

CMSC 132: Object-Oriented Programming II

Abstract Classes



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Modifier – Abstract

■ Description

- Represents generic concept
- Just a **placeholder**
- Leave lower-level details to subclass

■ Applied to

- Methods
- Classes

■ Example

```
abstract class Foo {           // abstract class  
    abstract void bar( ) { ... } // abstract method
```

Abstract – Motivating Example

■ Graphics drawing program

- Define a base class **Shape**
- Derive various subclasses for specific shapes
- Each subclass defines its own method **drawMe()**

```
public class Shape {  
    public void drawMe( ) { ... }    // generic drawing method  
}  
public class Circle extends Shape {  
    public void drawMe( ) { ... }    // draws a Circle  
}  
public class Rectangle extends Shape {  
    public void drawMe( ) { ... }    // draws a Rectangle  
}
```

Motivating Example – Shapes

■ Implementation

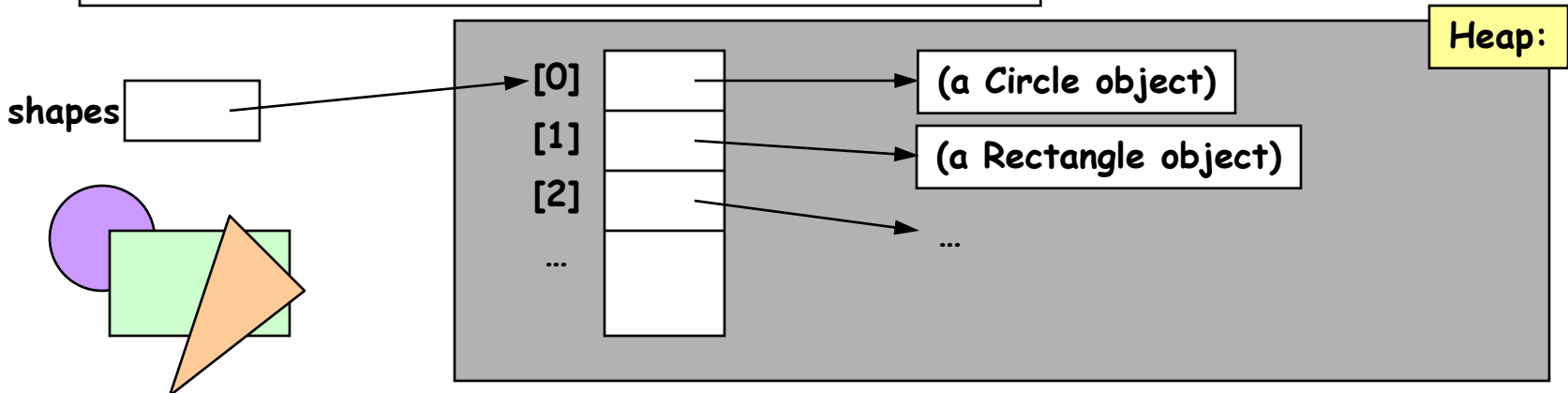
- Picture consists of array **shapes** of type **Shape[]**
- To draw the picture, invoke **drawMe()** for all shapes

```
Shape[ ] shapes = new Shape[...];  
shapes[0] = new Circle( ... );  
shapes[1] = new Rectangle( ... );
```

Store the shapes to be drawn in an array.

```
...  
for ( int i = 0; i < shapes.length; i++ )  
    shapes[i].drawMe( );
```

Draws all the shapes. Each call invokes drawMe for the specific shape.



Motivating Example – Shapes

■ Problem

- **Shape** object does not represent a specific shape

- Since Shape is just a superclass

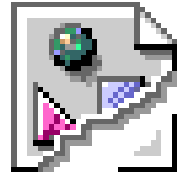
- How to implement Shape's drawMe() method?

```
public class Shape {  
    void drawMe( ) { ... } // generic drawing method  
}
```

Motivating Example – Shapes

■ Possible solutions

- Draw some special “undefined shape”
- Ignore the operation
- Issue an error message
- Throw an exception



■ Better solution

- Abstract drawMe() method, abstract Shape class
- Tells compiler Shape is incomplete class

Abstract Method

- Behaves much like method in interface
- Give a signature, but no body
- Includes modifier **abstract** in method signature
- Class descendants provide the implementation
- Abstract methods cannot be final
 - Since must be overridden by descendent class
 - Final would prevent this

Abstract Class

- Required if class contains any abstract method
- Includes modifier **abstract** in the class heading

```
public abstract class Shape { ... }
```

- An abstract class is incomplete

- Cannot be created using “new”

```
Shape s = new Shape( ... );           // Illegal!
```

- But can create concrete shapes (Circle, Rectangle) and assign them to variables of type Shape

```
Shape s = new Circle( ... );
```

Example Solution – Shapes

```
public abstract class Shape {  
    private int color;  
    Shape ( int c ) { color = c; }  
    public abstract void drawMe( );  
}
```

Base class **Shape** is abstract because it contains the abstract (undefined) method `drawMe( )`.

```
public class Circle extends Shape {  
    private double radius;  
    public Circle( int c, double r ) { ... details omitted ... }  
    public void drawMe( ) { ... Circle drawing code goes here ... }  
}
```

Derived class **Circle** is concrete because it defines `drawMe( )`.

```
public class Rectangle extends Shape {  
    private double height;  
    private double width;  
    public Rectangle( int c, double h, double w ) { ... details omitted ... }  
    public void drawMe( ) { ... Rectangle drawing code goes here ... }  
}
```

Derived class **Rectangle** is concrete because it defines `drawMe( )`.

The code for drawing the shapes given earlier can now be applied.

Abstract – Summary

■ Abstract methods

- Method that contains no body
- Subclass provides actual implementation

■ Abstract classes

- Required if any method in class is abstract
- Can contain non-abstract methods
- Can be partial description of class