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Programming basics (review)

- Computer programming
- Semantics, syntax, and style
- Variables and data type
- Methods and decomposition
- Methods for I/O in Java

Am I in the right place?

- What is computer programming?
- What is computer science?
- Why study computer science/programming?
  - Drives innovation in sciences (makes a positive difference!)
  - Foundational knowledge in problem solving and logical thinking
  - The “renaissance man” knowledge-base of the 21st century
  - Computing jobs rated among highest paying and most satisfying
  - Lots of teamwork! Good communication skills mandatory
  - Greatest job growth area (contrary to popular belief)
  - Its impossible to predict what will happen next in computing, there are constantly new opportunities to make new, significant contributions
Computer programming

- Essentially, computers are simple devices that:
  - allow input to memory
  - allow output from memory
  - allow limited processing (instructions) on memory

- **Computer programming** is the task of sequencing the limited processing operations towards solving a specific design goal.
- **High level languages** allow us to specify tasks without being aware of the specific instructions need on a system.

**Compilation Vs. Interpretation**

- An alternative to compiling your program is to interpret your program
  - each line of your program is translated into a machine language and immediately executed
- Like translating between natural languages
  - **Compiler**: human translator translates book in its entirety and then translated book is printed (compiled to executable format). That book can THEN be stored and read (executed) without repeating the process.
  - **Interpreter**: human interpreter translates each spoken statement in sequence AS speaker is speaking. No recording of the translated version is made. It must be re-interpreted to hear it again.
Compiling to a virtual machine

- Java uses both compiler and interpreter in a two-step process.
- Compiler program (bytecode).
  - Syntax in a generic "machine language" for a "virtual machine".
  - Does not correspond to any particular machine.
- Virtual Machine (VM) interprets bytecodes into native machine language and runs it.
- Different VM implementations exist for each machine (e.g., for different computer architecture language).
- Java bytecodes can be used on different computers without re-compiling source code.
- Allows you to test Java programs by getting just bytecodes from Web page.
- This makes Java code run cross-platform.
  - "Write once, run anywhere!"

Why Java?

- Java is VERY object-oriented.
- Java is popular in the field.
  - Early versions of Java were slow, buggy, and hard to use.
  - Platform independence still made it amazingly popular.
  - Current versions of Java have most/all features that are popular in other programming languages.
- Java and C++ are close cousins.
- Java run complete with thousands of library classes, nearly everywhere.
  - More power! Easier to develop with! Powerful (and free) IDEs!
- Although the fundamental concepts of this course apply to ALL programming, the specifics we will use for illustration and for formative/summative experiences will be in Java.
- If you've never used Java before, talk to your instructor ASAP.

Semantics, Syntax, and Style

```java
public class HelloWorld {
    public static void main (String[] args) {
        System.out.println("Hello World");
    } // end method main
} // end class HelloWorld
```

- Semantics – the "meaning".
  - When programming, we should focus on semantics.
- Syntax – the rules that must be followed when writing a program.
  - In algebra, what is 5 + 3? What is 5 - 3?
  - Programming language syntax rules are like grammar rules in natural/spoken languages. Syntax differs by language!
  - Syntax rules are required to avoid ambiguity.
- Compilers/IDEs help identify syntax errors but, like grammar, they must largely be memorized.
- Style – conventions that affect the readability of the program.
Code structure in Java

```java
public class HelloWorld {
    public static void main (String[] args) {
        System.out.println("Hello World");
    } // end method main
} // end class HelloWorld
```

- Put a class in a source file
  - A source code file (with a .java extension) holds one class definition
  - So far you may have only used one class (and thus one file)
  - In general, each class is just a piece (unit) of the application
- Put each method in a class
  - Methods are used to perform specific tasks
  - Exactly one "main" method must exist in your source file(s)
- Put statements in each method
  - Finally, we actually get to DO something!

Control flow

- Do something
  - Sequential execution of statements
    - statement1;
    - statement2;
    - ...
  - Do something under this condition
    - if (condition) {
      statement(s);
    } -or-
    - for (Initializer; condition; Update expression) {
      statement(s);
    }
    - else {
      statement(s);
    }
  - Do again and again
    - while (condition) {
      statement(s);
    }
    - do {
      statement(s);
    } while (condition)

Variables in review

- Semantics – abstract place to hold information
  - Be aware of the realities/limitations of the implementation:
    - type, scope, and precision
- Syntax – variables need a type and an identifier
  - Identifier characters (a-z, A-Z, 0-9, _, $)
  - Leading character must not be a digit
  - Case sensitive
- Style
  - Naming conventions
    - nameOfVariable Var, num, int, str, homework, keepTrackValue, template
  - NUM_OF_STUDENTS (for unchanging constant "final" values)
- Declaration conventions
  - Declaration block
  - Just in Time
  - Initialization conventions
Variables

<table>
<thead>
<tr>
<th>Variable declaration</th>
<th>Assignment statement</th>
<th>Initialized declaration</th>
</tr>
</thead>
<tbody>
<tr>
<td>int value;</td>
<td>value = 5;</td>
<td>int value = 5;</td>
</tr>
</tbody>
</table>

```
System.out.print("The value is ");
System.out.println(value);
```

1. This is a String literal. It will be printed as is.
2. The integer 5 will be printed out here. Notice no quote marks.

Data types in Review

- Select data types with care!
  - int, double, boolean, and char most frequent
- Be wary of compiler assumptions! In Java:
  - integer literals are cast as int
  - real number literals are cast as double
  - results of mixed types are promoted
  - Example: 2/3 is cast int 0
  - Example: 2.0/3 is cast double 0.666
- Java automatically promotes lower precision types to higher precision types but not visa-versa!
- Example: 2/3 is cast int 0
- Example: 2.0/3 is cast double 0.666
- The rules can be overridden by explicit typecasting
  
```
float x = (float) (5/3.0) ;
```

Semantics of Methods

- Smaller, simpler, subcomponent of program
- Provides abstraction
  - hides low-level details
  - gives high-level structure to program, easier to understand overall program flow
  - enables separable, independent development of modules as single components that can be later used to build more complex components
- Method have a signature
  - methods have a name (by convention, only one method named “main”)  
  - zero or multiple arguments passed in as typed parameters
  - single result returned
  - void
  - Primitive data type or Derived data type (class/object)
- In other languages, called functions, procedures, subroutines, ...
Calling a value-returning method

```java
total = sum(value1, value2);
```

```java
public static int sum(int num1, int num2) {
    int result;
    result = num1 + num2;
    return result;
} // end method sum
```

- At this point, you should be familiar with public static methods that return primitive data types.
- Later: other access modifiers (public, protected, private)
- Later: static Vs. regular (non-static) methods

Methods and your data

- A local variable is declared inside a method and is not accessible to statements outside the method.
  - Scope
  - Different methods can have local variables with the same names because the methods cannot see each other’s local variables.
  - A method’s local variables exist only while the method is executing.
  - Call by value
  - Changes to the local copies of variables do not change the original
  - Use returned value to make changes to primitive data types
- If a reference to an object is passed to a method, then the method makes a copy of the reference and can use that reference to make changes to the actual object.
  - Call by reference

Printf: formatting console output

```java
system.out.printf("%d\n", uid);
```

<table>
<thead>
<tr>
<th>Flag</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Left justified</td>
</tr>
<tr>
<td>+</td>
<td>Prefix with +/–</td>
</tr>
<tr>
<td>0</td>
<td>Pad with zeros</td>
</tr>
<tr>
<td></td>
<td>separate by thousands</td>
</tr>
<tr>
<td></td>
<td>negatives in paren</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>%d</td>
<td>integer (digits)</td>
</tr>
<tr>
<td>%f</td>
<td>floating point</td>
</tr>
<tr>
<td>%e</td>
<td>exponential/scientific notation (floating-point)</td>
</tr>
<tr>
<td>%s</td>
<td>character</td>
</tr>
<tr>
<td>%a</td>
<td>string</td>
</tr>
</tbody>
</table>

```java
printf("%+-5d  %+5d", 10, -20)
```

```
+1 0 _ _ _ _ _ - 2 0
```

```java
printf("%8.3f, %7.2f", 1.234567, 1.234567)
```

```
_ _ _ _ 1 . 2 3 4 _ _ _ 1 . 2 3
```

```java
printf("UID=%d\n", uid, loginName);
```

```
System.out.printf( "UID=%d
", uid, loginName);
```
import java.util.Scanner;

public class Main {

    public static int getValue(String prompt) {
        Scanner keyboard = new Scanner(System.in);
        int userValue;
        System.out.println(prompt);
        userValue = keyboard.nextInt();
        return userValue;
    }

    public static void main(String[] args) {
        int inputValue = getValue("Enter integer value: ");
        System.out.println("Value is ", inputValue);
    }
}

import java.io.File;
import java.util.Scanner;

public class Main {

    public static void main(String[] args) throws Exception {
        String filename = "Data.txt"; // use working directory
        File fileHandle = new File(filename);
        Scanner inputFile = new Scanner(fileHandle);

        String line;
        while (inputFile.hasNextLine()) {
            line = inputFile.nextLine();
            System.out.println(line);
        }
        inputFile.close();
    }
}

import java.io.FileWriter;
import java.io.PrintWriter;

public class Main {

    public static void main(String[] args) throws Exception {

        final boolean APPEND_EXISTING_FILE = true;
        final boolean CLOBBER_EXISTING_FILE = false;
        String filename = "Data.txt"; // use working directory
        String filename2 = "C:\Documents and Settings\w001ted\Desktop\Data.txt ";
        FileWriter fileHandle = new FileWriter(filename,CLOBBER_EXISTING_FILE);
        PrintWriter outputFile = new PrintWriter(fileHandle);
        outputFile.println("Hello file!");
        outputFile.close();
    }
}
Arrays

```java
public static void main(String[] args) {
    int[][] numList;
    int[] xList = {1, 2, 3, 4}, yList = {9, 8};
    numList = new int[3][];
    numList[0] = xList;
    numList[1] = yList;
    println(numList[0]);
    println(numList[1]);
    println(xList);
    println(yList);
    println(numList[2]);
} // end method main
```

```java
public static void printList(int[] list) {
    for (int i = 0; i < list.length; i++) {
        System.out.print(list[i] + " ");
    }
    System.out.println();
} // end method printList
```

```java
for / for
for / for
for / for
```

Some of the brightest people in Computer Science suggest that arrays should never be accessed randomly but only sequentially:
- Random accesses in arrays tend to be undisciplined, error prone, and hard to prove correct.
- They suggest other (more advanced) data structures for random access

The enhanced for loop (a type of for-each loop) provides a means to implement this stylistic constraint.

```java
for (datatype elementVariable : collection) { statements; }
```

Compare:

```java
double[] numberList = new double[20];
...
for(int i = 0; i < numberList.length; i++) {
    System.out.println(numberList[i]);
}
```

ArrayLists

The ArrayList class in the Java API is similar to an array, but it does not store primitive data types as elements.
- ArrayList data structures store any object using a generic data type
- ArrayList can hold objects of different types!

ArrayList data structures provide the following abstractions/features:
- Add an element: The ArrayList object automatically expands as items are added to it
- Remove an element: The ArrayList object automatically reduces as items are removed from it

```java
import java.util.ArrayList;
ArrayList nameList = new ArrayList();
nameList.add(new String("Bob"));
nameList.add(new String("Pat"));
nameList.add(new String("April"));
String name = (String) nameList.get(0); // NOTE TYPECASTING!
```
ArrayList methods

- Useful ArrayList methods:
  - .size() returns the size of the ArrayList
  - .add( object ) adds the object reference to the end
  - .add( index, object ) inserts the object before the index (updates others)
  - .set( index, object ) overwrites an existing object
  - .get( index ) returns the object reference, but doesn’t remove it
  - .remove( index ) returns the object reference and removes it

- ArrayList can be used as a parameterized class

```java
ArrayList<ArrayList<String>> nameList = new ArrayList<ArrayList<String>>();
```

- Parameterized ArrayLists can only hold objects of the named type and returns/gets are automatically typed
  - Strongly typed data structures help reduce errors!

```java
import java.util.ArrayList;
import java.util.Random;
```

The Random class

- Useful methods
  - .nextInt( int n ) returns an integer number [0, n)
  - .nextDouble() returns a double [0.0, 1.0]
  - .nextInt() returns a integer [minInt, maxInt]

```java
Random randomNumbers = new Random();
int dieRoll = randomNumbers.nextInt(6) + 1;
```

Complete Java Order of Precedence

<table>
<thead>
<tr>
<th>Operator</th>
<th>Precedence</th>
<th>Type of Operation</th>
<th>Associates</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ( )</td>
<td>1</td>
<td>parenthesis</td>
<td>L to R</td>
</tr>
<tr>
<td>1 [ ] ,</td>
<td>2</td>
<td>array subscript, member selection, comma delimiter, method reference (java 8)</td>
<td>L to R</td>
</tr>
<tr>
<td>2 (type)</td>
<td>3</td>
<td>new type cast, object instantiation</td>
<td>R to L</td>
</tr>
<tr>
<td>4 * / %</td>
<td>4</td>
<td>multiplication, division, modulo</td>
<td>L to R</td>
</tr>
<tr>
<td>5 + -</td>
<td>5</td>
<td>addition, subtraction, string concatenation</td>
<td>L to R</td>
</tr>
<tr>
<td>6 &lt; &gt; &lt;=</td>
<td>6</td>
<td>greaterThanOrEqual, lessThanOrEqual, greaterThan, lessThan, type comparison</td>
<td>L to R</td>
</tr>
<tr>
<td>7 == !=</td>
<td>7</td>
<td>equalTo, notEqualTo</td>
<td>L to R</td>
</tr>
<tr>
<td>8 &amp;</td>
<td>8</td>
<td>bitwise AND, boolean AND (no short circuit)</td>
<td>L to R</td>
</tr>
<tr>
<td>9 ^</td>
<td>9</td>
<td>bitwise XOR, boolean XOR (no short circuit)</td>
<td>L to R</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>bitwise OR, boolean OR (no short circuit)</td>
<td>L to R</td>
</tr>
<tr>
<td>11 &amp;&amp;</td>
<td>11</td>
<td>logical AND (short circuits)</td>
<td>L to R</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>13 ? :</td>
<td>13</td>
<td>conditional operator (boolean)?(do if true):(do if false)</td>
<td>R to L</td>
</tr>
<tr>
<td>14 = += -= *= /= %= &lt;&lt;= &gt;&gt;= &gt;&gt;&gt;= &amp;= ^=</td>
<td>14</td>
<td>assignment, plusAssign, minusAssign, timesAssign, dividesAssign, moduloAssign, leftShiftAssign, rightShiftAssign, rightShiftAssignUnsigned, ANDAssign, XORAssign, ORAssign</td>
<td>R to L</td>
</tr>
</tbody>
</table>
Example: Guessing game

- Guess a number game
  - Computer generates a random number between 1-16
  - You guess a number
  - Program responds with one of three responses
    - Your guess is too high!
    - Your guess is too low!
    - Your guess is correct!
  - You get four guesses.
  - If your forth guess is wrong, then you loose!

- Math note: What percentage of the time do you expect to win?

- Example 2: draw a random card from a standard 52 card deck?