Programming II

Assignment 4 –Inheritance, Polymorphism, Abstract Classes and Interfaces - Due in Week 13

Once you are done with your program, upload it to eCentennial under Assessments / Assignment / Assignment 4

Purpose: The purpose of this Assignment is to:

- Practice the use of inheritance, polymorphism, abstract classes and interfaces in C#

References: Content of weeks 8 and 9

Instructions: Be sure to read the following general instructions carefully:
This assignment should be completed in groups of 3 students. Members that are reported as not having contributed will be graded with 0 ZERO.

Submit the project **through e-Centennial, Assessments / Assignment**. You must name your Visual Studio solution according to the following rule: ***GroupCode***
For Example: **Group01**

Submit your assignment in a **zip file** that is named according to the following rule:
GroupCode.zip
Example: **Group01.zip**

Apply the naming conventions for variables, methods, classes, and namespaces:
- *variable names, parameters and fields* – use camelCasing
- *classes, methods, properties, enumerations* – use PascalCasing
- *constants:* SNAKE_UPPERCASE

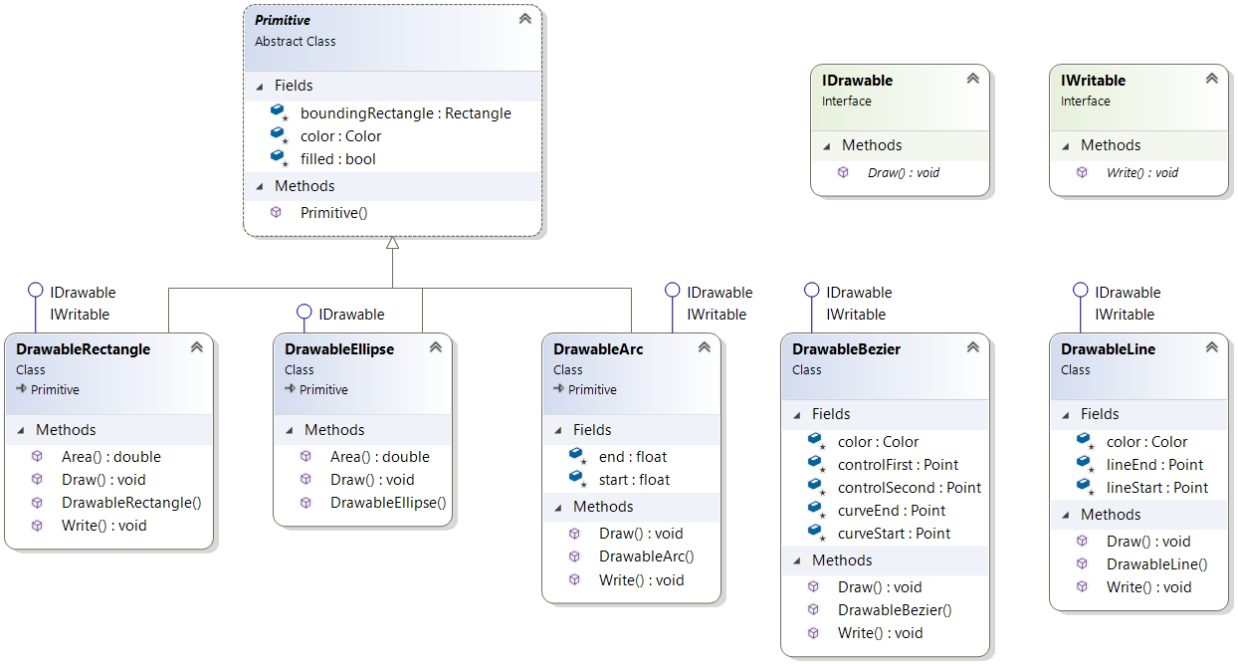
Exercise:

In this exercise you will be using inheritance to promote code re-use.

UML Diagram

You may choose to implement all the classes and interfaces from the diagram below in a single code file.

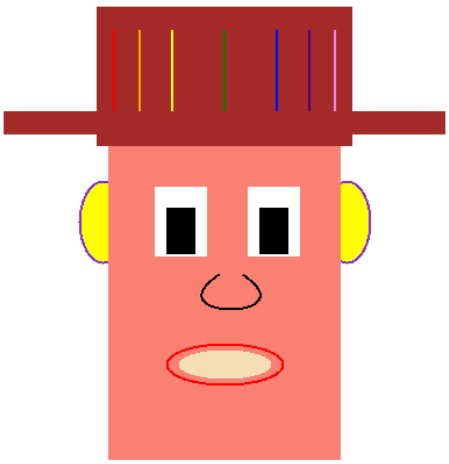
Note: You must follow the specifications exactly.



There are six classes and two interfaces participating in this application are shown in the diagram above. Each of them is fully described below. A bigger version of this diagram is also available on eCentennial and is called **"Assignment_04_UML.pdf"**

You will need to add a reference of the **"`System.Drawing`"** library to your project

Goal of the Exercise: Using the classes defined below and the test code in the end of this document, you should generate an image file showing this 2D face:



The IDrawable interface

This interface comprises of only one member:

IDrawable **Interface**
Properties
Methods
Draw(Graphics g) : void

Description of interface members

Methods:

1 mark

void Draw(Graphics g) – This method will be defined in the implementing class. You will have to add a reference to the **"System.Drawing"** library and insert the following using statements: using **System.Drawing** and **System.Drawing.Imaging**

The names of interfaces normally start with the letter "I".

Interfaces do not have fields or constructors, may contain properties, indexers and methods.

They contain just methods without bodies i.e. abstract.

The methods are always public; it is illegal to specify any accessibility specifiers e.g. public, protected or private or the abstract modifier

The IWritable interface

This interface comprises of only one member:

IWritable **Interface**
Properties
Methods
Write(TextWriter writer) : void

Description of interface members

Methods:

1 mark

void Write(TextWriter writer) – This method will be defined in the implementing class. You will need to add a using statement for the **TextWriter** class

The Primitive class

This abstract class comprises of four members:

Primitive **Abstract Class**
Fields
 # color : Color **# filled : bool** **# boundingRectangle : Rectangle**
Methods
+ <<constructor>> Primitive(Color color, bool filled, Rectangle rectangle)

Description of class members

Fields:

All the fields are protected

0.5 marks **color** – this **Color** represents the color of this object. This field is protected.

0.5 marks **filled** – this **bool** indicates if this object will be filled in. This field is protected.

0.5 marks **boundingRectangle** – this **Rectangle** represents the bounding rectangle of this object. This field is protected.

Properties:

There are no properties.

Constructor:

1 mark **Primitive(Color color, bool filled, Rectangle rectangle)** – This constructor takes three parameters and assigns it to the appropriate fields.

Methods:

There are no methods.

The DrawableRectangle class

This class inherits from the Primitive class and it implements the IDrawable and IWritable interfaces and comprises of three members:

DrawableRectangle **Class** **➡ Primitive, IDrawable, IWritable**
Properties
Methods
+ <<constructor>> DrawableRectangle(Color color, bool filled, Rectangle rectangle) **+ Draw(Graphics g) : void** **+ Write(TextWriter writer) : void** **+ Area() : double**

Description of class members

Fields:

There are no fields

Properties:

There are no properties

Constructor:

2 mark **DrawableRectangle(Color color, bool filled, Rectangle rectangle)** – This constructor passes the three parameters to its base constructor.

Methods:

There are two methods

1 mark **public void Draw(Graphics g)** – This method check the filled field.
If true, it creates a **SolidBrush** object with the appropriate color and then uses the **FillRectangle()** method of the **Graphics** class to draw a solid rectangle.
Otherwise, it creates a **Pen** object with the appropriate color and then uses the **DrawRectangle()** method of the **Graphics** class to draw the outline of a rectangle.

1 mark **public void Write(TextWriter writer)** – This method uses the **WriteLine()** method of the **TextWriter** class to write the three fields of this object.

1.5 marks **public double Area()** – This method uses Height and Width of the **boundingRectangle** to calculate the area.

The DrawableEllipse class

This class inherits from the Primitive class and it implements the IDrawable interface and comprises of two members:

DrawableEllipse **Class** **➡ Primitive, IDrawable**
Properties
Methods
+ <<constructor>> DrawableEllipse(Color color, bool filled, Rectangle rectangle) **+ Draw(Graphics g) : void** **+ Area() : double**

Description of class members

Fields:

There are no fields

Properties:

There are no properties

Constructor:

2 mark

DrawableEllipse(Color color, bool filled, Rectangle rectangle) – This constructor passes the three parameters to its base constructor.

Methods:

There is only one method

1 mark

public void Draw(Graphics g) – This method check the filled field.
If true, it creates a **SolidBrush** object with the appropriate color and then uses the **FillEllipse()** method of the **Graphics** class to draw a solid ellipse.
Otherwise, it creates a **Pen** object with the appropriate color and then uses the **DrawEllipse()** method of the **Graphics** class to draw the outline of a ellipse.

1.5 marks

public double Area() – This method uses Height and Width of the **boundingRectangle** to calculate the area of the Ellipsis – You need to find our how to calculate the area of an Ellipsis.

The DrawableLine class

This class implements the IDrawable and IWritable interfaces and comprises of six members:

DrawableLine **Class** **➡ IDrawable, IWritable**
Fields
 # color : Color **# lineStart: Point** **# lineEnd: Point**
Methods
+ <<constructor>> DrawableLine(Color color, Point start, Point end) **+ Draw(Graphics g) : void** **+ Write(TextWriter writer) : void**

Description of class members

Fields:

There are three fields

0.5 marks **color** – this field is of type **Color** and it represents the color of this object

0.5 marks **lineStart** – this field is of type **Point** and it represents the starting position of this object

0.5 marks **lineEnd** – this field is of type **Point** and it represents the ending position of this object

Did you know that the type **Point** is actually a **struct** instead of a **class**?

And so is **Rectangle**

Properties:

There are no properties

Constructor:

1 mark **DrawableLine(Color color, Point start, Point end)** – This constructor assigns the three parameters to the appropriate fields.

Methods:

There are two methods

1 mark **public void Draw(Graphics g)** – This method creates a **Pen** object with the appropriate color and then uses the **DrawLine()** method of the **Graphics** class to draw a line.

1 mark **public void Write(TextWriter writer)** – This method uses the **WriteLine()** method of the **TextWriter** class to write the three fields of this object.

The DrawableBezier class

This class implements the IDrawable and IWritable interfaces and comprises of six members:

DrawableBezier **Class** **➡ IDrawable, IWritable**
Fields
 # color : Color **# curveStart : Point** **# controlFirst : Point** **# controlSecond : Point** **# curveEnd : Point**
Methods
+ <<constructor>> DrawableBezier(Color color, Point start, Point first, Point second Point end) **+ Draw(Graphics g) : void** **+ Write(TextWriter writer) : void**

Description of class members

Fields:

0.5 marks **color** – this field is of type **Color** and it represents the color of this object

0.5 marks **curveStart** – this field is of type **Point** and it represents the starting position of this object

0.5 marks **controlFirst** – this field is of type **Point** and it represents the first control point of this object

0.5 marks **controlSecond** – this field is of type **Point** and it represents the second control point of this object

0.5 marks **curveEnd** – this field is of type **Point** and it represents the ending position of this object

Constructor:

1 mark **DrawableBezier(Color color, Point start, Point first, Point second, Point end)** – This constructor assigns the five parameters to the appropriate fields.

Methods:

There are two methods

1 mark **public void Draw(Graphics g)** – This method creates a **Pen** object with the appropriate color and then uses the **DrawBezier()** method of the **Graphics** class to draw a line

1 mark **public void Write(TextWriter writer)** – This method uses the **WriteLine()** method of the **TextWriter** class to write all of the fields of this object.

The DrawableArc class

This class implements the IDrawable and IWritable interfaces and comprises of six members:

DrawableArc **Class** **➡ Primitive, IDrawable, IWritable**
Fields
 # start : float **# end : float**
Methods
+ <<constructor>> DrawableArc(Color color, bool filled, Rectangle rectangle, float start, float end) **+ Draw(Graphics g) : void** **+ Write(TextWriter writer) : void**

Description of class members

Fields:

0.5 marks **start** – this field is of type **float** and it represents the starting angle of this object

0.5 marks **end** – this field is of type **float** and it represents the ending angle of this object

Constructor:

0.5 marks **DrawableArc(Color color, bool filled, Rectangle rectangle, float start, float end)** – This constructor passes to the base constructor with the first three parameters and assigns the last two to the appropriate fields.

Methods:

There are two methods

1 mark **public void Draw(Graphics g)** – This method creates a **Pen** object with the appropriate color and then uses the **DrawArc()** method of the **Graphics** class to draw an arc

1 mark **public void Write(TextWriter writer)** – This method uses the **WriteLine()** method of the **TextWriter** class to write all of the fields of this object.

How to test your application?

Add the following code to the **`Main()`** method of your program to see it in action and ensure it is creating the face with a hat below:

Note: For easy of copying, this code is also provided as a text file under eCentennial called **"Assignment_04_Inheritance.txt"** – You can just copy and paste from there.

2 marks

```
//interfaces are types.
List<IDrawable> face = new List<IDrawable>();

face.Add(new DrawableEllipse(Color.Yellow, true, new Rectangle(75, 160, 40, 70)));      //left ear
face.Add(new DrawableEllipse(Color.BlueViolet, false, new Rectangle(75, 160, 40, 70))); //left ear
face.Add(new DrawableEllipse(Color.Yellow, true, new Rectangle(285, 160, 40, 70)));     //right ear
face.Add(new DrawableEllipse(Color.BlueViolet, false, new Rectangle(285, 160, 40, 70)));//right ear
face.Add(new DrawableRectangle(Color.Salmon, true, new Rectangle(100, 100, 200, 300))); //face
face.Add(new DrawableRectangle(Color.White, true, new Rectangle(140, 165, 45, 60)));    //right eye
face.Add(new DrawableRectangle(Color.White, true, new Rectangle(220, 165, 45, 60)));    //left eye
face.Add(new DrawableRectangle(Color.Black, true, new Rectangle(150, 183, 25, 40)));    //right pupil
face.Add(new DrawableRectangle(Color.Black, true, new Rectangle(230, 183, 25, 40)));    //left pupil
face.Add(new DrawableRectangle(Color.Brown, true, new Rectangle(90, 10, 220, 120)));    //hat top
face.Add(new DrawableRectangle(Color.Brown, true, new Rectangle(10, 100, 380, 20)));    //hat rim

face.Add(new DrawableBezier(Color.Black, new Point(195, 240), new Point(135, 280), new Point(275, 280),
new Point(215, 240))); //nose

face.Add(new DrawableEllipse(Color.Red, false, new Rectangle(150, 300, 100, 35)));      //lips
face.Add(new DrawableEllipse(Color.Wheat, true, new Rectangle(160, 305, 80, 25)));      //mouth
face.Add(new DrawableLine(Color.Red, new Point(105, 30), new Point(105, 100)));         //lines
face.Add(new DrawableLine(Color.Orange, new Point(127, 30), new Point(127, 100)));      //lines
face.Add(new DrawableLine(Color.Yellow, new Point(155, 30), new Point(155, 100)));      //lines
face.Add(new DrawableLine(Color.Green, new Point(200, 30), new Point(200, 100)));       //lines
face.Add(new DrawableLine(Color.Blue, new Point(245, 30), new Point(245, 100)));        //lines
face.Add(new DrawableLine(Color.Indigo, new Point(273, 30), new Point(273, 100)));      //lines
face.Add(new DrawableLine(Color.Violet, new Point(295, 30), new Point(295, 100)));      //lines

int width = 400;
int length = 450;

Bitmap bitmap = new Bitmap(width, length);
Graphics graphic = Graphics.FromImage(bitmap);

foreach (var item in face)
{
    item.Draw(graphic);
    if (item is IWritable)
    {
        ((IWritable)item).Write(System.Console.Out);
    }
}

graphic.Dispose();

bitmap.Save("person.png", ImageFormat.Png);
bitmap.Dispose();

Console.ReadKey();
```