JAVA BASICS

Comments are almost like C++

The javadoc program generates HTML API documentation from the “javadoc” style comments in your code.

```
/* This kind of comment can span multiple lines */
// This kind is to the end of the line
/**
  * This kind of comment is a special
  * ‘javadoc’ style comment
  */
```

An example of a class

Variable

Method

```
class Person {
    String name;
    int age;

    void birthday ( ) {
        age++;
        System.out.println (name +
        ' is now ' + age);
    }
}
```

Scoping

- As in C/C++, scope is determined by the placement of curly braces {}.
- A variable defined within a scope is available only to the end of that scope.

```
{  int x = 12;
   /* only x available */
      { int q = 96;
         /* both x and q available */
      }
      /* only x available */
      /* q "out of scope" */
    }
```

This is ok in C/C++ but not in Java.

```
{   int x = 12;
    { int x = 96; /* illegal */
     }
  }
```

An array is an object

- `Person mary = new Person ( );`
- `int myArray[ ] = new int[5];`
- `int myArray[ ] = {1, 4, 9, 16, 25};`
- `String languages [ ] = {"Prolog", "Java"};`
- Since arrays are objects they are allocated dynamically
- Arrays, like all objects, are subject to garbage collection when no more references remain
  - so fewer memory leaks
  - Java doesn’t have pointers!

Scope of Objects

- Java objects don’t have the same lifetimes as primitives.
- When you create a Java object using **new**, it hangs around past the end of the scope.
- Here, the scope of name s is delimited by the {}s but the String object hangs around until GC’d

```
{
   String s = new String("a string");
} /* end of scope */
```

Methods, arguments and return values

- Java methods are like C/C++ functions. General case:

  returnType methodName (*arg1*, *arg2*, … *argN*) {

  methodBody

  }

The return keyword exits a method optionally with a value

```
int storage(String s) {return s.length() * 2;}
boolean flag() { return true; }
float naturalLogBase() { return 2.718f; }
void nothing() { return; }
void nothing2() {}
```

The static keyword

- Java methods and variables can be declared static
- These exist **independent of any object**
- This means that a Class's
  - static methods can be called even if no objects of that class have been created and
  - static data is "shared" by all instances (i.e., one rvalue per class instead of one per instance

```
class StaticTest {static int i = 47;}
StaticTest st1 = new StaticTest();
StaticTest st2 = new StaticTest();
// st1.i == st2.I == 47
StaticTest.i++;          // or st1.I++ or st2.I++
// st1.i == st2.I == 48
```

Array Operations

- Subscripts always start at 0 as in C
- Subscript checking is done automatically
- Certain operations are defined on arrays of objects, as for other classes
  - e.g. myArray.length == 5

Example Programs

Echo.java

```
C:\UMBC\331\java>type echo.java
//  This is the Echo example from the Sun tutorial
class echo {
  public static void main(String args[]) {
    for (int i=0; i < args.length; i++) {
      System.out.println( args[i] );
    }
  }
}

C:\UMBC\331\java>javac echo.java

C:\UMBC\331\java>java echo this is pretty silly
this
is
pretty
silly

C:\UMBC\331\java>
```

Factorial Example

From Java in a Nutshell

```
/**
 * This program computes the factorial of a number
 */
public class Factorial {                   // Define a class
  public static void main(String[] args) { // The program starts here
    int input = Integer.parseInt(args[0]); // Get the user's input
    double result = factorial(input);      // Compute the factorial
    System.out.println(result);            // Print out the result
  }                                        // The main() method ends here

  public static double factorial(int x) {  // This method computes x!
    if (x < 0)                             // Check for bad input
      return 0.0;                          //   if bad, return 0
    double fact = 1.0;                     // Begin with an initial value
    while(x > 1) {                         // Loop until x equals 1
      fact = fact * x;                     //   multiply by x each time
      x = x - 1;                           //   and then decrement x
    }                                      // Jump back to the star of loop
    return fact;                           // Return the result
  }                                        // factorial() ends here
}                                          // The class ends here
```

JAVA Classes

- The *class* is the fundamental concept in JAVA (and other OOPLs)
- A class describes some data object(s), and the operations (or methods) that can be applied to those objects
- Every object and method in Java belongs to a class
- Classes have data (fields) and code (methods) and classes (member classes or inner classes)
- Static methods and fields belong to the class itself
- Others belong to instances

Example

```
public class Circle {
  // A class field
  public static final double PI= 3.14159;     // A useful constant

  // A class method: just compute a value based on the arguments
  public static double radiansToDegrees(double rads) {
    return rads * 180 / PI;
  }

  // An instance field
  public double r;                  // The radius of the circle

  // Two methods which operate on the instance fields of an object
  public double area() {            // Compute the area of the
  circle
    return PI * r * r;
  }
  public double circumference() {   // Compute the circumference of
  the circle
    return 2 * PI * r;
  }
}
```

Constructors

- Classes should define one or more methods to create or construct instances of the class
- Their name is the same as the class name
  - note deviation from convention that methods begin with lower case
- Constructors are differentiated by the number and types of their arguments
  - An example of overloading
- If you don’t define a constructor, a default one will be created.
- Constructors automatically invoke the zero argument constructor of their superclass when they begin (note that this yields a recursive process!)

Constructor example

```
public class Circle {
    public static final double PI = 3.14159;  // A constant
    public double r;   // instance field holds circle’s radius

    // The constructor method: initialize the radius field
    public Circle(double r) { this.r = r; }

    // Constructor to use if no arguments
    public Circle() { r = 1.0; }
    // better: public Circle() { this(1.0); }

    // The instance methods: compute values based on radius
    public double circumference() { return 2 * PI * r; }
    public double area() { return PI * r*r; }
}
```

this.r refers to the r field of the class

This() refers to a constructor for the class

Extending a class

- Class hierarchies reflect subclass-superclass relations among classes.
- One arranges classes in hierarchies:
  - A class inherits instance variables and instance methods from all of its superclasses. Tree -> BinaryTree -> BST
  - You can specify only ONE superclass for any class.
- When a subclass-superclass chain contains multiple instance methods with the same signature (name, arity, and argument types), the one **closest** to the target instance in the subclass-superclass chain is the one executed.
  - All others are shadowed/overridden.
- Something like multiple inheritance can be done via interfaces (more on this later)
- What’s the superclass of a class defined without an extends clause?

Extending a class

```
public class PlaneCircle extends Circle {
  // We automatically inherit the fields and methods of Circle,
  // so we only have to put the new stuff here.
  // New instance fields that store the center point of the circle
  public double cx, cy;

  // A new constructor method to initialize the new fields
  // It uses a special syntax to invoke the Circle() constructor
  public PlaneCircle(double r, double x, double y) {
    super(r);       // Invoke the constructor of the superclass, Circle()
    this.cx = x;    // Initialize the instance field cx
    this.cy = y;    // Initialize the instance field cy
  }

  // The area() and circumference() methods are inherited from Circle
  // A new instance method that checks whether a point is inside the circle
  // Note that it uses the inherited instance field r
  public boolean isInside(double x, double y) {
    double dx = x - cx, dy = y - cy;             // Distance from center
    double distance = Math.sqrt(dx*dx + dy*dy);  // Pythagorean theorem
    return (distance < r);                       // Returns true or false
  }
}
```

Overloading, overwriting, and shadowing

- **Overloading** occurs when Java can distinguish two procedures with the same name by examining the number or types of their parameters.
- **Shadowing** or **overriding** occurs when two procedures with the same signature (name, the same number of parameters, and the same parameter types) are defined in different classes, one of which is a superclass of the other.

On designing class hierarchies

- Programs should obey the *explicit-representation principle*, with classes included to reflect natural categories.
- Programs should obey the *no-duplication principle*, with instance methods situated among class definitions to facilitate sharing.
- Programs should obey the *look-it-up principle*, with class definitions including instance variables for stable, frequently requested information.
- Programs should obey the *need-to-know principle*, with public interfaces designed to restrict instance-variable and instance-method access, thus facilitating the improvement and maintenance of nonpublic program elements.
- If you find yourself using the phrase *an X is a Y* when describing the relation between two classes, then the X class is a subclass of the Y class.
- If you find yourself using *X has a Y* when describing the relation between two classes, then instances of the Y class appear as parts of instances of the X class.

Data hiding and encapsulation

- Data-hiding or encapsulation is an important part of the OO paradigm.
- Classes should carefully control access to their data and methods in order to
  - Hide the irrelevant implementation-level details so they can be easily changed
  - Protect the class against accidental or malicious damage.
  - Keep the externally visible class simple and easy to document
- Java has a simple access control mechanism to help with encapsulation
  - Modifiers: public, protected, private, and package (default)

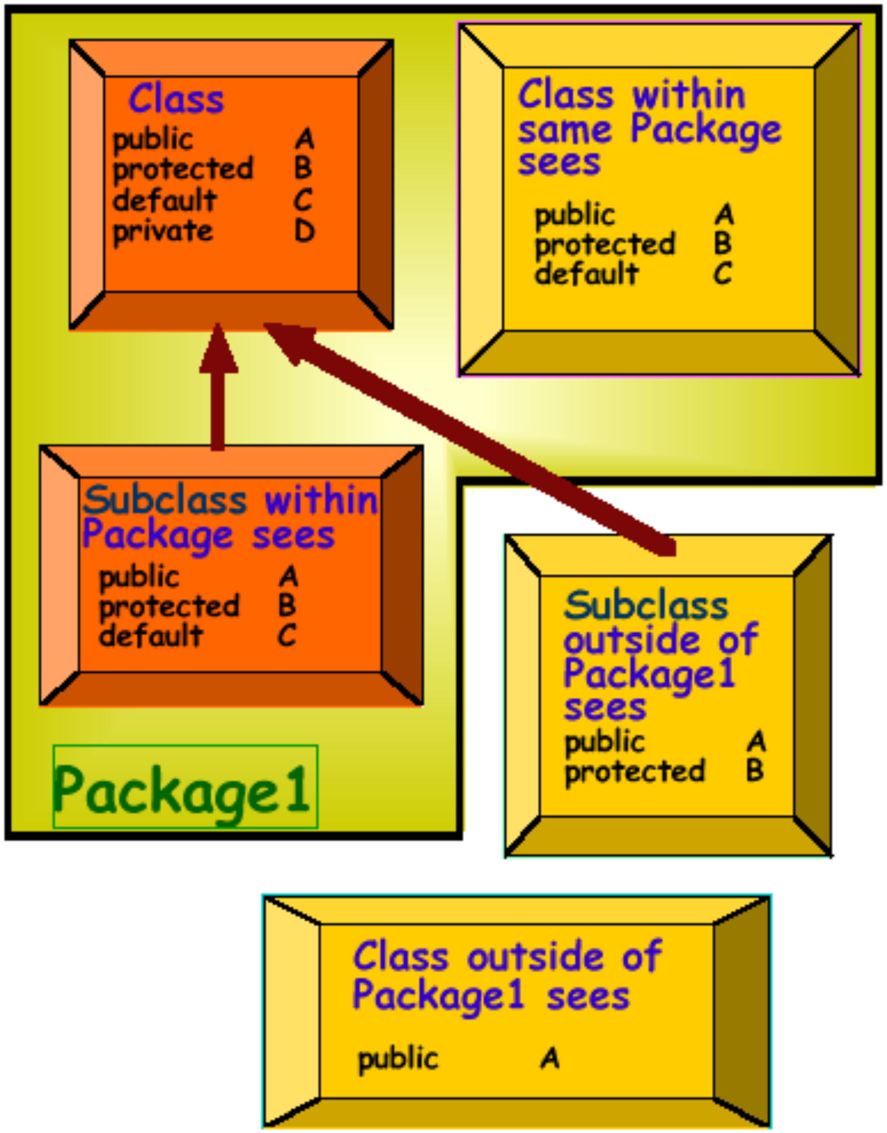
Example

encapsulation

```
package shapes;           // Specify a package for the class
public class Circle {     // The class is still public
  public static final double PI = 3.14159;

  protected double r;     // Radius is hidden, but visible to subclasses

  // A method to enforce the restriction on the radius
  // This is an implementation detail that may be of interest to subclasses
  protected checkRadius(double radius) {
    if (radius < 0.0)
      throw new IllegalArgumentException("radius may not be negative.");
  }
  // The constructor method
  public Circle(double r) {checkRadius(r); this.r = r; }

  // Public data accessor methods
  public double getRadius() { return r; };
  public void setRadius(double r) { checkRadius(r); this.r = r;}

  // Methods to operate on the instance field
  public double area() { return PI * r * r; }
  public double circumference() { return 2 * PI * r; }
}
```

Access control

- Access to packages
  - Java offers no control mechanisms for packages.
  - If you can find and read the package you can access it
- Access to classes
  - All top level classes in package P are accessible anywhere in P
  - All public top-level classes in P are accessible anywhere
- Access to class members (in class C in package P)
  - Public: accessible anywhere C is accessible
  - Protected: accessible in P and to any of C’s subclasses
  - Private: only accessible within class C
  - Package: only accessible in P (the default)



A summary of Java scoping visibility

Getters and setters

- A getter is a method that extracts information from an instance.
  - One benefit: you can include additional computation in a getter.
- A setter is a method that inserts information into an instance (also known as mutators).
  - A setter method can check the validity of the new value (e.g., between 1 and 7) or trigger a side effect (e.g., update a display)
- Getters and setters can be used even without underlying matching variables
- Considered good OO practice
- Essential to javabeans
- Convention: for variable fooBar of type fbtype, define
  - getFooBar()
  - setFooBar(fbtype x)

Example

getters and setters

```
package shapes;           // Specify a package for the class

public class Circle {     // The class is still public
  // This is a generally useful constant, so we keep it public
  public static final double PI = 3.14159;

  protected double r;     // Radius is hidden, but visible to subclasses

  // A method to enforce the restriction on the radius
  // This is an implementation detail that may be of interest to subclasses
  protected checkRadius(double radius) {
    if (radius < 0.0)
      throw new IllegalArgumentException("radius may not be negative.");
  }

  // The constructor method
  public Circle(double r) { checkRadius(r); this.r = r;}

  // Public data accessor methods
  public double getRadius() { return r; };
  public void setRadius(double r) { checkRadius(r); this.r = r;}

  // Methods to operate on the instance field
  public double area() { return PI * r * r; }
  public double circumference() { return 2 * PI * r; }
}
```

Abstract classes and methods

- Abstract vs. concrete classes
- Abstract classes can not be instantiated

```
public abstract class shape { }
```

- An abstract method is a method w/o a body

```
public abstract double area();
```

- (Only) Abstract classes can have abstract methods
- In fact, any class with an abstract method is automatically an abstract class

Example

abstract class

```
public abstract class Shape {
  public abstract double area();  // Abstract methods: note
  public abstract double circumference();// semicolon instead of body.
}

class Circle extends Shape {
  public static final double PI = 3.14159265358979323846;
  protected double r;                              // Instance data
  public Circle(double r) { this.r = r; }          // Constructor
  public double getRadius() { return r; }          // Accessor
  public double area() { return PI*r*r; }          // Implementations of
  public double circumference() { return 2*PI*r; } // abstract methods.
}

class Rectangle extends Shape {
  protected double w, h;                               // Instance data
  public Rectangle(double w, double h) {               // Constructor
    this.w = w;  this.h = h;
  }
  public double getWidth() { return w; }               // Accessor method
  public double getHeight() { return h; }              // Another accessor
  public double area() { return w*h; }                 // Implementations of
  public double circumference() { return 2*(w + h); }  // abstract methods.
}
```

Syntax Notes

- No global variables
  - class variables and methods may be applied to any instance of an object
  - methods may have local (private?) variables
- No pointers
  - but complex data objects are “referenced”
- Other parts of Java are borrowed from PL/I, Modula, and other languages