- **ICloneable** interface acts as Prototype



The Prototype Abstract Class

SoftUni Foundation

```
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

SoftUni Foundation

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

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

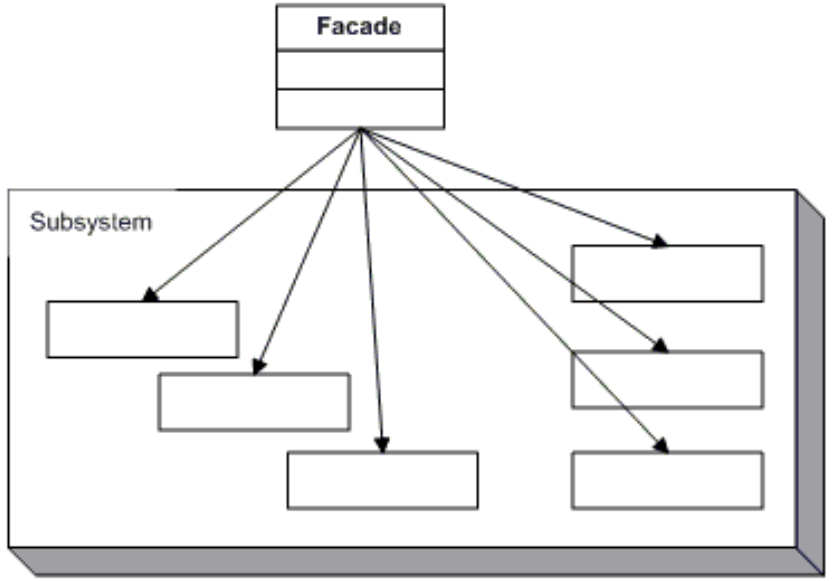
Structural Patterns

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**

Façade 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 Façade Class (1)

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

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

The Façade Class (2)

SoftUni Foundation

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

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

Subsystem Classes

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

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

Composite Pattern

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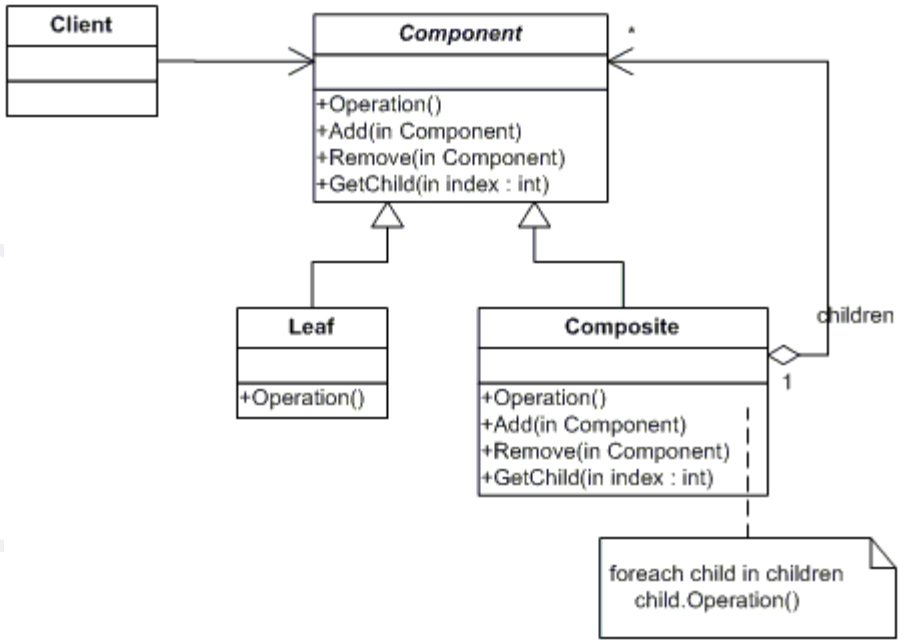
- Allows to **combine** different types of objects in tree structures
- Gives the possibility to treat the **same object(s)**
- Used when
  - You have different objects that you want to **treat the same way**
  - You want to present **hierarchy** of objects



The Component Abstract Class

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```
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)

SoftUni Foundation

```
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)

SoftUni Foundation

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

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

The Leaf Class

SoftUni Foundation

```
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);
}
```

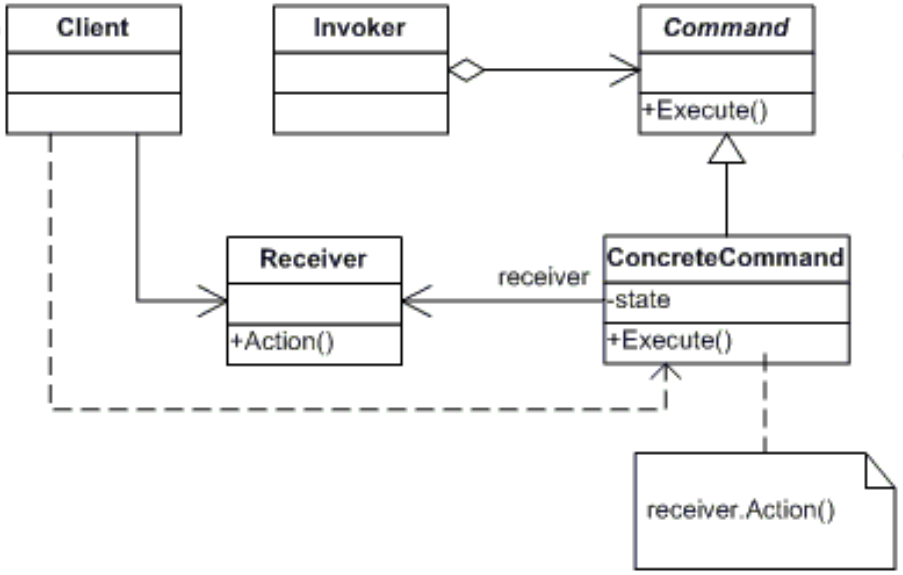
Behavioral Patterns

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

Command Pattern

- 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

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```
abstract class Command
{
  protected Receiver receiver;

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

  public abstract void Execute();
}
```

Concrete Command Class

SoftUni Foundation

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

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

The Receiver Class

SoftUni Foundation

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

The Invoker Class

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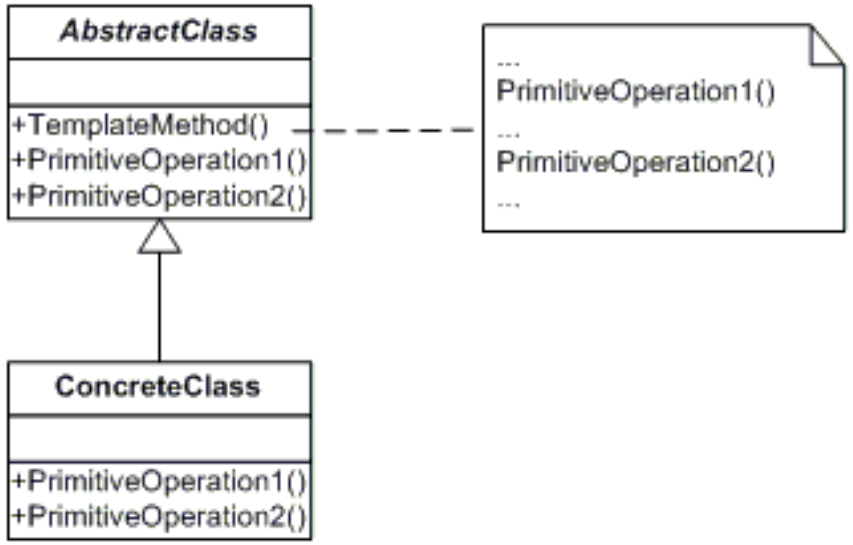
```
class Invoker
{
  private Command _command;

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

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

Template 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



The Abstract Class

SoftUni Foundation

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

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

A Concrete Class

SoftUni Foundation

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

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

Summary

- 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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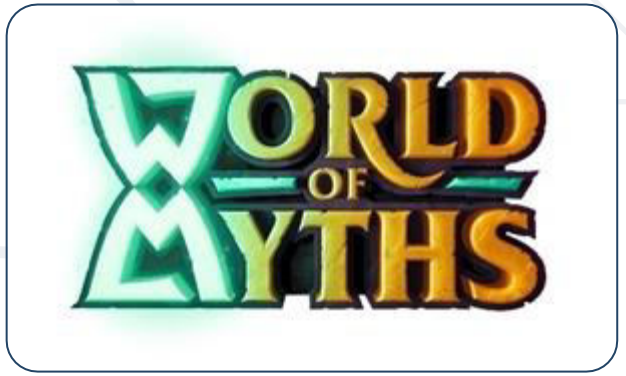

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