

Object-Oriented Programming

Objectives

- ◆ Explain about OOP
- ◆ Explain classes and objects
- ◆ Define and describe methods
- ◆ Explain about the access modifiers
- ◆ Define and describe inheritance
- ◆ Explain about method overriding
- ◆ Explain about polymorphism and abstraction

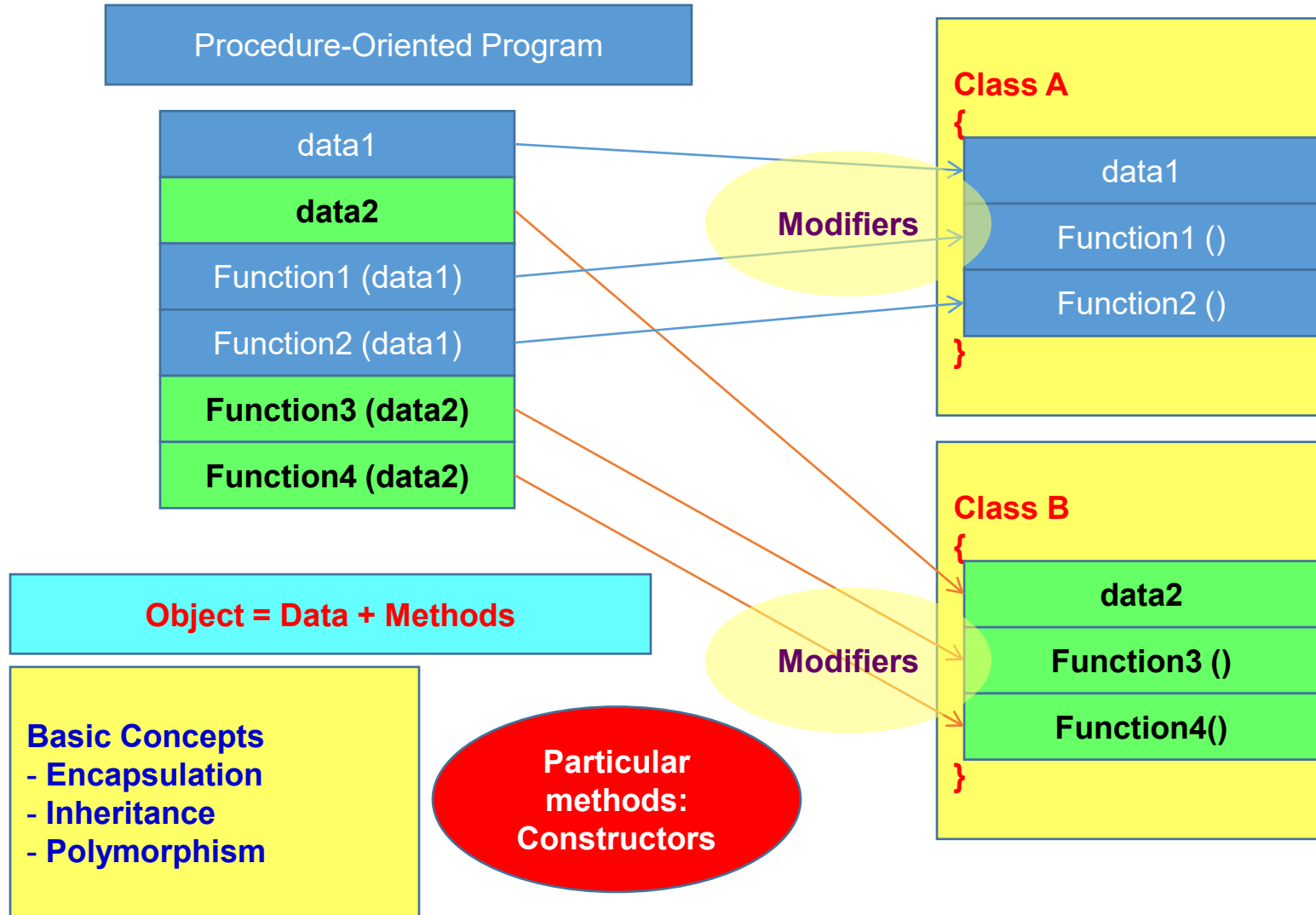
Objectives

- ◆ Discuss more new features in OOP :
 - Properties, Auto-implemented properties
 - Static class and Extension Method
 - Anonymous Type and Default constructor
 - Readonly members and Default interface methods
 - Using declarations
 - Expression-bodied members
 - Record type
 - Object Initialize
 - Read-only auto-properties and Init-Only Properties

Object-Oriented Programming(OOP)

- ◆ Programming languages are based on two fundamental concepts: data and ways to manipulate data. This approach had several drawbacks such as lack of **re-use** and lack of **maintainability**
- ◆ To overcome these difficulties, OOP was introduced, which focused on data rather than the ways to manipulate data
- ◆ The object-oriented approach defines objects as entities having a defined set of values and a defined set of operations that can be performed on these values
- ◆ **Abstraction, encapsulation, polymorphism, and inheritance** are the core principles of object-oriented programming

OOP Paradigm

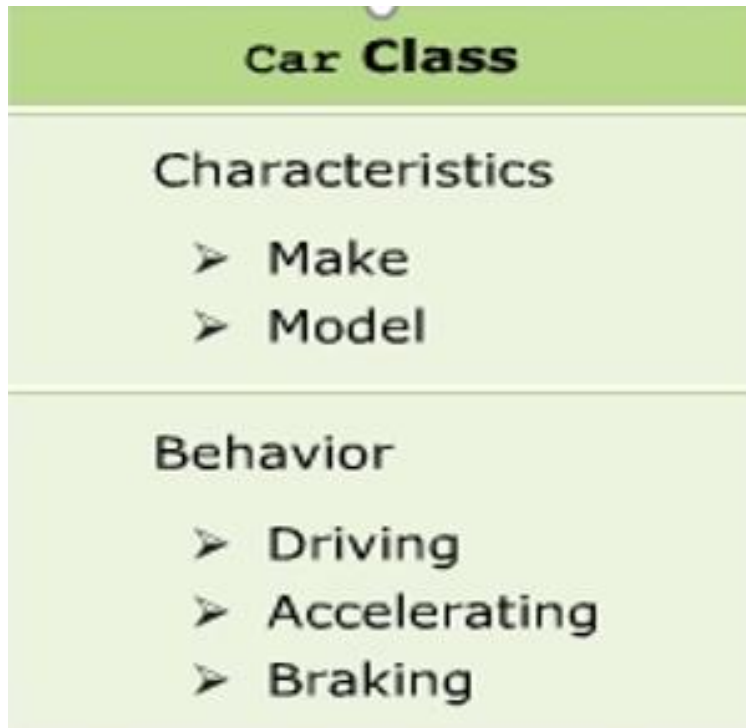


Object-Oriented Programming

- ◆ OOP is a powerful concept that solves many problems found in software development. OOP is not the holy grail of programming but it can help in writing code that is easy to read, easy to maintain, easy to update, and easy to expand
- ◆ An object can inherit the properties of another object using the concept of **inheritance**. Hence, we can say that object-oriented programming is organized around data and the operations that are permitted on the data
- ◆ When we do object-oriented programming, we start with identifying the entities we need to operate on, how they relate to each other, and how they interact. This is a process called **data modeling** and the result of this is a set of classes that generalize the identified entities

Classes and Objects

- ◆ A class is a user-defined blueprint or prototype from which objects are created. Basically, a class combines the fields and methods (member function which defines actions) into a single unit

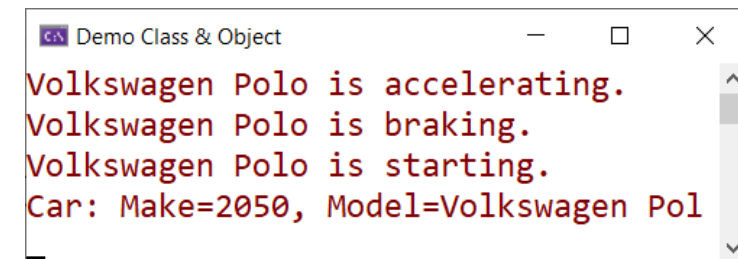


Classes and Objects

- ◆ An object is an instance of the class and represents a real-life entity. To initialize an object in C#, we use a **new** keyword followed by the name of the class that the object will be based on

```
public class Car{
    public string Make;
    public string Model;
    public void Starting(){
        Console.WriteLine($"{Model} is starting.");
    }
    public void Accelerating(){
        Console.WriteLine($"{Model} is accelerating.");
    }
    public void Braking(){
        Console.WriteLine($"{Model} is braking.");
    }
    public override string ToString() {
        return $"Make={Make}, Model={Model}";
    }
}
```

```
class Program{
    static void Main(string[] args){
        Car wwPolo = new Car();
        wwPolo.Make = "2050";
        wwPolo.Model = "Volkswagen Polo";
        wwPolo.Accelerating();
        wwPolo.Braking();
        wwPolo.Starting();
        Console.WriteLine($"Car: {wwPolo}");
        Console.ReadLine();
    }
}
```



```
Demo Class & Object
Volkswagen Polo is accelerating.
Volkswagen Polo is braking.
Volkswagen Polo is starting.
Car: Make=2050, Model=Volkswagen Pol
```


Member Visibility

- ◆ There are five access specifiers: private, public, protected, internal, and protected internal. By default, the members are private to the class
- **public**: The type or member can be accessed by any other code in the same assembly or another assembly that references it
- **private**: The type or member can be accessed only by code in the same class or struct
- **protected**: The type or member can be accessed only by code in the same class, or in a class that is derived from that class

Member Visibility

- **internal**: The type or member can be accessed by any code in the same assembly, but not from another assembly
- **protected internal**: The type or member can be accessed by any code in the assembly in which it's declared, or from within a derived class in another assembly
- **private protected**: The type or member can be accessed only within its declaring assembly, by code in the same class or in a type that is derived from that class

OOP-Encapsulation

- ◆ Encapsulation is defined as binding data and code that manipulates it together in a single unit
- ◆ Data is privately bound within a class without direct access from the outside of the class
- ◆ All objects that need to read or modify the data of an object should do it through the public methods that a class provides
- ◆ This characteristic is called data hiding and makes code less error-prone by defining a limited number of entry points to an object's data

OOP-Encapsulation

```
class Customer{
    private int Id;
    //Full properties
    public int CustomerID {
        get {
            return Id;
        }
        set {
            Id = value;
        }
    }
    //Automatic properties
    public string CustomerName { get; set; } = "New customer";
    public void Print(){
        Console.WriteLine($"ID:{CustomerID}, Name:{CustomerName}");
    }
}
```

```
class Program {
    static void Main(string[] args) {
        Customer obj = new Customer();
        obj.CustomerID = 1000;
        Console.WriteLine($"ID:{obj.CustomerID}, Name:{obj.CustomerName}");
        obj.CustomerID = 2000;
        obj.CustomerName = "Jack";
        obj.Print();
        Console.ReadLine();
    }
}
```

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ID:1000, Name:New customer
ID:2000, Name:Jack

Read-only auto properties & Init-Only properties

- When we write a property only with "get", it automatically becomes a Read Only property or we can use **Init-Only properties**

```
public class MyClass{
    //Init-Only Properties
    public int x { get; init; }
    //Read-Only Auto Properties
    public int y { get; }
    public MyClass(){
        x = 10;
        y = 20;
    }
    public MyClass(int a, int b){
        x = a;
        y = b;
    }
}
```

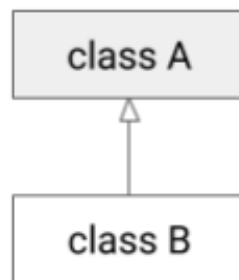
```
class Program {
    static void Main(string[] args) {
        MyClass obj1 = new MyClass { x = 1 };
        Console.WriteLine($"x:{obj1.x},y:{obj1.y}");
        //obj.x = 10; //error
        //obj.y = 20; //error
        MyClass obj2 = new MyClass();
        Console.WriteLine($"x:{obj2.x},y:{obj2.y}");
        MyClass obj3 = new MyClass(30,50);
        Console.WriteLine($"x:{obj3.x},y:{obj3.y}");
        Console.ReadLine();
    }
}
```

CS DemoReadOnlyAutoProperties

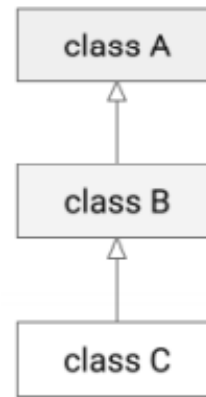
x:1,y:20
x:10,y:20
x:30,y:50

OOP-Inheritance

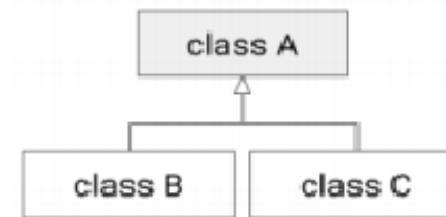
- ◆ Inheritance is a mechanism through which a class can inherit the properties and functionalities of another class
- ◆ Other classes can inherit these functionalities and data of the parent class as well as extending or modifying them and adding additional functionalities and properties.
- ◆ There are three types of inheritance supported in C#:



Single inheritance:



Multilevel inheritance



Hierarchical inheritance

OOP-Inheritance

```
class Employee{
    private int id;
    private string name;
    //Constructor
    public Employee(int id, string name){
        this.Id = id;
        this.Name = name;
    }
    //Properties
    public string Name {
        get { return name; }
        set { name = value; }
    }
    public int Id{
        get { return id; }
        set { id = value; }
    }
}
```

```
class Manager:Employee
{
    private string email;
    public Manager(int id, string name, string email):base(id,name){
        this.Email = email;
    }
    public string Email {
        get { return email; }
        set { email = value; }
    }
    public override string ToString(){
        return $"Id:{Id},Name:{Name},Email:{Email}";
    }
}

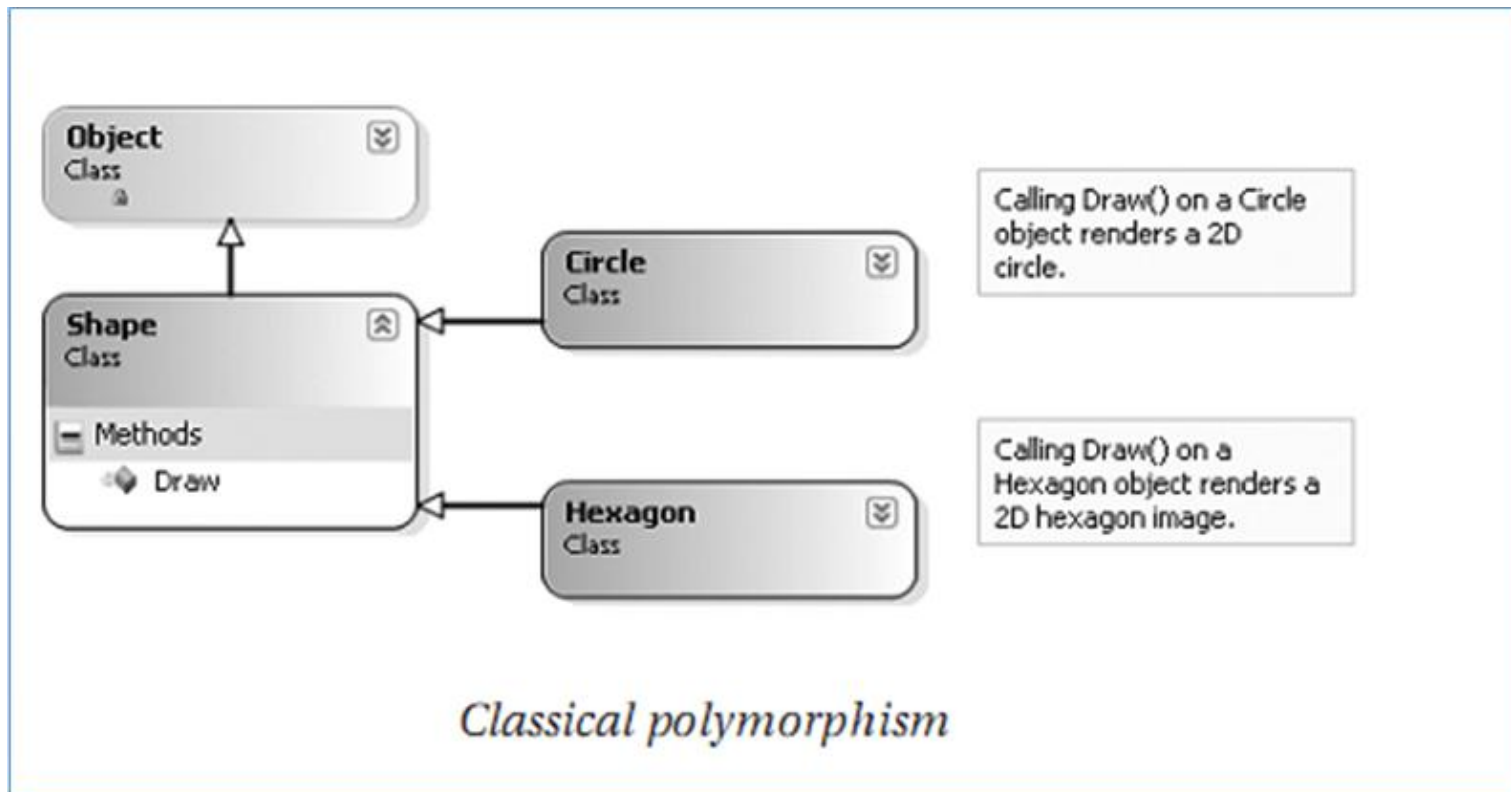
class Program {
    static void Main(string[] args) {
        Manager jack = new Manager(1000,"Jack","Jack@gmail.com");
        Console.WriteLine(jack);
        Console.ReadLine();
    }
}
```

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Id:1000,Name:Jack,Email:Jack@gmail.com

OOP-Polymorphism

- ◆ Ability allows many versions of a method based on overloading and overriding methods techniques




```
public abstract class Shape{
    public int Height { get; set; }
    public int Width { get; set; }
    // Virtual method
    public virtual void Draw() {
        Console.WriteLine("Performing base class Drawing tasks");
    }
    public void Print() {
        Console.WriteLine("Performing base class Printing tasks");
    }
    // Abstract method
    public abstract void Display();
}
```

virtual : provide a default implementation.
Can be overridden if necessary

abstract: sub-classes MUST override

```
public class Circle : Shape {
    public override void Draw() {
        Console.WriteLine("Drawing a circle");
    }
    public override void Display(){
        Console.WriteLine("Display Circle");
    }
}
```

```
D:\Demo\FU\Basic.NET\Demo_Slot_04_05\DemoPolymorphism\bin
Display Circle
Drawing a circle
Display Rectangle
Drawing a rectangle
Performing base class Printing tasks
```

```
public class Rectangle : Shape {
    public override void Draw() {
        Console.WriteLine("Drawing a rectangle");
    }
    public override void Display() {
        Console.WriteLine("Display Rectangle");
    }
    public new void Print(){
        Console.WriteLine("Print Rectangle");
    }
}
```

```
class Program {
    static void Main(string[] args)
    {
        Shape p = new Circle();
        p.Display();
        p.Draw();
        p = new Rectangle();
        p.Display();
        p.Draw();
        p.Print();
        Console.ReadLine();
    }
}
```

OOP-Interface

- ◆ An interface contains definitions for a group of related functionalities that a class or a struct must implement
- ◆ An interface cannot be instantiated but can only be inherited by classes or other interfaces
- ◆ An interface may not declare instance data such as fields, auto-implemented properties, or property-like events. Interface names begin with a capital “I”

```
public interface ISomeInterface
{
    string SomeProperty { get; set; }
    string SomeMethod();
    void SomethingElse();
}
```

```
public class SomeClass : ISomeInterface{
    public string SomeProperty { get; set; }
    public string SomeMethod(){
        return "Hello World.";
    }
    public void SomethingElse(){
        Console.WriteLine(DateTime.Now);
    }
}
```

OOP-Interface

```
public interface IFirst{
    void Print();
    void Display();
}
public interface ISecond {
    void Print();
}
public class MyClass : IFirst, ISecond{
    public void Display(){
        Console.WriteLine("Display method");
    }
    //Explicitly Implementing Interfaces
    void IFirst.Print(){
        Console.WriteLine("IFirst's Print method.");
    }
    //Explicitly Implementing Interfaces
    void ISecond.Print(){
        Console.WriteLine("ISecond's Print method.");
    }
}
```

```
class Program{
    static void Main(string[] args){
        MyClass obj = new MyClass();
        obj.Display();
        IFirst first = obj;
        first.Print();
        ISecond second = obj;
        second.Print();
        Console.ReadLine();
    }
}
```

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Display method
IFirst's Print method.
ISecond's Print method.

Interface Inheritance

```
public interface ICar
{
    void Drive();
}
```

```
public interface IUnderwaterCar
{
    void Dive();
}
```

```
// Here we have an interface with TWO base interfaces.
public interface IJamesBondCar : ICar, IUnderwaterCar
{
    void TurboBoost();
}
```

```
public class MyClass : IJamesBondCar
{
    public void TurboBoost()
    {
        // Do something
    }

    public void Drive()
    {
        // Do something
    }

    public void Dive()
    {
        // Do something
    }
}
```

Default Interface Methods

- ◆ C# allows to add a method with their implementation to the interface without breaking the existing implementation of the interface, such type of methods is known as **default interface methods (virtual extension methods)**

```
public interface ISample{
    static void Print(){
        Console.WriteLine("Static method");
    }
    string GetString(string s)
    {
        return "Hello "+s;
    }
}
```

```
interface ISample01{
    void MyMethod(){
        Console.WriteLine("ISample01.MyMethod");
    }
}
interface ISample02 : ISample01{
    //override the ISample01's MyMethod()
    void ISample01.MyMethod(){
        Console.WriteLine("ISample02.MyMethod");
    }
}
```

Default Interface Methods

```
public interface ISample {
    static void Print(){
        Console.WriteLine(" Welcome to .NET");
    }
    string GetString(string s){
        return " Hello " + s;
    }
    void Display();
}

public class MySample : ISample{
    public void Display() {
        Console.WriteLine(" Hi !");
    }
}

public class MySample : ISample{
    public void Display() {
        Console.WriteLine(" Hi !");
    }
}
```

```
class Program {
    static void Main(string[] args) {
        string str;
        MySample obj = new MySample();
        obj.Display();
        //obj.Print(); //Error
        //Default Implement Method
        ISample.Print();
        ISample sample = obj;
        str = sample.GetString("Jack");
        Console.WriteLine(str);
        Console.ReadLine();
    }
}
```

Default Implement Method

```
Hi !
Welcome to .NET
Hello Jack
```

The **is** and **as** Operators

- ◆ The **is** operator is used to check if the run-time type of an object is compatible with the given type or not whereas **as** operator is used to perform conversion between compatible reference types or Nullable types
- ◆ The **is** operator returns true if the given object is of the same type whereas **as** operator returns the object when they are compatible with the given type
- ◆ The **is** operator returns false if the given object is not of the same type whereas **as** operator return null if the conversion is not possible
- ◆ The **is** operator is used for only reference, boxing, and unboxing conversions whereas **as** operator is used only for nullable, reference and boxing conversions

The **is** and **as** Operators

```
interface ICalculate {
    double Area();
}

class Rectangle : ICalculate
{
    float length;
    float width;
    public Rectangle(float x, float y) {
        length = x;
        width = y;
    }
    public double Area() {
        return length * width;
    }
}
```

```
class Program{
    static void Main(string[] args){
        Rectangle objRectangle = new Rectangle(10.2F, 20.3F);
        ICalculate calculate;
        if (objRectangle is ICalculate) {
            calculate = objRectangle as ICalculate;
            Console.WriteLine("Area : {0:F2}", calculate.Area());
        }
        else {
            Console.WriteLine("Interface method not implemented");
        }
    }
}
```

Microsoft Visual Studio Debug Console

Area : 207.06

Static Constructor

- ◆ Prevent static field to be reset
- ◆ A given class (or structure) may define only a single static constructor
- ◆ A static constructor executes exactly one time, regardless of how many objects of the type are created
- ◆ A static constructor does not take an access modifier and cannot take any parameters
- ◆ The static constructor executes before any instance-level constructors

```
class MyClass{
    public static int x = 1;
    static MyClass(){
        x = 2;
        Console.WriteLine("Static constructor : x={0}",x);
    }
    public MyClass(){
        x++;
        Console.WriteLine("Object constructor : x={0}", x);
    }
} //end class
class Program {
    static void Main(string[] args)
    {
        MyClass m1 = new MyClass();
        MyClass.x = 4;
        MyClass m2 = new MyClass();
    }
}
```

Static Class

- ◆ Classes that cannot be instantiated or inherited are known as classes and the static keyword is used before the class name that consists of static data members and static methods
 - ◆ It is not possible to create an instance of a static class using the **new** keyword. The main features of static classes are as follows:
 - They can only contain static members
 - They cannot be instantiated or inherited and cannot contain instance constructors
- However, the developer can create static constructors to initialize the static members

Static Class

```
static class UtilityClass
{
    public static void PrintTime()
    { Console.WriteLine(DateTime.Now.ToShortTimeString()); }

    public static void PrintDate()
    { Console.WriteLine(DateTime.Today.ToShortDateString()); }
}

class Program
{
    static void Main(string[] args)
    {
        UtilityClass.PrintDate();
    }
}
```

No instance created

Extension Method

- ◆ Extension methods allow us to extend an existing type with new functionality without directly modifying those types
- ◆ Extension methods are static methods that have to be declared in a static class
- ◆ We can declare an extension method by specifying the first parameter with the **this** keyword
- ◆ The first parameter in this method identifies the type of objects in which the method can be called
- ◆ The object that we use to invoke the method is automatically passed as the first parameter

Extension Method

```
static class Utils
{
    public static int Add(int a, int b) { return a + b; }
    public static int Sub(this int a, int b) { return a - b; }
}
class Program
{
    static void Main(string[] args)
    {
        int x = 3, y = 2;
        int r = Utils.Add(x, y);
        Console.WriteLine("{0}+{1}={2}", x, y, r);
        r = x.Sub(y);
        Console.WriteLine($"{x}-{y}={r}");
        Console.ReadLine();
    }
}
```

Expression-bodied Members

- ◆ Expression body definitions let us provide a member's implementation in a very concise, readable form
- ◆ We can use an expression body definition whenever the logic for any supported member, such as a method or property, consists of a single expression
- ◆ An expression body definition has the following general syntax:

```
member => expression;
```

- ◆ Members can be: Method, Read-only property, Property, Constructor, Finalizer (destructors) and Indexer

Expression-bodied Members

```
public int Add(int x, int y)
{
    return x + y;
}
```

```
public int Add(int x, int y) => x + y;
```

```
public string Name
{
    get
    {
        return FirstName + " " + LastName;
    }
}
```

```
public string Name => FirstName + " " + LastName;
```

```
public class Location
{
    private string locationName;

    public Location(string name) => Name = name;

    public string Name
    {
        get => locationName;
        set => locationName = value;
    }
}
```

Anonymous Type

- ◆ Is basically a class with no name and is not explicitly defined in code
- ◆ Uses object initializers to initialize properties and fields. Since it has no name, we need to declare an implicitly typed variable to refer to it
- ◆ Anonymous types are class types that derive directly from object, and that cannot be cast to any type except object

```
static void Main(string[] args)
```

```
{
```

```
    var obj1 = new { id = 1000, name = "jack" };
```

```
    Console.WriteLine($"id:{obj1.id},name:{obj1.name}");
```

```
    dynamic obj2 = new { id = 2000, name = "scott", Email= "scott@gmail.com" };
```

```
    Console.WriteLine($"id:{obj2.id},name:{obj2.name},Email:{obj2.Email}");
```

```
    Console.ReadLine();
```

```
}
```

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id:1000,name:jack

id:2000,name:scott,Email:scott@gmail.com

Object Initialize

- ◆ Object initializers let we assign values to any accessible fields or properties of an object at creation time without having to invoke a constructor followed by lines of assignment statements
- ◆ The object initializer syntax enables us to specify arguments for a constructor or omit the arguments

```
class Customer {
    public string Name { get; set; }
    public int Age { get; set; }
}
```

```
Customer c = new Customer();
c.Name = "Jack";
c.Age = 20;
```

Can be combined with
any constructor call

```
var c = new Customer(){ Name = "Jack", Age = 20};
```

Readonly Member and Const Keyword

- ◆ In a field declaration, **readonly** indicates that assignment to the field can only occur as part of the declaration or in a constructor in the same class
- ◆ A readonly field can't be assigned after the constructor exits
- ◆ A **const** field can only be initialized at the declaration of the field(a compile-time constant)
- ◆ A **readonly** field can be assigned multiple times in the field declaration and in any constructor(a run-time constants)

Readonly member and const keyword

```
public class SamplePoint{
    public int x;
    // Initialize a readonly field
    public readonly int y = 25;
    public readonly int z;
    // Initialize a const field
    public const int t = 100;
    public SamplePoint(){
        // Initialize a readonly instance field
        z = 24;
    }
    public SamplePoint(int p1, int p2, int p3, int p4=50){
        x = p1;
        y = p2;
        z = p3;
        //t = p4; //error
    }
}
```

```
class Program{
    static void Main(string[] args) {
        SamplePoint p1 = new SamplePoint(11, 21, 32);
        Console.WriteLine($"t = {SamplePoint.t}");
        Console.WriteLine($"p1: x={p1.x}, y={p1.y}, z={p1.z}");
        SamplePoint p2 = new SamplePoint();
        Console.WriteLine($"p2: x={p2.x}, y={p2.y}, z={p2.z}");
        Console.ReadLine();
    }
}
```

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```
t =100
p1: x=11, y=21, z=32
p2: x=0, y=25, z=24
```

Record type

- ◆ Records type is a new reference type that we can create instead of classes or structs
- ◆ Records are distinct from classes in that record types use value-based equality
- ◆ We define a **record** by declaring a type with the **record** keyword

```
public record Person
{
    public string Name { get; set; }
    public int Age { get; set; }
}
```

```
public record Person(string Name, int Age);
```

Record type

```
public record Customer{
    public string Name { get; init; } = "New customer";
    public int Age { get; init; } = 20;
    public void Print(){
        Console.WriteLine($"Name:{Name}, Age:{Age}");
    }
}

class Program {
    static void Main(string[] args)
    {
        Customer customer01 = new Customer { Name = "Jack", Age = 25 };
        customer01.Print();
        Customer customer02 = customer01 with { Name = "John"};
        customer02.Print();
        Customer customer03 = new();
        customer03.Print();
        Console.ReadLine();
    }
}
```

 D:\Demo\FU\Basic.NET\Demo_Slot_04_05\Demo

Name:Jack, Age:25
Name:John, Age:25
Name:New customer, Age:20

Using Declarations

With the using declaration, the objects are disposed automatically. Its scope is automatically defined from the object's declaration statement to the end of the current code block

```
static void Main(string[] args) {
    try
    {
        using var reader = new System.IO.StreamReader(@"C:\data.txt");
        var content = reader.ReadToEnd();
        Console.WriteLine($"File length: {content.Length}");
    }
    catch (System.IO.FileNotFoundException fe) {
        Console.WriteLine(fe.Message);
    }
    catch (Exception ex)
    {
        Console.WriteLine(ex.Message);
    }
    Console.ReadLine();
}
```

OOP with C# 11, C#12

- ◆ Primary Constructors for Classes and Structs
- ◆ This feature simplifies class and struct declarations by allowing you to define the constructor directly within the type declaration.
- ◆ It eliminates the need for a separate constructor method, leading to more concise and readable code.

```
internal partial class Program
{
    0 references
    private static void Main(string[] args)
    {
        var employee = new Employee("John", "Doe", new DateTime(2020, 1, 1), 50000);
    }
}

1 reference
public class Employee(string firstName, string lastName, DateTime hireDate, decimal salary)
{
    0 references
    public string FirstName { get; init; } = firstName;
    0 references
    public string LastName { get; init; } = lastName;
    0 references
    public DateTime HireDate { get; init; } = hireDate;
    0 references
    public decimal Salary { get; init; } = salary;
}
```

OOP with C# 11, C#12

◆ Alias Any Type

- ◆ C# 12 extends the ability to alias types beyond just namespaces. You can now create aliases for any type, including unnamed types like tuples.
- ◆ This improves code readability and allows for concise references to complex types.

```
using Point = (int X, int Y);
using var file = File.OpenRead("data.txt");
using var reader = new StreamReader(file);
1 reference
internal partial class Program
{
    0 references
    private static async void Main(string[] args, StreamReader reader)
    {
        Point p = (3, 5);
        Console.WriteLine($"{p.X}, {p.Y}");

        string line = await reader.ReadLineAsync();
    }
}
```


OOP with C# 11, C#12

- ◆ **Required Keyword (from C# 11 but relevant to OOP)**
- ◆ While introduced in C# 11, the required keyword is relevant to OOP as it enforces mandatory property and field initialization during object construction.
- ◆ This helps prevent null reference exceptions and ensures object validity.

```
internal partial class Program
{
    0 references
    private static void Main(string[] args)
    {
        // Usage:
        Book book = new() { Title = "The Lord of the Rings" }; // Valid
        Book book2 = new(); // Compile-time error: required member 'Title' not set.
    }
}

4 references
public class Book
{
    1 reference
    public required string Title { get; set; }
    0 references
    public string? Author { get; set; }
}
```

Summary

- ◆ Explain about OOP
- ◆ Explain classes and objects
- ◆ Define and describe methods
- ◆ Explain about the access modifiers
- ◆ Explain method overriding
- ◆ Define and describe inheritance
- ◆ Explain about polymorphism
- ◆ Explain about abstraction

Summary

- ◆ Discuss more new features in OOP :
 - Properties, Auto-implemented properties
 - Static class and Extension Method
 - Anonymous Type and Default constructor
 - Readonly members and Default interface methods
 - Using declarations
 - Expression-bodied members
 - Record type
 - Object Initialize
 - Read-only auto-properties and Init-Only Properties

Discuss

- What is object-oriented programming? What is class and object? give an example. 1
- What is access specifier? how many types of it? features of them? Give some examples. 2
- What is inheritance? give some examples in code? 3
- What is polymorphism? Static(compile) and dynamic(runtime) give some examples in code? 4 7
- What is abstraction and interface? give some examples in code? 5 8
- What are is, as, readonly, const and using keyword? how to use them? 6
- What are extension method, expression body and anonymous type? give some examples in code?
9
- What are property and record type? how to use them? 10