Abstraction

اَللّٰهُمَّ اُرْزُقْنِى عِلْمًا نَافِعًا وَاسِعًا عَمِيْقًا

اَللّٰهُمَّ اُرْزُقْنِى رِزْقًا وَاسِعًا حَلَالًا طَيِّبًا
مُبَارَكًا مِنْ عِنْدِكَ

Problem Scenario

We want to develop a system such it allows to create three types of shapes.

Rectangle: to represent a rectangle, width and height are required. Formula to find the area is wxh.

Triangle: to represent a Triangle, base (b) and height (h) are required. Formula to find the area of triangle is (h*b)/2

Circle: to represent a radius (r) is enough. Formula to find the area of Circle is $2\pi r^2$

Problem Scenario

One way to implement this is through Dynamic Polymorphism that we have already discussed.

Problem Scenario

Every shape has its own attributes according to its definition.
Like Circle needs to save radius and Triangle needs to save base and height.
Therefore, a separate class for each type of shape will be created.

Problem Scenario

In addition, Every shape must have two functions:

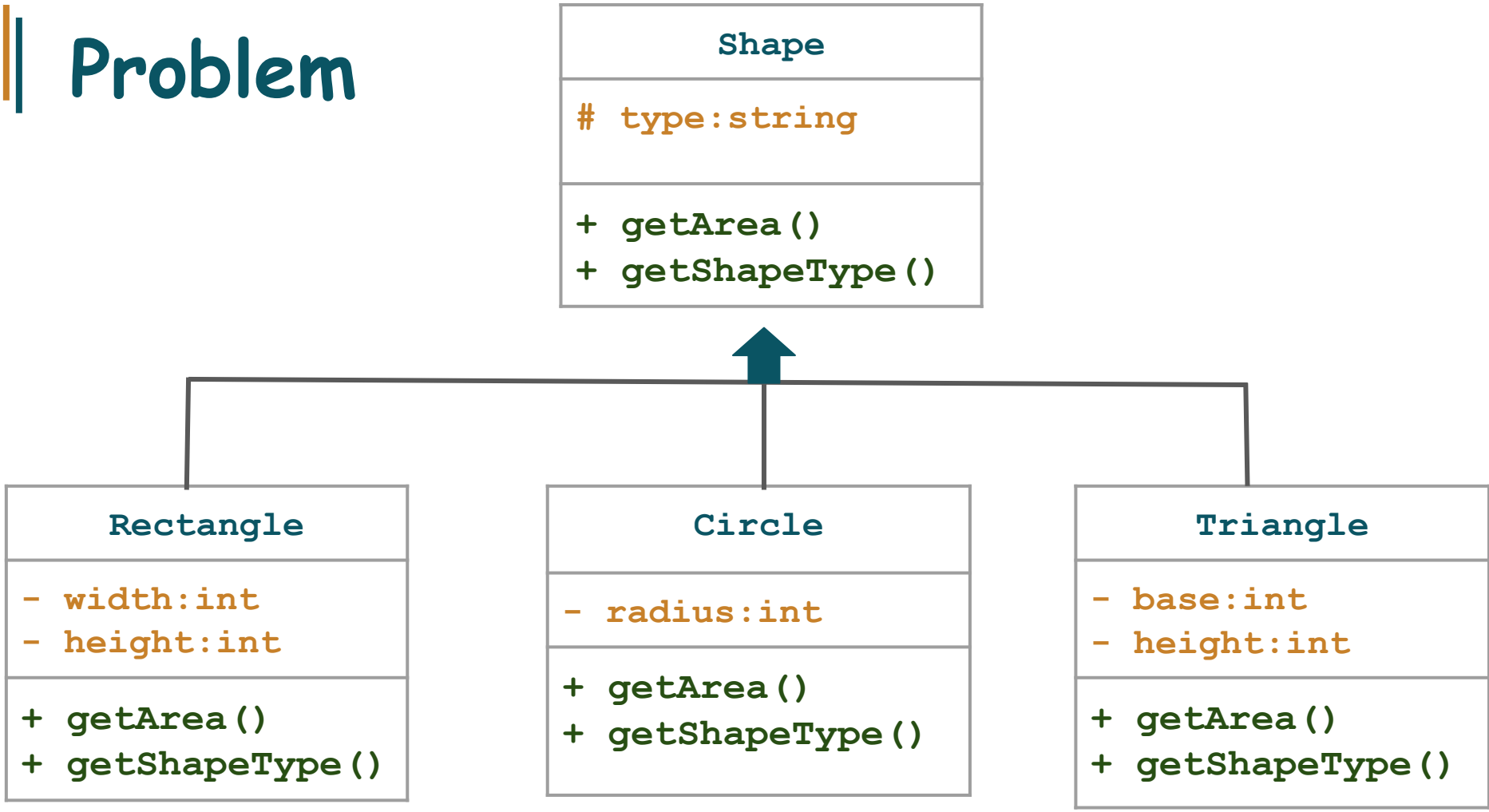
- getArea()
- getShapeType().

Therefore, in order to maintain a single list and to obtain the dynamic behaviour, we can create a parent class with those two methods and all other classes inherit this class.

Problem Scenario

As child classes, have different definition for getArea() and getShapeType(), therefore all these children overrides the parent methods.

Problem


Shape
type:string
+ getArea()
+ getShapeType()
Rectangle
- width:int
- height:int
+ getArea()
+ getShapeType()
Circle
- radius:int
+ getArea()
+ getShapeType()
Triangle
- base:int
- height:int
+ getArea()
+ getShapeType()

Problem

```
class Shape
{
    public virtual double getArea()
    {
          return 0;
    }

    public virtual string getShapeType()
    {
          return "undefined.";
    }
}
```

```
class Rectangle:Shape
{
  private int width;
  private int height;
  public Rectangle(int width,int height)
  {
     this.width=width;
     this.height=height;
  }
  public override double getArea()
  {
      return width * height;
  }
  public override string getShapeType()
  {
      return "Rectangle";
  }
}
```

Problem with the Shape Class

Do you see any Issue with the Shape class ?

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

Problem with the Shape Class

Here we know getArea() and getShapeType() methods should be in Shape class but we can not give their definition because we do not know how they work.

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

Problem with the Shape Class

But to add the functions within the Shape class we have added the functions with some invalid implementation.

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

Problem with the Shape Class

We encounter such scenarios many times during the modeling of the real world problems.

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

Problem with the Shape Class

Sometimes we know there should be some function but we do know what it will do. Its implementation depends on the class that extends it.

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

Problem with the Child Class

Similarly, at the child end, how can we guarantee child implement the virtual function ?

```
class Shape
{
    public virtual double getArea()
    {
        return 0;
    }

    public virtual string getShapeType()
    {
        return "undefined.";
    }
}
```

```
class Rectangle:Shape
{
  private int width;
  private int height;
  public Rectangle(int width,int height)
  {
      this.width=width;
      this.height=height;
  }
  public override double  getArea()
  {
       return width * height;
  }
  public override string getShapeType()
  {
       return "Rectangle";
  }
}
```

What we need.

We need some mechanism where we can define the functions that has only header (what shall be the input and output of function) but do not have any body and also it should be essential for children to provide definition of this method.

Abstraction

We need some mechanism where we can define the functions that has only header (what shall be the input and output of function) but no body and also it should be essential for children to provide definition of this method.

Such Mechanism in OOP is called Abstraction.

Abstraction

Abstraction means when something is an idea and does not exist in concrete form (an event) in current context.

In Code, We can declare a method abstract and leave its body for the child class to implement.

Abstraction

Abstraction means when something is an idea and does not exist in concrete form (an event) in current context.

In Code, We can declare a method abstract and leave its body for the child class to implement.

Here We have

```
public abstract double getArea();
```

Abstraction

However, when declare an abstract method in a class we get an error message.

```
class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

Abstraction

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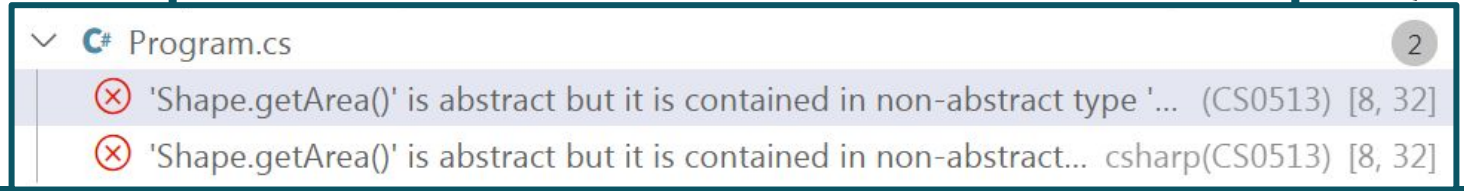

Abstraction

If a class contains an abstract method, class should be declared as abstract too.

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

Abstraction

If a class contains an abstract method, class should be declared as abstract too.

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

Abstraction

Objects of abstract class can not be created because its definition is not complete.

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

Abstraction

Abstract class instance can be created through it child class.

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

Abstraction

It is must for child class that inherits abstract class to provide definition of all abstract methods of the parent class.

```
abstract class Shape {
   public abstract double getArea();
   public virtual string getShapeType()
   {
      return "undefined.";
   }
}
```

Abstraction

It is must for child class that inherits abstract class to provide definition of all abstract methods of the parent class.

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

```
class Rectangle: Shape
{
 private int width;
 private int height;
 public override double getArea()
 {
      return this.width * height;
 }
 //Other part of code
}
```

Abstraction

If the child class that inherits the abstract class, does not provide the definition of all abstract methods of the Parent Class, then the child class will also be an Abstract Class

Abstraction: Advantage?

Then what is the advantage of declaring the abstract methods, when we were already doing same work with virtual methods ?

```
abstract class Shape {
  public abstract double getArea();
  public virtual string getShapeType()
  {
    return "undefined.";
  }
}
```

```
class Rectangle: Shape
{
 private int width;
 private int height;
 public override double getArea()
 {
      return this.width * height;
 }
 //Other part of code
}
```

Abstraction: Advantage

Abstraction applies more strict conditions on the child classes that they must give the definition of the abstract method or otherwise they become abstract as well.

Abstraction: Advantage

It is philosophical more sound that if class can not provide some of its implementation then it should be abstract and also its object can not be created.

Conclusion

- An abstract class is a class that is declared abstract.
- Abstraction means when something is an idea and not exist in concrete form (an event) in current context.
- Abstract classes cannot be instantiated, they can only be inherited.
- When an abstract class is inherited, the subclass usually provides implementations for all of the abstract methods in its parent class. However, if it does not, then the subclass must also be declared abstract.

Learning Objective

Implement Abstraction in Parent Class when it is known WHAT should be a functionality but do not know HOW it will be achieved.

Self Assessment: Output?

```
abstract class Bank
{
    public virtual void issueCard()
    {
        Console.WriteLine("Card is issued");
    }
    public abstract int getInterestRate();
}
```

```
class HBL : Bank
{

    public override int getInterestRate()
    { return 7; }
}
```

```
public static void main(string[] args)
{
    Bank b;
    b = new HBL();
    Console.WriteLine("HBL Rate of Interest is: " + b.getInterestRate() + "%");
    b.issueCard();
}
```

Self Assessment: Output?

```
abstract class Bank
{
    public virtual void issueCard()
    {
        Console.WriteLine("Card is issued");
    }
    public abstract int getInterestRate();
}
```

```
class MCB : Bank
{
    public override void issueCard()
    {
        Console.WriteLine("MCB Card is issued");
    }
}
```

```
public static void main(string[] args)
{
    Bank b;
    b = new MCB();
    Console.WriteLine("MCB Rate of Interest is: " + b.getInterestRate() + "%");
    b.issueCard();
}
```