CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Abstract Classes/Modifiers

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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
}
```

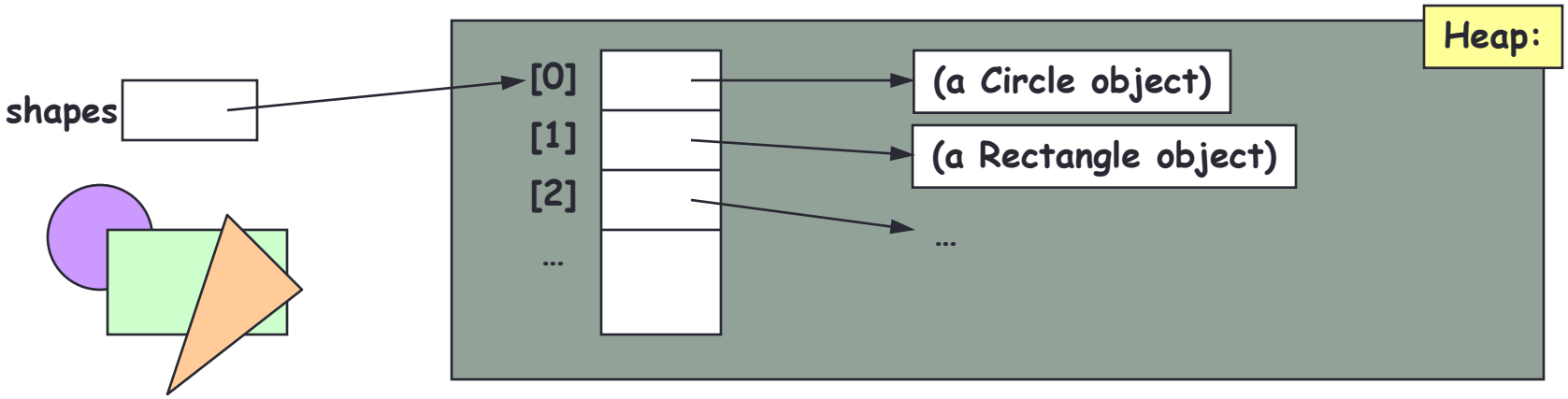
Motivating Example – Shapes

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

Store the shapes to be drawn in an array.

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



Motivating Example – Shapes

- 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

- **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
}
```

- **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 Class

- **Abstract Methods**
  - 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; }
    int getColor() { return color; }
    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.

Modifiers

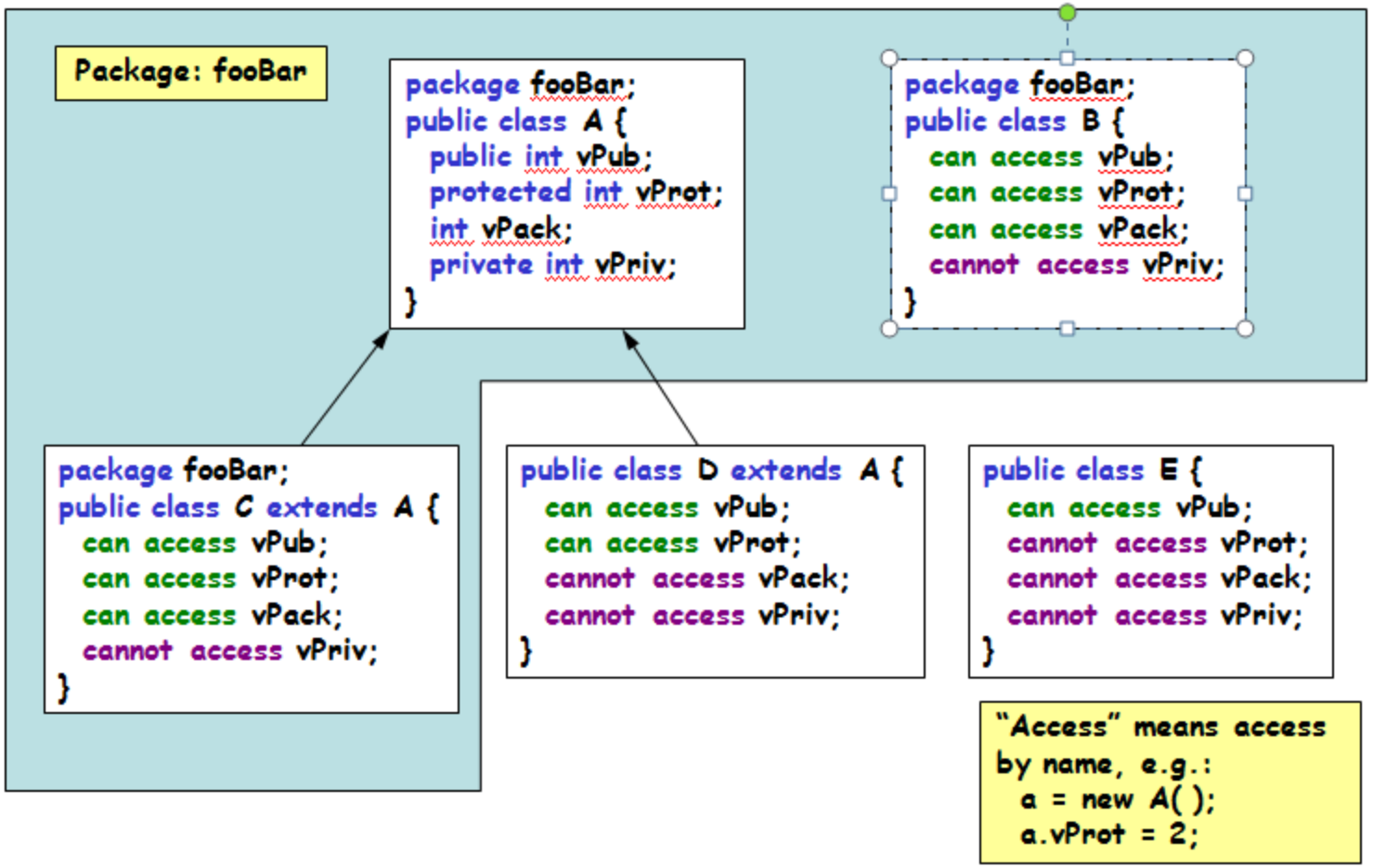
- Description
  - Java keyword (added to definition)
  - Specifies characteristics of a language construct
- (Partial) list of modifiers
  - Visibility modifiers (public / private / protected)
  - static
  - final
  - abstract
- Examples

```
public class Foo {
    private static int count;
    private final int increment = 5;
    protected void finalize { … }
}
public abstract class Bar {
    abstract int go( ) { … }
}
```

Visibility Modifiers

- **None specified (package)**
  - Referenced only within package
- **public**
  - Referenced anywhere (i.e., outside package)
- **protected**
  - Referenced within package, or by subclasses outside package
- **private**
  - Referenced only within class definition
  - Applicable to class fields & methods

Visibility Modifier



Static Modifier

- Static variable
  - Single copy for class
  - Shared among all objects of class
- Static method
  - Can be invoked through class name
  - Does not need to be invoked through object
  - Can be used even if no objects of class exist
  - Can not reference instance variables

Final Modifier

- **Final variable**
  - Value can not be changed
  - Must be initialized in every constructor
  - Attempts to modify final are caught at compile time
- **Final static variable**
  - Used for constants
  - Example

    final static int Increment = 5;
- **Final method**
  - Method can not be overridden by subclass
  - Private methods are implicitly final
- **Final class**
  - Class can not be a superclass (extended)
  - Methods in final class are implicitly final
  - Prevents inheritance / polymorphism
  - May be useful for
    - Security
    - Object oriented design
  - **Example: String class**