CMSC 132:
Object-Oriented Programming II

Abstract Classes/Modif ers

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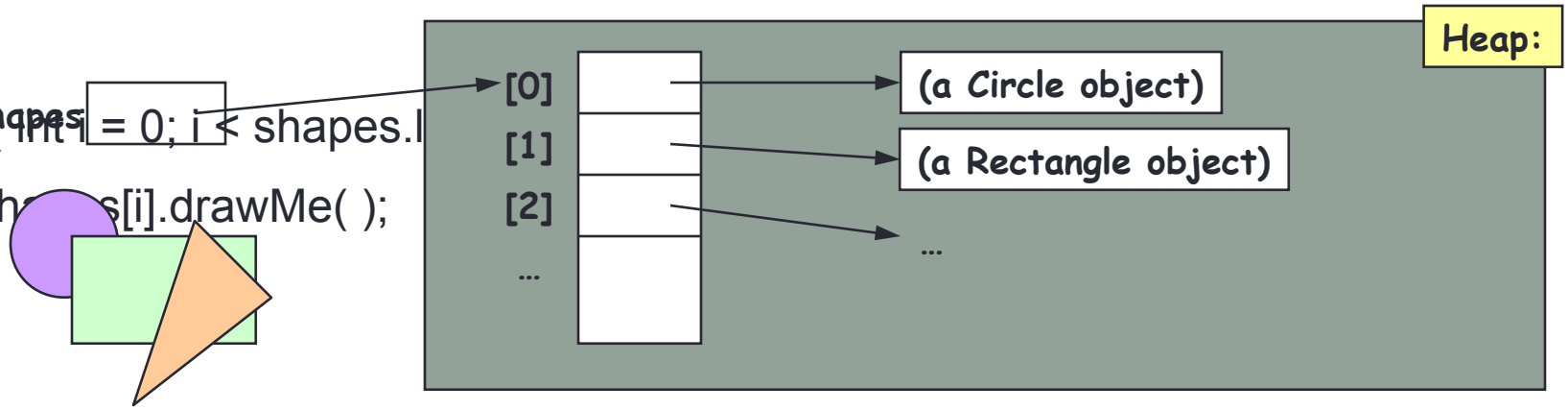
Motivating Example – Shapes

- **Example:** AbsClassesModifiersCode
- Implementation
  - Picture consists of array shapes of type Shape[ ]
  - To draw the picture, invoke drawMe( )

Store the shapes to be drawn in an array.

```
Shape[ ] shapes = new Shape[…];

shapes[0] = new Circle( … );

shapes[1] = new Rectangle( … );

…

for (int i = 0; i < shapes.l

    sh  s[i].drawMe( );
```

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, still users can create instances of it (Shape s = new Shape();)
  - How to implement Shape's drawMe( ) method?

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

- **Possible solutions**
  - Draw some special "undefined shape"

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 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!

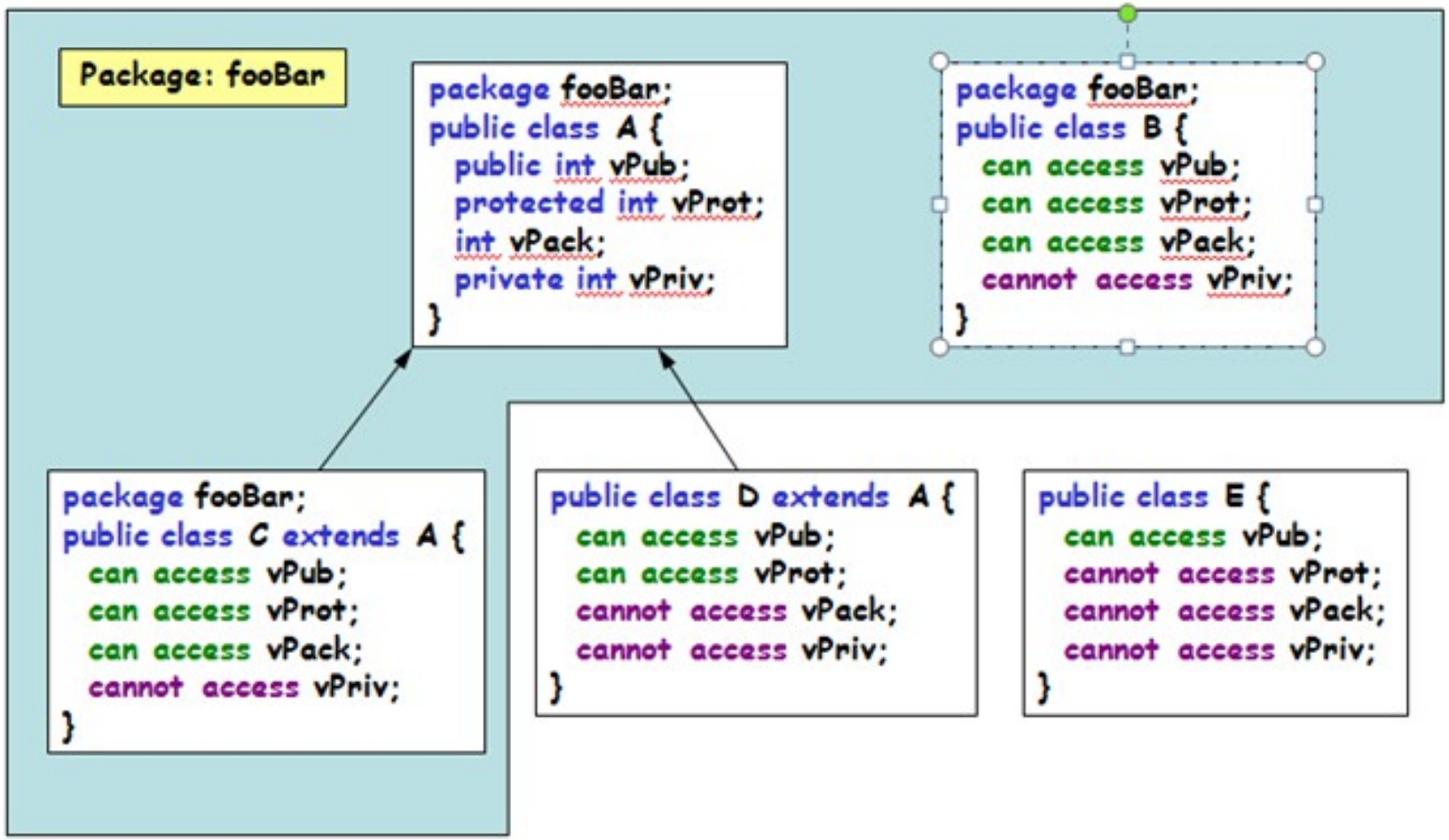
Modifiers

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

Visibility Modifiers

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

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
- **Example:** AbsClassesModifiersCode

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
- **Example:** AbsClassesModifiersCode
- **Final class**