Lab 1: Tìm hiểu và cài đặt nhóm mẫu Creation (5 tiết)

Yêu cầu:

- Sinh viên đọc hiểu rõ mục đích, ý nghĩa và áp dụng ứng dụng của nhóm mẫu Creation.
- Sử dụng Visual Studio cài đặc nhóm mẫu trên.
- Nộp bài sau buổi thực hành: Bài tóm tắt nội dung (2 trang word)+ chương trình

Creational Patterns:

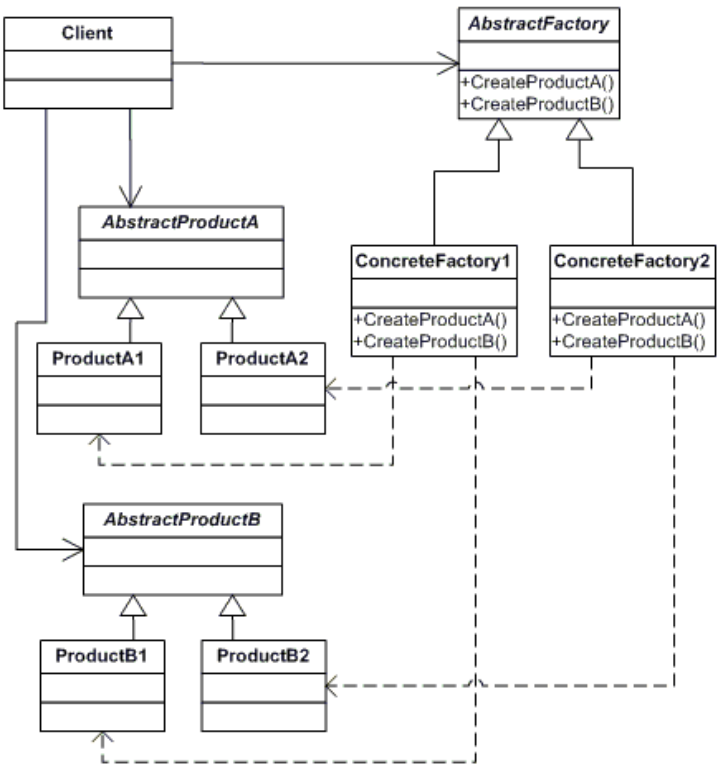
Abstract Factory	Creates an instance of several families of classes
Builder	Separates object construction from its representation
Factory Method	Creates an instance of several derived classes
Prototype	A fully initialized instance to be copied or cloned
Singleton	A class of which only a single instance can exist

1. Abstract Factory

definition

Provide an interface for creating families of related or dependent objects without specifying their concrete classes.

UML class diagram



Participants

The classes and/or objects participating in this pattern are:

- **AbstractFactory (ContinentFactory)**
  - Declares an interface for operations that create abstract products
- **ConcreteFactory (AfricaFactory, AmericaFactory)**
  - Implements the operations to create concrete product objects
- **AbstractProduct (Herbivore, Carnivore)**
  - Declares an interface for a type of product object
- **Product (Wildebeest, Lion, Bison, Wolf)**
  - Defines a product object to be created by the corresponding concrete factory
  - Implements the AbstractProduct interface
- **Client (AnimalWorld)**
  - Uses interfaces declared by AbstractFactory and AbstractProduct classes

Sample code in C#

This structural code demonstrates the Abstract Factory pattern creating parallel hierarchies of objects. Object creation has been abstracted and there is no need for hard-coded class names in the client code.

```
// Abstract Factory pattern -- Structural example

using System;

namespace DoFactory.GangOfFour.Abstract.Structural
{
  /// <summary>
  /// MainApp startup class for Structural
  /// Abstract Factory Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    public static void Main()
    {
      // Abstract factory #1
      AbstractFactory factory1 = new ConcreteFactory1();
      Client client1 = new Client(factory1);
      client1.Run();

      // Abstract factory #2
      AbstractFactory factory2 = new ConcreteFactory2();
      Client client2 = new Client(factory2);
      client2.Run();

      // Wait for user input
      Console.ReadKey();
```

```
  }
}

/// <summary>
/// The 'AbstractFactory' abstract class
/// </summary>
abstract class AbstractFactory
{
  public abstract AbstractProductA CreateProductA();
  public abstract AbstractProductB CreateProductB();
}


/// <summary>
/// The 'ConcreteFactory1' class
/// </summary>
class ConcreteFactory1 : AbstractFactory
{
  public override AbstractProductA CreateProductA()
  {
    return new ProductA1();
  }
  public override AbstractProductB CreateProductB()
  {
    return new ProductB1();
  }
}

/// <summary>
/// The 'ConcreteFactory2' class
/// </summary>
class ConcreteFactory2 : AbstractFactory
{
  public override AbstractProductA CreateProductA()
  {
    return new ProductA2();
  }
  public override AbstractProductB CreateProductB()
  {
    return new ProductB2();
  }
}

/// <summary>
/// The 'AbstractProductA' abstract class
/// </summary>
abstract class AbstractProductA
{
}

/// <summary>
```

```
/// The 'AbstractProductB' abstract class
/// </summary>
abstract class AbstractProductB
{
  public abstract void Interact(AbstractProductA a);
}


/// <summary>
/// The 'ProductA1' class
/// </summary>
class ProductA1 : AbstractProductA
{
}

/// <summary>
/// The 'ProductB1' class
/// </summary>
class ProductB1 : AbstractProductB
{
  public override void Interact(AbstractProductA a)
  {
    Console.WriteLine(this.GetType().Name + " interacts with " + a.GetType().Name);
  }
}

/// <summary>
/// The 'ProductA2' class
/// </summary>
class ProductA2 : AbstractProductA
{
}

/// <summary>
/// The 'ProductB2' class
/// </summary>
class ProductB2 : AbstractProductB
{
  public override void Interact(AbstractProductA a)
  {
    Console.WriteLine(this.GetType().Name + " interacts with " + a.GetType().Name);
  }
}

/// <summary>
/// The 'Client' class. Interaction environment for the products.
/// </summary>
class Client
{
  private AbstractProductA _abstractProductA;
  private AbstractProductB _abstractProductB;
```

```
  // Constructor
  public Client(AbstractFactory factory)
  {
    _abstractProductB = factory.CreateProductB();
    _abstractProductA = factory.CreateProductA();
  }

  public void Run()
  {
    _abstractProductB.Interact(_abstractProductA);
  }
 }
}
```

Output

```
ProductB1 interacts with ProductA1
ProductB2 interacts with ProductA2
```

This real-world code demonstrates the creation of different animal worlds for a computer game using different factories. Although the animals created by the Continent factories are different, the interactions among the animals remain the same.

```
// Abstract Factory pattern -- Real World example

using System;

namespace DoFactory.GangOfFour.Abstract.RealWorld
{
 /// <summary>
 /// MainApp startup class for Real-World
 /// Abstract Factory Design Pattern.
 /// </summary>
 class MainApp
 {
  /// <summary>
  /// Entry point into console application.
  /// </summary>
  public static void Main()
  {
   // Create and run the African animal world
   ContinentFactory africa = new AfricaFactory();
   AnimalWorld world = new AnimalWorld(africa);
   world.RunFoodChain();

   // Create and run the American animal world
   ContinentFactory america = new AmericaFactory();
   world = new AnimalWorld(america);
   world.RunFoodChain();
```

```
    // Wait for user input
    Console.ReadKey();
  }
}


/// <summary>
/// The 'AbstractFactory' abstract class
/// </summary>
abstract class ContinentFactory
{
  public abstract Herbivore CreateHerbivore();
  public abstract Carnivore CreateCarnivore();
}

/// <summary>
/// The 'ConcreteFactory1' class
/// </summary>
class AfricaFactory : ContinentFactory
{
  public override Herbivore CreateHerbivore()
  {
    return new Wildebeest();
  }
  public override Carnivore CreateCarnivore()
  {
    return new Lion();
  }
}

/// <summary>
/// The 'ConcreteFactory2' class
/// </summary>
class AmericaFactory : ContinentFactory
{
  public override Herbivore CreateHerbivore()
  {
    return new Bison();
  }
  public override Carnivore CreateCarnivore()
  {
    return new Wolf();
  }
}

/// <summary>
/// The 'AbstractProductA' abstract class
/// </summary>
abstract class Herbivore
{
```

```
}

/// <summary>
/// The 'AbstractProductB' abstract class
/// </summary>
abstract class Carnivore
{
  public abstract void Eat(Herbivore h);
}

/// <summary>
/// The 'ProductA1' class
/// </summary>
class Wildebeest : Herbivore
{
}

/// <summary>
/// The 'ProductB1' class
/// </summary>
class Lion : Carnivore
{
  public override void Eat(Herbivore h)
  {
    // Eat Wildebeest
    Console.WriteLine(this.GetType().Name + " eats " + h.GetType().Name);
  }
}

/// <summary>
/// The 'ProductA2' class
/// </summary>
class Bison : Herbivore
{
}

/// <summary>
/// The 'ProductB2' class
/// </summary>
class Wolf : Carnivore
{
  public override void Eat(Herbivore h)
  {
    // Eat Bison
    Console.WriteLine(this.GetType().Name + " eats " + h.GetType().Name);
  }
}

/// <summary>
/// The 'Client' class
/// </summary>
```

```
class AnimalWorld
{
  private Herbivore _herbivore;
  private Carnivore _carnivore;

  // Constructor
  public AnimalWorld(ContinentFactory factory)
  {
    _carnivore = factory.CreateCarnivore();
    _herbivore = factory.CreateHerbivore();
  }

  public void RunFoodChain()
  {
    _carnivore.Eat(_herbivore);
  }
 }
}
```

Output

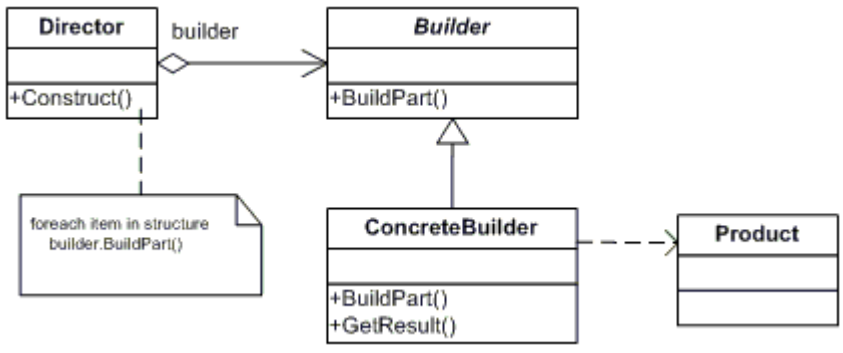
```
Lion eats Wildebeest
Wolf eats Bison
```

2. Builder

Definition

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

UML class diagram



Participants

The classes and/or objects participating in this pattern are:

- **Builder (VehicleBuilder)**
  - Specifies an abstract interface for creating parts of a Product object

- **ConcreteBuilder (MotorCycleBuilder, CarBuilder, ScooterBuilder)**
  - Constructs and assembles parts of the product by implementing the Builder interface
  - Defines and keeps track of the representation it creates
  - Provides an interface for retrieving the product
- **Director (Shop)**
  - Constructs an object using the Builder interface
- **Product (Vehicle)**
  - Represents the complex object under construction. ConcreteBuilder builds the product's internal representation and defines the process by which it's assembled
  - Includes classes that define the constituent parts, including interfaces for assembling the parts into the final result

Sample code in C#

This structural code demonstrates the Builder pattern in which complex objects are created in a step-by-step fashion. The construction process can create different object representations and provides a high level of control over the assembly of the objects.

```
// Builder pattern -- Structural example

using System;
using System.Collections.Generic;

namespace DoFactory.GangOfFour.Builder.Structural
{
  /// <summary>
  /// MainApp startup class for Structural
  /// Builder Design Pattern.
  /// </summary>
  public class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    public static void Main()
    {
      // Create director and builders
      Director director = new Director();

      Builder b1 = new ConcreteBuilder1();
      Builder b2 = new ConcreteBuilder2();

      // Construct two products
      director.Construct(b1);
      Product p1 = b1.GetResult();
      p1.Show();

      director.Construct(b2);
      Product p2 = b2.GetResult();
      p2.Show();
```

```
    // Wait for user
    Console.ReadKey();
  }
}

/// <summary>
/// The 'Director' class
/// </summary>
class Director
{
  // Builder uses a complex series of steps
  public void Construct(Builder builder)
  {
    builder.BuildPartA();
    builder.BuildPartB();
  }
}

/// <summary>
/// The 'Builder' abstract class
/// </summary>
abstract class Builder
{
  public abstract void BuildPartA();
  public abstract void BuildPartB();
  public abstract Product GetResult();
}

/// <summary>
/// The 'ConcreteBuilder1' class
/// </summary>
class ConcreteBuilder1 : Builder
{
  private Product _product = new Product();

  public override void BuildPartA()
  {
    _product.Add("PartA");
  }

  public override void BuildPartB()
  {
    _product.Add("PartB");
  }

  public override Product GetResult()
  {
    return _product;
  }
}
```

```
/// <summary>
/// The 'ConcreteBuilder2' class
/// </summary>
class ConcreteBuilder2 : Builder
{
  private Product _product = new Product();

  public override void BuildPartA()
  {
    _product.Add("PartX");
  }

  public override void BuildPartB()
  {
    _product.Add("PartY");
  }

  public override Product GetResult()
  {
    return _product;
  }
}

/// <summary>
/// The 'Product' class
/// </summary>
class Product
{
  private List<string> _parts = new List<string>();

  public void Add(string part)
  {
    _parts.Add(part);
  }

  public void Show()
  {
    Console.WriteLine("\nProduct Parts -------");
    foreach (string part in _parts)
      Console.WriteLine(part);
  }
 }
}
```

Output

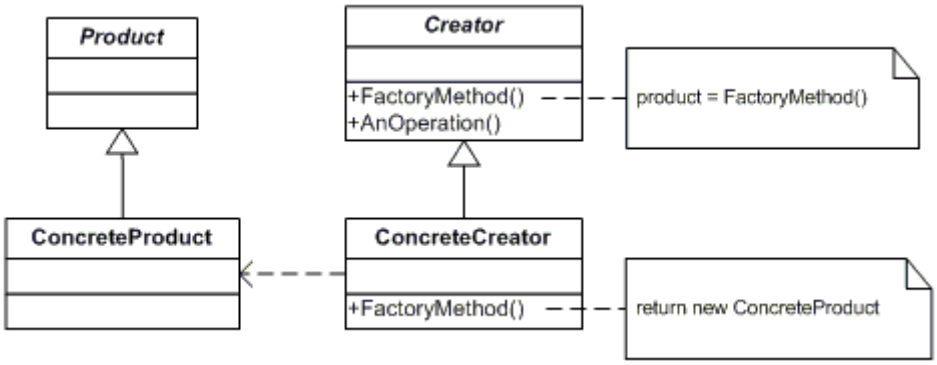
```
Product Parts -------
PartA
PartB

Product Parts -------
PartX
PartY
```

3. Factory Method

Definition

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

UML class diagram



Participants

The classes and/or objects participating in this pattern are:

- **Product (Page)**
  - Defines the interface of objects the factory method creates
- **ConcreteProduct (SkillsPage, EducationPage, ExperiencePage)**
  - Implements the Product interface
- **Creator (Document)**
  - Declares the factory method, which returns an object of type Product. Creator may also define a default implementation of the factory method that returns a default ConcreteProduct object.
  - May call the factory method to create a Product object.
- **ConcreteCreator (Report, Resume)**
  - Overrides the factory method to return an instance of a ConcreteProduct.

Sample code in C#

This structural code demonstrates the Factory method offering great flexibility in creating different objects. The Abstract class may provide a default object, but each subclass can instantiate an extended version of the object.

```
// Factory Method pattern -- Structural example

using System;

namespace DoFactory.GangOfFour.Factory.Structural
{
  /// <summary>
  /// MainApp startup class for Structural
  /// Factory Method Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    static void Main()
    {
      // An array of creators
      Creator[] creators = new Creator[2];

      creators[0] = new ConcreteCreatorA();
      creators[1] = new ConcreteCreatorB();

      // Iterate over creators and create products
      foreach (Creator creator in creators)
      {
        Product product = creator.FactoryMethod();
        Console.WriteLine("Created {0}",   product.GetType().Name);
      }

      // Wait for user
      Console.ReadKey();
    }
  }

  /// <summary>
  /// The 'Product' abstract class
  /// </summary>
  abstract class Product
  {
  }

  /// <summary>
  /// A 'ConcreteProduct' class
  /// </summary>
  class ConcreteProductA : Product
  {
  }

  /// <summary>
  /// A 'ConcreteProduct' class
```

```
/// </summary>
class ConcreteProductB : Product
{
}

/// <summary>
/// The 'Creator' abstract class
/// </summary>
abstract class Creator
{
  public abstract Product FactoryMethod();
}

/// <summary>
/// A 'ConcreteCreator' class
/// </summary>
class ConcreteCreatorA : Creator
{
  public override Product FactoryMethod()
  {
    return new ConcreteProductA();
  }
}

/// <summary>
/// A 'ConcreteCreator' class
/// </summary>
class ConcreteCreatorB : Creator
{
  public override Product FactoryMethod()
  {
    return new ConcreteProductB();
  }
 }
}
```

Output

```
Created ConcreteProductA
Created ConcreteProductB
```

This real-world code demonstrates the Factory method offering flexibility in creating different documents. The derived Document classes Report and Resume instantiate extended versions of the Document class. Here, the Factory Method is called in the constructor of the Document base class.

```
// Factory Method pattern -- Real World example

using System;
using System.Collections.Generic;
```

```
namespace DoFactory.GangOfFour.Factory.RealWorld
{
  /// <summary>
  /// MainApp startup class for Real-World
  /// Factory Method Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    static void Main()
    {
      // Note: constructors call Factory Method
      Document[] documents = new Document[2];

      documents[0] = new Resume();
      documents[1] = new Report();

      // Display document pages
      foreach (Document document in documents)
      {
        Console.WriteLine("\n" + document.GetType().Name + "--");
        foreach (Page page in document.Pages)
        {
          Console.WriteLine(" " + page.GetType().Name);
        }
      }

      // Wait for user
      Console.ReadKey();
    }
  }

  /// <summary>
  /// The 'Product' abstract class
  /// </summary>
  abstract class Page
  {
  }

  /// <summary>
  /// A 'ConcreteProduct' class
  /// </summary>
  class SkillsPage : Page
  {
  }

  /// <summary>
  /// A 'ConcreteProduct' class
  /// </summary>
```

```
class EducationPage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class ExperiencePage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class IntroductionPage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class ResultsPage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class ConclusionPage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class SummaryPage : Page
{
}

/// <summary>
/// A 'ConcreteProduct' class
/// </summary>
class BibliographyPage : Page
{
}

/// <summary>
/// The 'Creator' abstract class
/// </summary>
abstract class Document
{
```

```
  private List<Page> _pages = new List<Page>();

  // Constructor calls abstract Factory method
  public Document()
  {
    this.CreatePages();
  }

  public List<Page> Pages
  {
    get { return _pages; }
  }

  // Factory Method
  public abstract void CreatePages();
}

/// <summary>
/// A 'ConcreteCreator' class
/// </summary>
class Resume : Document
{
  // Factory Method implementation
  public override void CreatePages()
  {
    Pages.Add(new SkillsPage());
    Pages.Add(new EducationPage());
    Pages.Add(new ExperiencePage());
  }
}

/// <summary>
/// A 'ConcreteCreator' class
/// </summary>
class Report : Document
{
  // Factory Method implementation
  public override void CreatePages()
  {
    Pages.Add(new IntroductionPage());
    Pages.Add(new ResultsPage());
    Pages.Add(new ConclusionPage());
    Pages.Add(new SummaryPage());
    Pages.Add(new BibliographyPage());
  }
 }
}
```

Output

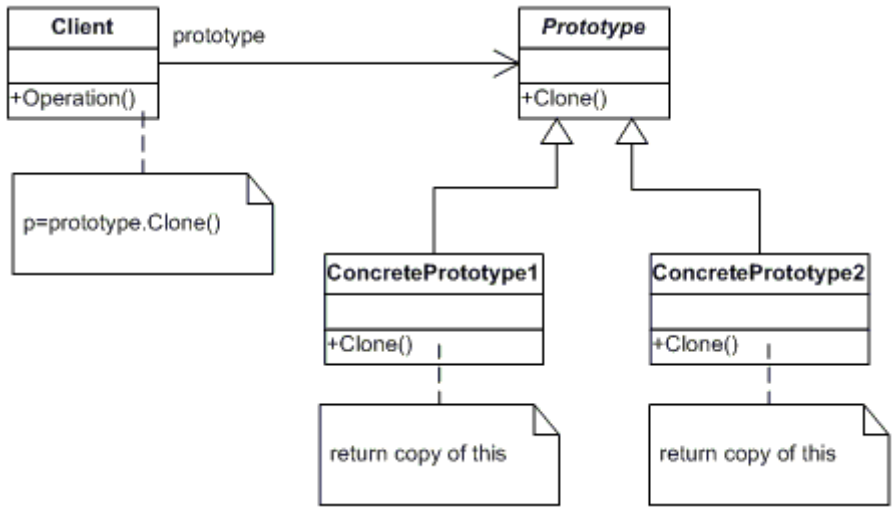
```
Resume -------
 SkillsPage
 EducationPage
 ExperiencePage

Report -------
 IntroductionPage
 ResultsPage
 ConclusionPage
 SummaryPage
 BibliographyPage
```

4. Prototype

Definition

Specify the kind of objects to create using a prototypical instance, and create new objects by copying this prototype.

UML class diagram



Participants

The classes and/or objects participating in this pattern are:

- **Prototype (ColorPrototype)**
  - Declares an interface for cloning itself
- **ConcretePrototype (Color)**
  - Implements an operation for cloning itself
- **Client (ColorManager)**
  - Creates a new object by asking a prototype to clone itself

Sample code in C#

This structural code demonstrates the Prototype pattern in which new objects are created by

copying pre-existing objects (prototypes) of the same class.

```
// Prototype pattern -- Structural example

using System;

namespace DoFactory.GangOfFour.Prototype.Structural
{
  /// <summary>
  /// MainApp startup class for Structural
  /// Prototype Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    static void Main()
    {
      // Create two instances and clone each

      ConcretePrototype1 p1 = new ConcretePrototype1("I");
      ConcretePrototype1 c1 = (ConcretePrototype1)p1.Clone();
      Console.WriteLine("Cloned: {0}", c1.Id);

      ConcretePrototype2 p2 = new ConcretePrototype2("II");
      ConcretePrototype2 c2 = (ConcretePrototype2)p2.Clone();
      Console.WriteLine("Cloned: {0}", c2.Id);

      // Wait for user
      Console.ReadKey();
    }
  }

  /// <summary>
  /// The 'Prototype' abstract class
  /// </summary>
  abstract class Prototype
  {
    private string _id;

    // Constructor
    public Prototype(string id)
    {
      this._id = id;
    }

    // Gets id
    public string Id
    {
      get { return _id; }
```

```
  }

  public abstract Prototype Clone();
 }

 /// <summary>
 /// A 'ConcretePrototype' class
 /// </summary>
 class ConcretePrototype1 : Prototype
 {
  // Constructor
  public ConcretePrototype1(string id)
    : base(id)
  {
  }

  // Returns a shallow copy
  public override Prototype Clone()
  {
    return (Prototype)this.MemberwiseClone();
  }
 }

 /// <summary>
 /// A 'ConcretePrototype' class
 /// </summary>
 class ConcretePrototype2 : Prototype
 {
  // Constructor
  public ConcretePrototype2(string id)
    : base(id)
  {
  }

  // Returns a shallow copy
  public override Prototype Clone()
  {
    return (Prototype)this.MemberwiseClone();
  }
 }
}
```

Output

```
Cloned: I
Cloned: II
```

This real-world code demonstrates the Prototype pattern in which new Color objects are created by copying pre-existing, user-defined Colors of the same type.

```
// Prototype pattern -- Real World example
```

```
using System;
using System.Collections.Generic;

namespace DoFactory.GangOfFour.Prototype.RealWorld
{
  /// <summary>
  /// MainApp startup class for Real-World
  /// Prototype Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    static void Main()
    {
      ColorManager colormanager = new ColorManager();

      // Initialize with standard colors
      colormanager["red"] = new Color(255, 0, 0);
      colormanager["green"] = new Color(0, 255, 0);
      colormanager["blue"] = new Color(0, 0, 255);

      // User adds personalized colors
      colormanager["angry"] = new Color(255, 54, 0);
      colormanager["peace"] = new Color(128, 211, 128);
      colormanager["flame"] = new Color(211, 34, 20);

      // User clones selected colors
      Color color1 = colormanager["red"].Clone() as Color;
      Color color2 = colormanager["peace"].Clone() as Color;
      Color color3 = colormanager["flame"].Clone() as Color;

      // Wait for user
      Console.ReadKey();
    }
  }

  /// <summary>
  /// The 'Prototype' abstract class
  /// </summary>
  abstract class ColorPrototype
  {
    public abstract ColorPrototype Clone();
  }

  /// <summary>
  /// The 'ConcretePrototype' class
  /// </summary>
  class Color : ColorPrototype
```

```
{
  private int _red;
  private int _green;
  private int _blue;

  // Constructor
  public Color(int red, int green, int blue)
  {
    this._red = red;
    this._green = green;
    this._blue = blue;
  }

  // Create a shallow copy
  public override ColorPrototype Clone()
  {
    Console.WriteLine(
      "Cloning color RGB: {0,3},{1,3},{2,3}",
      _red, _green, _blue);

    return this.MemberwiseClone() as ColorPrototype;
  }
}

/// <summary>
/// Prototype manager
/// </summary>
class ColorManager
{
  private Dictionary<string, ColorPrototype> _colors =
    new Dictionary<string, ColorPrototype>();

  // Indexer
  public ColorPrototype this[string key]
  {
    get { return _colors[key]; }
    set { _colors.Add(key, value); }
  }
}
```

Output

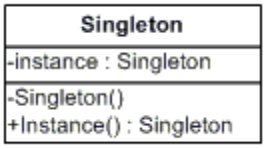
```
Cloning color RGB: 255,  0,  0
Cloning color RGB: 128,211,128
Cloning color RGB: 211, 34, 20
```

5. Singleton

Definition

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

UML class diagram



Participants

The classes and/or objects participating in this pattern are:

- **Singleton (LoadBalancer)**
  - Defines an Instance operation that lets clients access its unique instance. Instance is a class operation.
  - Responsible for creating and maintaining its own unique instance.

Sample code in C#

This structural code demonstrates the Singleton pattern which assures only a single instance (the singleton) of the class can be created.

```
// Singleton pattern -- Structural example

using System;

namespace DoFactory.GangOfFour.Singleton.Structural
{
  /// <summary>
  /// MainApp startup class for Structural
  /// Singleton Design Pattern.
  /// </summary>
  class MainApp
  {
    /// <summary>
    /// Entry point into console application.
    /// </summary>
    static void Main()
    {
      // Constructor is protected -- cannot use new
      Singleton s1 = Singleton.Instance();
      Singleton s2 = Singleton.Instance();

      // Test for same instance
      if (s1 == s2)
      {
        Console.WriteLine("Objects are the same instance");
      }
```

```
    // Wait for user
    Console.ReadKey();
  }
 }

 /// <summary>
 /// The 'Singleton' class
 /// </summary>
 class Singleton
 {
  private static Singleton _instance;

  // Constructor is 'protected'
  protected Singleton()
  {
  }

  public static Singleton Instance()
  {
   // Uses lazy initialization.
   // Note: this is not thread safe.
   if (_instance == null)
   {
    _instance = new Singleton();
   }

   return _instance;
  }
 }
}
```

Output

```
Objects are the same instance
```

This real-world code demonstrates the Singleton pattern as a LoadBalancing object. Only a single instance (the singleton) of the class can be created because servers may dynamically come on- or off-line and every request must go throught the one object that has knowledge about the state of the (web) farm.

```
// Singleton pattern -- Real World example

using System;
using System.Collections.Generic;
using System.Threading;

namespace DoFactory.GangOfFour.Singleton.RealWorld
{
 /// <summary>
 /// MainApp startup class for Real-World
 /// Singleton Design Pattern.
```

```
/// </summary>
class MainApp
{
  /// <summary>
  /// Entry point into console application.
  /// </summary>
  static void Main()
  {
    LoadBalancer b1 = LoadBalancer.GetLoadBalancer();
    LoadBalancer b2 = LoadBalancer.GetLoadBalancer();
    LoadBalancer b3 = LoadBalancer.GetLoadBalancer();
    LoadBalancer b4 = LoadBalancer.GetLoadBalancer();

    // Same instance?
    if (b1 == b2 && b2 == b3 && b3 == b4)
    {
      Console.WriteLine("Same instance\n");
    }

    // Load balance 15 server requests
    LoadBalancer balancer = LoadBalancer.GetLoadBalancer();
    for (int i = 0; i < 15; i++)
    {
      string server = balancer.Server;
      Console.WriteLine("Dispatch Request to: " + server);
    }

    // Wait for user
    Console.ReadKey();
  }
}

/// <summary>
/// The 'Singleton' class
/// </summary>
class LoadBalancer
{
  private static LoadBalancer _instance;
  private List<string> _servers = new List<string>();
  private Random _random = new Random();

  // Lock synchronization object
  private static object syncLock = new object();

  // Constructor (protected)
  protected LoadBalancer()
  {
    // List of available servers
    _servers.Add("ServerI");
    _servers.Add("ServerII");
    _servers.Add("ServerIII");
```

```
    _servers.Add("ServerIV");
    _servers.Add("ServerV");
  }

  public static LoadBalancer GetLoadBalancer()
  {
    // Support multithreaded applications through
    // 'Double checked locking' pattern which (once
    // the instance exists) avoids locking each
    // time the method is invoked
    if (_instance == null)
    {
      lock (syncLock)
      {
        if (_instance == null)
        {
          _instance = new LoadBalancer();
        }
      }
    }

    return _instance;
  }

  // Simple, but effective random load balancer
  public string Server
  {
    get
    {
      int r = _random.Next(_servers.Count);
      return _servers[r].ToString();
    }
  }
 }
}
```

Output

```
Same instance

ServerIII
ServerII
ServerI
ServerII
ServerI
ServerIII
ServerI
ServerIII
ServerIV
ServerII
ServerII
ServerIII
ServerIV
ServerII
ServerIV
```