Module 10

"Interfaces"

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Agenda

- **Introducing Interfaces**
- Using Interfaces
- Building Comparable Objects with `IComparable`
- Building Enumerable Types with `IEnumerable`
- *Optional:* Using Types with `IDisposable`
- Lab 10
- Discussion and Review

What is an Interface?

- An *interface* is a named set of abstract members

```
interface IDropTarget
{
   void OnDragDrop( DragEventArgs e );
   void OnDragEnter( DragEventArgs e );
   void OnDragLeave( EventArgs e );
   void OnDragOver( DragEventArgs e );
   bool AllowDrop { get; set; }
}
```

- It is a more or less rock-steady rule that interface names start with a capital `I`
- Interfaces can contain methods, properties, events declarations only
  - Cannot contain member variables, method bodies or implementation
- Interface methods are implicitly public, so access modifiers are disallowed
- An interface is a reference type

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Defining Custom Interfaces

- You can easily define your own interface types

```
interface IPointy
{
   int Points{ get; }
}
```

```
static void Main()
{
   IPointy p = new IPointy();
}
```

```
interface IPointy
{
   public int numberOfPoints;
   public IPointy()
   {
      numberOfPoints = 0;
   }
   int GetNumberOfPoints()
   {
      return numberOfPoints;
   }
}
```

- Interfaces does not really provide any substance until they're implemented by a concrete class or struct

Interfaces vs Abstract Classes

- Differences
  - Interfaces cannot contain implementation
  - Abstract classes are used for partial implementation
  - Interface members are all public
  - Interfaces can derive only from other interfaces
  - Interfaces are for types unrelated by inheritance – abstract classes enforce inheritance relationship
- Identical aspects
  - Reference types
  - Cannot be instantiated
  - Not allowed to be sealed
  - Can be derived from by classes

Implementing an Interface

- The implementing method or property must be public and have the same signature as the interface method or property being implemented

```
public class Triangle : Shape, IPointy
{
   public Triangle( ) { }
   public override void Draw()
   {
      Console.WriteLine( "Drawing {0} the Triangle", PetName );
   }
   public int Points
   {
      get { return 3; }
   }
}
```

- Using Visual Studio eases interface implementation

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Invoking Members at the Object Level

- Invoke methods and properties directly

```
Triangle tri = new Triangle();
Console.WriteLine("Points: {0}", tri.Points );
```

- Alternatively, you could explicitly convert to the interface type to check whether type implements the interface

```
Triangle tri = new Triangle();
try
{
   IPointy pointy = (IPointy) tri;
   Console.WriteLine( pointy.Points );
}
catch( InvalidCastException e )
{
   Console.WriteLine( e.Message );
}
```

The `is` and `as` Keywords for Interfaces

- If the object can be treated as implementing the interface, as returns a reference to such an interface

```
Triangle tri = new Triangle();
IPointy pointy = tri as IPointy;
if( pointy != null )
{
   Console.WriteLine( pointy.Points );
}
else { // Does not implement Ipointy }
```

- `is` can be used to check directly for implementation of a specific interface

```
if( tri is IPointy )
{
   Console.WriteLine( ( (IPointy) tri).Points );
}
else { // Does not implement Ipointy }
```

Interfaces as Parameters and Return Values

- Interfaces are reference types and behave exactly like other reference types with respect to methods
- They can be passed to methods as parameters

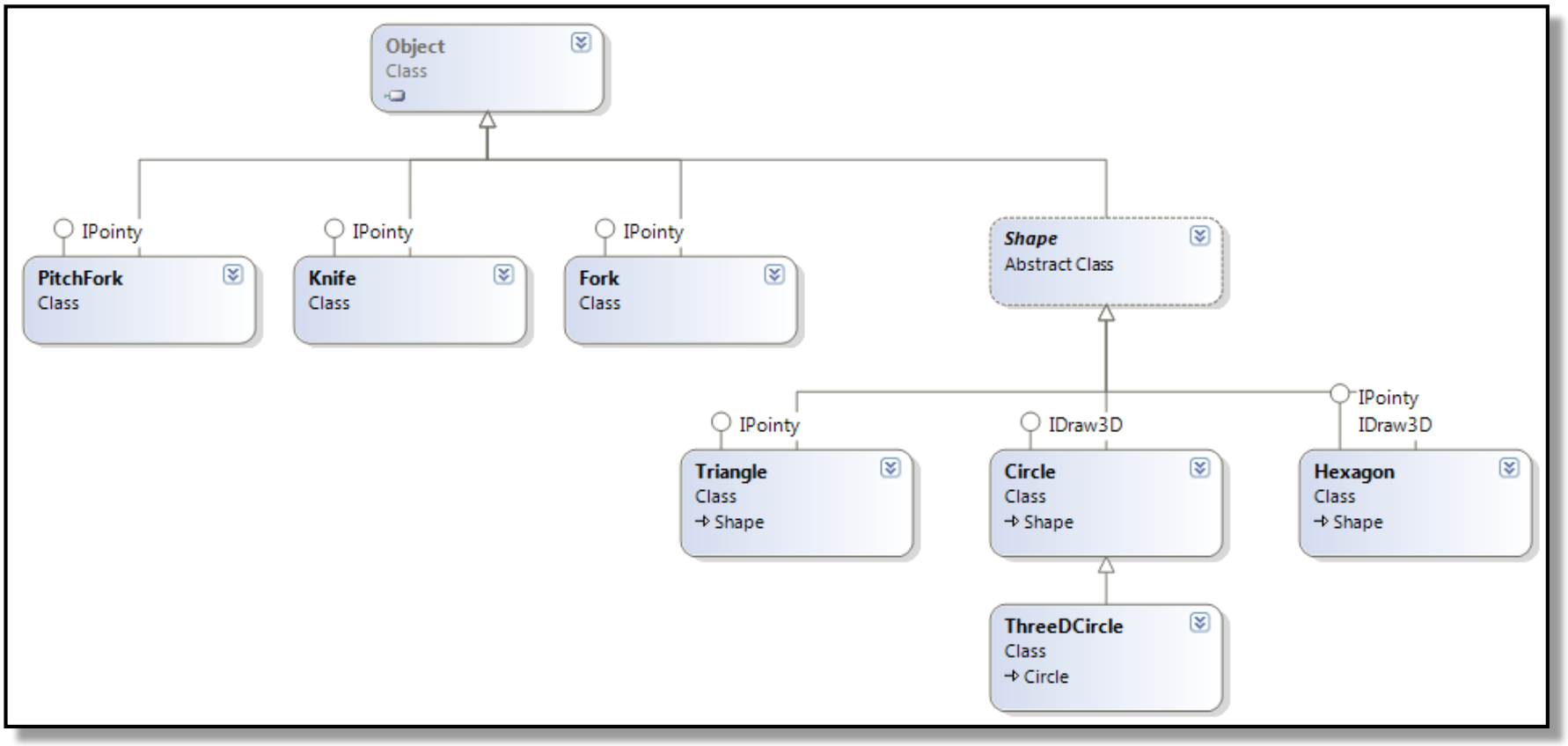
```
static void WritePointy( IPointy pointy )
{
   Console.WriteLine( pointy.Points );
}
```

- Similarly, they can be returned from methods as return values

```
static IPointy ExtractPointyness( object o )
{
   return o as IPointy;
}
```

Arrays of Interface Types

- You can iterate through an array of interfaces and treat each item identically



Multiple Inheritance with Interface Types

- A class can implement an arbitrary number of interfaces
  - But only have one superclass!

```
interface IDrawable
{
   void Draw();
}
```

```
interface IPrintable
{
   void Print();
   void Draw();
}
```

```
interface IRenderToMemory
{
   void Render();
}
```

```
class SuperShape : IDrawable, IPrintable, IRenderToMemory
{
   public void Draw() { ... }
   public void Print() { ... }
   public void Render() { ... }
}
```

- Potential name clash!

Designing Interface Hierarchies

- An interface can extend an arbitrary number of interfaces
- Arrange your related interfaces into interface hierarchies!
- This has been done extensively through the .NET Framework classes
  - E.g. **`IList`**, **`ICollection`**, …

```
interface IList : ICollection, IEnumerable
{
   ...
}
```

- An interface cannot be more accessible than it's base interface!

Quiz: Designing Interfaces – Right or Wrong?

```
interface IDrawable
{
   void Draw();
}
```

```
class WyattEarp : IDrawable
{
   void Draw() { ... }
}
```

```
class Circle : IDrawable
{
   public void Draw() { Console.WriteLine("Drawing..."); }
}
```

```
class Artist : IDrawable
{
   public void Draw( Canvas c ) { ... }
}
```

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The `IComparable` Interface

- Implement `IComparable` to compare objects to each other

```
interface IComparable
{
   int CompareTo( object obj );
}
```

`CompareTo()` Return Value	Indicating…
< 0	This instance is before `obj`
0	This instance is equal to `obj`
> 0	This instance is after `obj`

- Built into .NET

Implementing **IComparable**

- You can implement **IComparable** in your own types

```
public class Car : IComparable
{
   public int ID { get; set; }
   ...

   public int CompareTo( object obj )
   {
      Car other = obj as Car;
      if( this.carID < other.carID ) { return -1; }
      else if( this.carID > other.carID ) { return 1; }
      return 0;
   }
}
```

```
Car c1 = ...;
Car c2 = ...;
if( c1.CompareTo( c2 ) < 0 )
{
   // c1 is less than c2
}
```

- **IComparable** types can be sorted e.g. in arrays

The **IComparer** Interface

- Multiple sort orders can be obtained using the more general `IComparer`

```
interface IComparer
{
   int Compare( object o1, object o2 );
}
```

```
public class PetNameComparer : IComparer
{
   int IComparer.Compare( object o1, object o2 )
   {
      Car c1 = o1 as Car;
      Car c2 = o2 as Car;
      return String.Compare( c1.PetName, c2.PetName );
   }
}
```

```
Array.Sort( cars, new PetNameComparer() );
```

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The `IEnumerable` Interface

- The **`IEnumerable`** interface states that the items of a class can be enumerated

```
using System.Collections;

interface IEnumerable
{
   IEnumerator GetEnumerator();
}
```

```
interface IEnumerator
{
   bool MoveNext ();
   object Current { get; }
   void Reset ();
}
```

- The **`IEnumerator`** interface provides an enumerator mechanism for the class

- Both are built into the .NET Framework base classes in the **`System.Collections`** namespace
- Arrays and collection types implement **`IEnumerable`** out-of-the-

Implementing **IEnumerable**

- You can implement **IEnumerable** in your own types

```
public class Garage : IEnumerable
{
   private Car[] carArray = new Car[ 4 ];
   public Garage()
   {
      carArray[ 0 ] = new Car(
      carArray[ 1 ] = new Car(
      carArray[ 2 ] = new Car(
      carArray[ 3 ] = new Car(
   }

   public IEnumerator GetEnumerator() { ... }
}
```

```
Garage garage = new Garage();
foreach( Car c in garage )
{
   Console.WriteLine( c.PetName );
}
```

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Objects, Values, and Scope

- Local variables live only throughout the scope in which they are declared
  - Fixed lifetime
  - Scheduled destruction
- Objects can outlive the scope in which the were allocated
  - Unbounded lifetime
  - Undetermined destruction
- Consequently; Objects are cleaned up by the *Garbage Collector*

```
static void Main()
{
   bool b = true;
   A longLivingVariable;
   if( b )
   {
      int i = 0;
      while( true )
      {
         A a = new A( i );
         if( ++i % 100 == 0 )
         {
           longLivingVariable = a;
         }
      }
   }
}
```

Deallocating Objects

- There is no construct in C# to explicitly destroy objects
  - This is to avoid
    - Forgetting to destroy objects
    - Destroying more than once
    - Dangling references
    - …
- The garbage collector *finalizes* the objects back into unused memory

Defining Destructors

- Put cleanup logic in the destructor

```
class DataHandler
{
   FileStream fs;
   ...
   ~DataHandler()
   {
      fs.Close();
   }
}
```

- Similar to constructors, the destructor is named after the class (but with ~)
- Similar to constructors, destructors have no return type
- No access modifier is allowed
- Just a single destructor (with no parameters!) is allowed in each class

Be Careful Out There!

- The finalization process takes place after "ordinary" garbage collection
- If your class has only managed resources, you should use a destructor!
- Avoid destructors whenever possible
  - Costs time
  - Hard to debug
  - Prolongs object life and memory usage
- Cannot know exactly when finalization takes place…!

Disposing Classes

- Many .NET Framework classes implement **`IDisposable`**
  - You can also implement it yourselves
- You should always invoke **`Dispose()`** on objects if they implement **`IDisposable`**

```
using System.IO;
static void Main()
{
   FileStream fs =
      new FileStream( "myFile.txt", FileMode.OpenOrCreate );

   // These method calls do the same thing!
   fs.Close();   // WTF???
   fs.Dispose();
}
```

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The `using` Statement

- The `using` statement is a convenient shorthand to help you to remember to `Dispose()`

```
using( MyDisposableClass d = new MyDisposableClass() )
{
   d.DoStuff();
   ...
}
```

- `Dispose()` is always invoked at the end of the using block – even in the presence of exceptions!

- Strive to use `using` whenever possible instead of manually invoking `Dispose()`

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Lab 10: Working with Interfaces

Discussion and Review

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- Building Comparable Objects with **`IComparable`**
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- *Optional:* Using Types with **`IDisposable`**


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