Northeastern University

Lecture 2: Fundamentals of Programming - 2

Prof. Chen-Hsiang (Jones) Yu, Ph.D.
College of Engineering

Materials are edited by Prof. Jones Yu from Prof. Charlie Wiseman's materials.

Outline

- Introduction to Computation and Programming
- Variables, I/O, Types and Strings
- Control Flow and Conditions
- Methods
- Arrays
- File I/O

Outline

- Introduction to Computation and Programming
- Variables, I/O, Types and Strings
- Control Flow and Conditions
- Methods
- Arrays
- File I/O

Variables, I/O, Types and Strings

Variables

- Every variable has a *value* that is stored in a particular memory location.
- Each variable has a *name* that the programmer uses to access and modify that variable's value.
- Each variable holds exactly one value.
- Over time, as a program executes, the value of a variable can change.

Variable Names

- In Java, variable names:
  - » Must start with either a letter (uppercase or lowercase), an underscore, or a dollar sign ($)
  - » Must contain only letters, digits, underscores, and dollar signs ($)
  - » Are case sensitive
- Examples: count, x, user_input2, hit_points, $value
- Invalid names: 42, 5x, #yolo, file.cpp, a-b

Variable Declarations

- Every variable must be *declared* before you can use it.
- To declare a variable, give it a specific *type*:
  - » **int**: integer (whole number), positive or negative
  - » **double**: numbers with a fractional component
  - » **boolean**: boolean value (true or false)
  - » **char**: a single character
- Syntax: TYPE NAME;
  - » **int** count;
  - » **int** num_vals;
  - » **double** average;
  - » **char** first_initial;

Variable Initialization

- You can *initialize* a variable when you declare it or you can do so afterwards.
- Syntax after declaration: NAME = VALUE;
- Syntax during declaration: TYPE NAME = VALUE;
- Examples
  - » count = 0;
  - » ultimate_answer = 42;
  - » **int** num_vals = 10;
  - » **double** pi = 3.14159;

Data Types - Numbers

- **int**
  - » Integer, whole numbers
  - » Examples: 0, 15, -100464, 420712003, -1
  - » Range: -2^{31} (-2147483648) to $2^{31}-1$ (2147483647)
  - » 4 bytes of memory
- **double**
  - » Numbers with a fractional component (15 digit precision)
  - » Examples: 11.23, -959.75, 0.5, -1.0
  - » Range: $\sim 10^{-308}$ to $\sim 10^{308}$, positive or negative
  - » 8 bytes of memory

Data Types - Alphanumeric

- **char**
  - » Single character or symbol
  - » Always put in single quotes
  - » Examples: ‘a’, ‘C’, ‘3’, ‘.’, ‘$’
  - » 2 bytes of memory
- String
  - » A sequence of characters and/or symbols
  - » Always put in double quotes
  - » Examples: “Hello World”, “475!”, “a”, “$”

Data Types - Boolean

- **boolean**
  - » Boolean valued
  - » Only values: **true**, **false**
  - » At least one byte of memory

Program Output

- `System.`***`out`***`.println()` is used to output the current value of a variable.
- Don't put the name of the variable in quotes
  - » This is one of the most common mistakes made by new programmers.
- Any values in quotes are printed out literally.
- Any values not in quotes are assumed to be variable names.

Program Output (cont.)

- You can mix literal text in quotes with variable names with the plus sign (+).
- If you don't want a new line automatically added to the end of your output message you can use `System.out.print()` instead.
  - » Otherwise it works the same as `System.out.println()`

```java
package edu.northeastern.csye6200;

import java.util.Scanner;

public class MyClass {

   public static void main(String[] args) {

      //TODO: Write your codes here
      System.out.print("Hello World");
      ...

   }

}
```

Example: MyClass.java

Program Input

- We also need a way to get user input into our programs while they are running.
- Java doesn't (easily) allow reading directly from System.***in***
- Instead, you use a Scanner object that handles reading the input and ensures that the type of data you read matches what you want.

Input with a Scanner

- First, you have to declare and initialize the Scanner object
  - » `Scanner input = new Scanner(System.in);`
- Then you call different methods on the Scanner object to read different types of values from the keyboard
  - » Read an **int**: `variable = input.nextInt();`
  - » Read a **double**:
    `variable = input.nextDouble();`

Exercise

- Write a Java program that reads exactly three integers from the user, calculates the average of the three numbers, and prints out the average.

Note: If you not yet setup your programming environment for Java, you can use online editor to practice for now. (Not recommend though)

https://www.programiz.com/java-programming/online-compiler/

Answer

```java
import java.util.Scanner;

public class ClassExamples {

    public static void main(String[] args) {

        Scanner input = new Scanner(System.in);

        int a, b, c;
        double average;

        System.out.println("Enter three integers:");
        a = input.nextInt();
        b = input.nextInt();
        c = input.nextInt();

        average = (a + b + c) / 3.0;

        System.out.println("The average is " + average);

    }

}
```

The ".0" after 3 is necessary to get a **double** result!

Format String

- The format string contains literals (items you want outputted verbatim), converters, and flags.
  - » A converter looks to the arguments to fill in a value
    - Starts with a % and ends with a single character code
  - » A flag modifies a converter with options
    - Goes between the % and the converter code
- Each time you use a converter, you must supply a corresponding argument (other than newline).

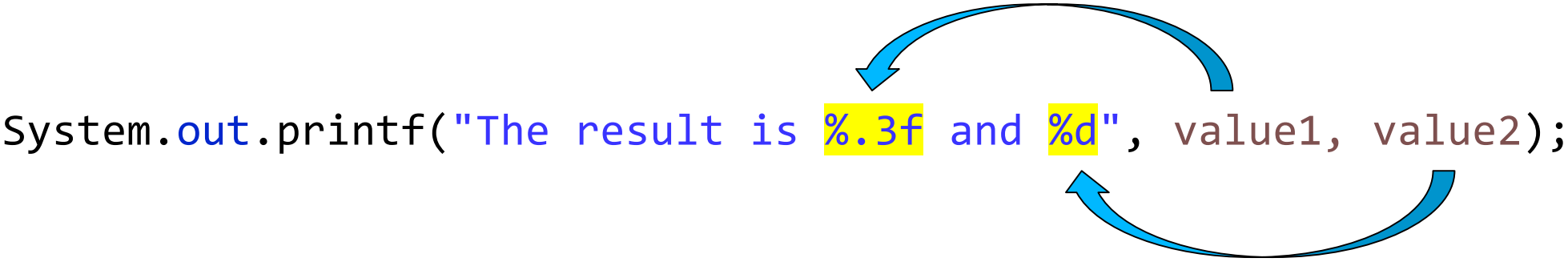
Some Converters, Flags

Converter	Flag	Description
d		An integer
f		A float (includes double)
e		A float in scientific notation.
n		New line
	+	Includes the sign (positive or negative)
	,	Includes grouping characters
	.3	Three places after the decimal.

Many more options exist:
https://docs.oracle.com/javase/8/docs/api/java/util/Formatter.html#syntax

Example of Using String Formatting

```
double value1 = 3.1415;
int value2 = 13;
```



Exercise

- Write a program that asks the user for a decimal value – output that value with exactly three decimal places, rounding as necessary.

```
Enter a value: 3.14159

Rounded: 3.142
```

Answer

```
public static void main(String[] args) {
    Scanner input = new Scanner(System.in);
    System.out.print("Enter a value: ");
    double value = input.nextDouble();
    System.out.printf("Rounded: %.3f%n", value);
}
```

Flow Control and Conditions

Control Flow

- Control flow is the order in which program statements are executed.
- So far, all of our programs have been executed straight-through from the first statement to the last.
- In general, you will need more complex control flow.
- For example, to choose between two (or more) possibilities.

if-else

- Generic form:

```
if(BOOLEAN EXPRESSION)
{
    YES/TRUE STATEMENTS
}
else
{
    NO/FALSE STATEMENTS
}
```

- Example:

```
if(grade >= 60)
{
    System.out.println("Good Job!!");
}
else
{
    System.out.println("Please Work Hard");
}
```

Multiple `else if` Statements

```
if(x > 10)
{
    System.out.println("x is greater than 10");
}
else if(x > 5)
{
    System.out.println("x is between 6 and 10 inclusive");
}
else if(x > 0)
{
    System.out.println("x is between 1 and 5 inclusive");
}
else
{
    System.out.println("x is less than 1");
}
```

`while` Loops

- `while` loops are used to repeat a set of Java statements *while* some condition is *true*.
- Example:

```
int iteration = 1;
while (iteration <= 100) {
    System.out.println("I will not expose the ignorance of the faculty.");
    iteration = iteration + 1;
}
```

do-while Loops

- A **while** loop body might be executed zero times if the condition is never true
- If you need to always execute the body at least once, use a **do-while** loop
- Example:

```
int input_value;
do {
    System.out.print("Enter 1 to print this message again:");
    input_value = input.nextInt();
} while (input_value == 1);
```

`while` Loops

- `While` loops are often used to repeat a task a fixed number of times, which leads to a similar structure based on a counter variable.

```
int count;
count = 1;
while (count <= 8) {
    System.out.println(count + " squared is " + count*count);
    count++;
}
```

counter variable initialization

counter variable boolean expression

counter variable update

for loops

- **for** loops are specialized loops based on that counter structure

counter variable initialization

counter variable boolean expression

counter variable update

```
int count;
for (count = 1; count <= 8; count++) {
    System.out.println(count + " squared is " + count * count);
}
```

Exercise

- Write a program that uses a `do-while` loop to read integer values from the user until a value between 1 and 100 (inclusive) is entered.

Answer

```
int input_value;

do {
    System.out.print("Enter a number between 1 and 100 (inclusive): ");
    input_value = input.nextInt();
} while (input_value < 1 || input_value > 100);
```