Learning the Java Language

Based on The Java™ Tutorial
(http://docs.oracle.com/javase/tutorial/java/)

Bryn Mawr College
CS206 Intro to Data Structures

Language Basics

- Variables
- Operators
- Expressions, Statements and Blocks
- Control Flow Statements

What is an object

- Objects
  - State: stored in *fields*
  - Behavior: exposed through *methods*, the primary mechanism for object-to-object communication
- *Data encapsulation:* hiding internal state and requiring all interaction to be performed through an object's methods (an OOP fundamental principle)
- Benefits of using objects
  - Modularity
  - Information-hiding
  - Code re-use
  - Pluggability and debugging ease

What is a class

- *Class*: A blueprint for a software object.
- A specific object is called an *instance* of the class of objects.

```
public class Bicycle {
    int speed = 0;
    int gear = 1;

    void changeGear(int newValue) {
        gear = newValue;
    }

    void speedUp(int increment) {
        speed = speed + increment;
    }

    void applyBrakes(int decrement) {
        speed = speed - decrement;
    }

    void printStates() {
        System.out.println("speed:" +
            speed + " gear:" + gear);
    }
}
```

```
public class BicycleDemo {
    public static void main(String[] args) {

        // Create two different
        // Bicycle objects
        Bicycle bike1 = new Bicycle();
        Bicycle bike2 = new Bicycle();

        // Invoke methods on
        // those objects
        bike1.speedUp(10);
        bike1.changeGear(2);
        bike1.printStates();

        bike2.speedUp(10);
        bike2.changeGear(2);
        bike2.speedUp(10);
        bike2.changeGear(3);
        bike2.printStates();
    }
}
```

Variables

- An object stores its state in *fields*.
  - int speed = 0;
  - int gear = 1;
- Kinds of variables:
  - **Instance Variables (Non-Static Fields)**: a.k.a instance variables (because their values are unique to each instance of a class, i.e., to each object. E.g., the currentSpeed of one bicycle is independent from the currentSpeed of another.
  - **Class Variables (Static Fields):**
    - Any field declared with the **static** modifier.
    - **Exactly** one copy of this variable in existence, regardless of how many times the class has been instantiated.
    - E.g., static int numGears = 6;
  - **Local Variables:** only visible to the methods in which they are declared; they are not accessible from the rest of the class.
  - **Parameters**
    - E.g., void changeGear(int newValue)

Variable Naming

- Variable names are case-sensitive.
- A variable name begins with:
  - Legally, a letter, the dollar sign "$", or the underscore character "_".
  - Convention: begins with a letter, not "$" or "_".
- Subsequent characters:
  - letters, digits, dollar signs, or underscore characters
- White space is not permitted.
- Must not choose keyword or reserved word.
- One word only: all lowercase letters.
- More than one word: capitalize the first letter of each subsequent word. E.g., currentGear
- If a variable stores a constant value, capitalize every letter. E.g., static final int NUM_GEARS = 6.

Primitive Data Types

Display 1.2 **Primitive Types**

TYPE NAME	KIND OF VALUE	MEMORY USED	SIZE RANGE
`boolean`	`true` or `false`	1 byte	not applicable
`char`	single character (Unicode)	2 bytes	all Unicode characters
`byte`	integer	1 byte	−128 to 127
`short`	integer	2 bytes	−32768 to 32767
`int`	integer	4 bytes	−2147483648 to 2147483647
`long`	integer	8 bytes	−9223372036854775808 to 9223372036854775807
`float`	floating-point number	4 bytes	$-3.40282347 \times 10^{+38}$ to $-1.40239846 \times 10^{-45}$
`double`	floating-point number	8 bytes	$\pm 1.76769313486231570 \times 10^{+308}$ to $\pm 4.94065645841246544 \times 10^{-324}$

Literals

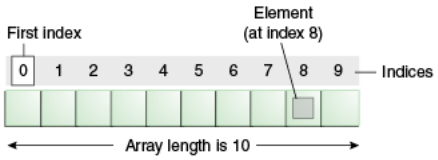
```
boolean result = true;
char capitalC = 'C';
byte b = 100;
short s = 10000;
int i = 100000;
// The number 26, in decimal
int decVal = 26;
// The number 26, in hexadecimal
int hexVal = 0x1a;
// The number 26, in binary
int binVal = 0b11010;
double d1 = 123.4;
float f1 = 123.4f;
```

Character and String Literals

- \b (backspace),
- \t (tab),
- \n (line feed),
- \f (form feed),
- \r (carriage return),
- \" (double quote),
- \' (single quote),
- \\ (backslash).
- null: used as a value for any reference type (not for primitive types)

Arrays

- An *array* is a container object that holds a fixed number of values of a single type.



- Declaring a variable to refer to an array
  - int[] anArrayOfChars;

Creating, Initializing and Accessing an Array

```
// create an array of integers
anArray = new int[10];
anArray[0] = 100; // initialize first element
anArray[1] = 200; // initialize second element
anArray[2] = 300; // and so forth
System.out.println("Element 2 at index 1: " + anArray[1]); // access by index

Alternatively,
int[] anArray = {
    100, 200, 300,
    400, 500, 600,
    700, 800, 900, 1000
};
```

Multidimensional Array

- An array whose components are themselves arrays (rows are allowed to vary in length)

```
class MultiDimArrayDemo {
    public static void main(String[] args) {
        String[][] names = {
            {"Mr. ", "Mrs. ", "Ms. "},
            {"Smith", "Jones"}
        };
        // Mr. Smith
        System.out.println(names[0][0] + names[1][0]);
        // Ms. Jones
        System.out.println(names[0][2] + names[1][1]);
    }
}
```

Copying Arrays

- The **System** class has an arraycopy() method to efficiently copy data from one array into another:

```
public static void arraycopy(Object src, int srcPos,
                             Object dest, int destPos, int length)
```

```
class ArrayCopyDemo {
    public static void main(String[] args) {
        char[] copyFrom = { 'd', 'e', 'c', 'a', 'f', 'f', 'e',
                                        'i', 'n', 'a', 't', 'e', 'd' };
        char[] copyTo = new char[7];

        System.arraycopy(copyFrom, 2, copyTo, 0, 7);
        System.out.println(new String(copyTo));
    }
}
```

Operators

Simple Assignment Operator

= Simple assignment operator

Arithmetic Operators

+ Additive operator (also used for String concatenation)

- Subtraction operator

* Multiplication operator

/ Division operator

% Remainder operator

Unary Operators

+ Unary plus operator; indicates positive value (numbers are positive without this, however)

- Unary minus operator; negates an expression

++ Increment operator; increments a value by 1

-- Decrement operator; decrements a value by 1

! Logical complement operator; inverts the value of a boolean

Operators

Equality and Relational Operators

== Equal to

!= Not equal to

> Greater than

>= Greater than or equal to

< Less than

<= Less than or equal to

Conditional Operators

&& Conditional-AND

|| Conditional-OR

?: Ternary (shorthand for if-then-else statement)

Type Comparison Operator

instanceof Compares an object to a specified type

Bitwise and Bit Shift Operators

~ Unary bitwise complement

<< Signed left shift

>> Signed right shift

>>> Unsigned right shift

& Bitwise AND

^ Bitwise exclusive OR

| Bitwise inclusive OR

instanceOfDemo

```
class InstanceofDemo {
   public static void main(String[] args) {

      Animal obj1 = new Animal();
      Animal obj2 = new Cat();

      System.out.println("obj1 instanceof Animal: " + (obj1 instanceof Animal));
      System.out.println("obj1 instanceof Cat: " + (obj1 instanceof Cat ));
      System.out.println("obj2 instanceof Animal: "+ (obj2 instanceof Animal));
      System.out.println("obj2 instanceof Cat: "+ (obj2 instanceof Cat ));
   }
}

class Animal {}
class Cat extends Animal{}
```

Pre-, Post-Increment Operator

```
class PrePostDemo {
    public static void main(String[] args){
        int i = 3;
        i++;
        System.out.println(i);    // "4"
        ++i;
        System.out.println(i);    // "5"
        System.out.println(++i);  // "6"
        System.out.println(i++);  // "6"
        System.out.println(i);    // "7"
    }
}
```

Expressions

- An *expression* is a construct made up of variables, operators, and method invocations
  - constructed according to the syntax of the language
  - evaluates to a single value

```
int gear = 0;
anArray[0] = 100;
System.out.println("Element 1 at index 0: " +anArray[0]);
int result = 1 + 2; // result is now 3
if (value1 == value2)
    System.out.println("value1 == value2");
```

Compound Expressions

- Compound expressions can be constructed from various smaller expressions as long as the data type required by one part of the expression matches the data type of the other.

- x + y / 100 // ambiguous
- (x + y) / 100 // unambiguous, recommended
- x + (y / 100) // unambiguous, recommended

Operator Precedence

Operators	Precedence
postfix	*expr*++ *expr*--
unary	++*expr* --*expr* +*expr* -*expr* ~ !
multiplicative	* / %
additive	+ -
shift	<< >> >>>
relational	< > <= >= instanceof
equality	== !=
bitwise AND	&
bitwise exclusive OR	^
bitwise inclusive OR	|
logical AND	&&
logical OR	||
ternary	? :
assignment	= += -= *= /= %= &= ^= |= <<= >>= >>>=

Practice: Evaluating Expressions

Given integer variables a, b, c, d, and e, where a = 1, b = 2, c = 3, d = 4,

evaluate the following expressions:

a + b - c + d

a * b / c

1 + a * b % c

a + d % b - c

e = b = d + c / b - a

Practice: Evaluating Expressions

int answer, value = 4 ;

Code	Value	Answer
	4	
1. value = value + 1 ;		
2. value++ ;		
3. ++value ;		
4. answer = 2 * value++ ;		
5. answer = ++value / 2 ;		
6. value-- ;		
7. --value ;		
8. answer = --value * 2 ;		
9. answer = value-- / 3 ;		

Statements

- Statements are roughly equivalent to sentences in natural languages.
- A *statement* forms a complete unit of execution.
- *Expression statements*: terminated with a semicolon (;).
  - Assignment expressions: aValue = 8933.234;
  - Any use of ++ or --: aValue++;
  - Method invocations:
    System.out.println("Hello World!");
  - Object creation expressions:
    Bicycle myBike = new Bicycle();
- *Declaration statements:* double aValue = 8933.234;
- *Control flow statements:* more later…

Blocks

- A *block* is a group of zero or more statements between balanced braces and can be used anywhere a single statement is allowed.

```
class BlockDemo {
   public static void main(String[] args) {
          boolean condition = true;
             if (condition) { // begin block 1
                System.out.println("Condition is true.");
             } // end block 1
             else { // begin block 2
                System.out.println("Condition is false.");
             } // end block 2
   }
}
```

Control Flow Statements: if-then-else

- Once a condition is satisfied, the appropriate statements are executed and the remaining conditions are not evaluated.

```
class IfElseDemo {
    public static void main(String[] args) {
            int testscore = 76;
            char grade;
            if (testscore >= 90) {
               grade = 'A';
            } else if (testscore >= 80) {
               grade = 'B';
            } else if (testscore >= 70) {
               grade = 'C';
            } else if (testscore >= 60) {
               grade = 'D';
            } else {
               grade = 'F';
            }
            System.out.println("Grade = " + grade);
    }
}
```

Control Flow: switch

```
public class SwitchDemo {
    public static void main(String[] args) {
            int month = 8;
            String monthString;
            switch (month) {
            case 1: monthString = "January"; break;
            case 2: monthString = "February"; break;
            case 3: monthString = "March"; break;
            case 4: monthString = "April"; break;
            case 5: monthString = "May"; break;
            case 6: monthString = "June"; break;
            case 7: monthString = "July"; break;
            case 8: monthString = "August"; break;
            case 9: monthString = "September"; break;
            case 10: monthString = "October"; break;
            case 11: monthString = "November"; break;
            case 12: monthString = "December"; break;
            default: monthString = "Invalid month"; break;
            }
            System.out.println(monthString);
    }
}
```

Control Flow: switch (break)

```
public class SwitchDemoFallThrough {
    public static void main(String[] args) {
        java.util.ArrayList<String> futureMonths = new java.util.ArrayList<String>();
        int month = 8;
        switch (month) {
        case 1: futureMonths.add("January");  case 2: futureMonths.add("February");
        case 3: futureMonths.add("March"); case 4: futureMonths.add("April");
        case 5: futureMonths.add("May");  case 6: futureMonths.add("June");
        case 7: futureMonths.add("July"); case 8: futureMonths.add("August");
        case 9: futureMonths.add("September"); case 10: futureMonths.add("October");
        case 11: futureMonths.add("November");
        case 12: futureMonths.add("December"); break;
        default: break; }
        if (futureMonths.isEmpty()) {
            System.out.println("Invalid month number");
        } else {
            for (String monthName : futureMonths) {
                System.out.println(monthName);
            }
        }
    }
}
```

Notes on Switch

- A switch works with the byte, short, char, and int primitive data types. It also works with *enumerated types* (discussed in Enum Types), the String class, and a few special classes that wrap certain primitive types: Character, Byte, Short, and Integer (discussed later…).
- In Java SE 7 and later, you can use a String object in the switch statement's expression.

Control Flow: while, do-while

```
while (expression) {
    statement(s)
}

do {
    statement(s)
} while (expression);
```

The statements within the do block are always executed at least once.

Control Flow: while, do-while

```
class WhileDemo {
    public static void main(String[] args){
        int count = 1;
        while (count < 11) {
            System.out.println("Count is: " + count);
            count++;
        }
    }
}

class DoWhileDemo {
    public static void main(String[] args){
        int count = 1;
        do {
            System.out.println("Count is: " + count);
            count++;
        } while (count < 11);
    }
}
```

Control Flow: for

for (*initialization*; *termination*; *increment*) {
    statement(s)
}

```
class EnhancedForDemo {
   public static void main(String[] args){
      int[] numbers = {1,2,3,4,5,6,7,8,9,10};
      for (int item : numbers) {
         System.out.println("Count is: " + item);
      }
   }
}
```

Control Flow: Branching - break

- Problem:
  - Search for a specific number in an array.

unlabeled

Control Flow: Branching - break

unlabeled

```
class BreakWithLabelDemo {
   public static void main(String[] args) {
      int[] arrayOfInts = {32, 87, 3, 589, 12, 1076, 2000, 8, 622, 127};
      int searchfor = 12;
      int i;
      boolean foundIt = false;

      for (i = 0; i < arrayOfInts.length; i++) {
         if (arrayOfInts[i] == searchfor) {
               foundIt = true;
               break;
         }
      }
      if (foundIt) {
         System.out.println("Found " + searchfor + " at " + i);
      } else {
         System.out.println(searchfor + " not in the array");
      }
   }
}
```

Control Flow: Branching - break

labeled

- Problem:
  - Search for a value in a two-dimensional array.

Control Flow: Branching - break

labeled

```
class BreakWithLabelDemo {
   public static void main(String[] args) {
      int[][] arrayOfInts = { { 32, 87, 3, 589 }, { 12, 1076, 2000, 8 },
                              { 622, 127, 77, 955 } };
      int searchfor = 12;
      int i; int j = 0;
      boolean foundIt = false;
   search:
      for (i = 0; i < arrayOfInts.length; i++) {
         for (j = 0; j < arrayOfInts[i].length; j++) {
            if (arrayOfInts[i][j] == searchfor) {
               foundIt = true;
               break search;
            }
         }
      }
      if (foundIt) {
         System.out.println("Found " + searchfor + " at " + i + ", " + j);
      } else {
         System.out.println(searchfor + " not in the array");
      }
   }
}
```

Control Flow: continue

- Problem:
  - Count the number of occurrences of a specific character in a given string.

Control Flow: continue

The continue statement skips the current iteration of a for, while , or do-while loop.

```
class ContinueDemo {
   public static void main(String[] args) {
      String searchMe = "peter piper picked a " + "peck of pickled peppers";
      int max = searchMe.length();
      int numPs = 0;
      for (int i = 0; i < max; i++) {
         // interested only in p's
         if (searchMe.charAt(i) != 'p')
            continue;
         // process p's
         numPs++;
      }
      System.out.println("Found " + numPs + " p's in the string.");
   }
}
```

Control Flow: continue

labeled

- Problem:
  - Search for a substring within another string.

Control Flow: continue

labeled

```
class ContinueWithLabelDemo {
    public static void main(String[] args) {
        String searchMe = "Look for a substring in me";
        String substring = "sub";
        boolean foundIt = false;
        int max = searchMe.length() - substring.length();
    test:
        for (int i = 0; i <= max; i++) {
            int n = substring.length(); int j = i; int k = 0;
            while (n-- != 0) {
                if (searchMe.charAt(j++) != substring.charAt(k++)) {
                    continue test;
                }
            }
            foundIt = true; break test;
        }
        System.out.println(foundIt ? "Found it" : "Didn't find it");
    }
}
```

Control Flow: return

- The return statement exits from the current method, and control flow returns to where the method was invoked.
- Two forms:
  - returns a value, e.g., return ++count;
  - doesn't return a value (when a method is declared void), e.g., return;