First Programs

CSE 1310 – Introduction to Computers and Programming
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Output

• System.out.println(...) prints out something.
  – System.out.println is the first piece of Java that we learn in this class.

• We will see in detail what kind of things can get printed.

• In the beginning, the things we care about printing are:
  – Numbers.
  – Strings (text).
Examples of System.out.println

Program:

public class hello1 {
    public static void main(String[] args) {
        System.out.println("Have a nice day.");
        System.out.println(6.3 + 12/7);
    }
}

Output (as is in Netbeans):

run:
Have a nice day.
7.3
BUILD SUCCESSFUL (total time: 0 seconds)

Output (as we will show in the future):

Have a nice day.
7.3
Syntax of System.out.println

Program:

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println("Have a nice day.");
        System.out.println(6.3 + 12/7);
    }
}
```

- What you want to print is called **the argument**.
- To use System.out.println, you write a line like this:
  - System.out.println(*argument*);
  - In other words, you write **System.out.println**, followed by a left parenthesis, followed by an argument, followed by a right parenthesis, followed by a semicolon.
Syntax of System.out.println

Program:

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println("Have a nice day.");
        System.out.println(6.3 + 12/7);
    }
}
```

- If the argument is text (also called a **string**), then it must be enclosed in double quotes.
- If the argument is a numerical expression, then System.out.println prints the **result** of that expression.
Syntax of System.out.println

• Is each of these lines correct or not? If correct, what will it print?

    System.out.println("6.3 + 12/7");

Correct, prints 6.3 + 12/7
Note that the argument here is text.

    System.out.println(6.3 + 12/7);

Correct, prints 7.3
Note that the argument here is a numerical expression.
Syntax of System.out.println

- What is wrong with these lines?

```java
System.out.println(hello);
System.out.println("hello")
System.out.println "hello";
System.out.println(6.3 + 12/7);
System.out.println "hello" ();
System.out.println 6.3 + 12/7 ();
```
Syntax of System.out.println

• What is wrong with these lines?  Will not run.

```java
System.out.println(hello);
System.out.println("hello")
System.out.println "hello";
System.out.println 6.3 + 12/7;
System.out.println "hello" ();
System.out.println 6.3 + 12/7 ();
```

Missing quotes

Missing semicolon

Missing parentheses.

Misplaced parentheses.
Syntax of System.out.println

• As we saw a few slides ago, to use System.out.println, you write a line like this:
  – System.out.println(argument);

• Java (like any programming language) is very strict.

• If you do not follow the syntax **EXACTLY**, it will refuse to execute that line.

• This is true not only for System.out.println, but for any syntax rules that we will see in this course.
Java as a Calculator.

We can type in arbitrary numerical expressions, and Java evaluates them.

This is still not that exciting.

However, such calculations are a useful building block for real programs.

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println((23*3) + 12/4.5);
        System.out.println(6.3 + 12/7 - 4);
    }
}
```

Output:

71.66666666666667
3.3
public class hello1 {
    public static void main(String[] args) {
        System.out.println(Math.pow(2, 10));
        System.out.println(8 * Math.pow(2 + 3.5/7, 4));
        System.out.println(Math.sqrt(3));
        System.out.println(4 - Math.sqrt(3+5/7.2));
    }
}

Output:
1024.0
312.5
1.7320508075688772
2.077906234221534

• Powers:
  – \(2^{10}\) becomes `Math.pow(2, 10)`
  – \(8 \left(2 + \frac{3.5}{7}\right)^4\) becomes `8 * Math.pow(2 + 3.5/7, 4)`

• Roots
  – \(\sqrt{3}\) becomes `Math.sqrt(3)`
  – \(4 - \sqrt{3 + \frac{5}{7.2}}\) becomes `4 - Math.sqrt(3+5/7.2)`
More Math Calculations

public class hello1 {
    public static void main(String[] args) {
        System.out.println(Math.PI);
        System.out.println(Math.sin(Math.PI / 2));
        System.out.println(Math.cos(Math.PI / 2));
        System.out.println(Math.tan(Math.PI / 2));
        System.out.println(Math.log(12.5));
    }
}

Output:
3.141592653589793
1.0
6.123233995736766E-17
1.633123935319537E16
2.5257286443082556

• The pi constant: `Math.PI`
• The sine of x: `Math.sin(x)`
• The cosine of x: `Math.cos(x)`
• The tangent of x: `Math.tan(x)`
• The natural logarithm of x: `Math.log(x)`
Division: Floating Point and Integer

• Floating point division:
  – 7.0 / 4.0
  – 7 / 4.0
  – 7.0 / 4
  – They all evaluate to 1.75

• Integer division:
  – 7 / 4 evaluates to 1
  – 7 % 4 produces the remainder of 7/4, so it evaluates to 3.

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println(7.0 / 4.0);
        System.out.println(7 / 4.0);
        System.out.println(7.0 / 4);
        System.out.println(7 / 4);
        System.out.println(7 % 4);
    }
}
```

Output:

1.75
1.75
1.75
1
3
Circumference and Area of Circle

Steps for solving a problem

• We want to write a program to compute the circumference and area of a circle.

• First, you must be able to solve it “on paper” (must know the math answer).
  – What do the circumference and area of a circle depend on?

• Next, we will write a program for it.
  – For more complex problem there will be one more intermediary level: writing the algorithm.
Circumference and Area of Circle - on paper

• We want to write a program to compute the circumference and area of a circle.

• Math (on paper):
  – What do the circumference and area of a circle depend on?
    • The radius of the circle.
  – circumference = 2 * pi * radius
  – area = pi * radius²
Circumference and Area of Circle - code

• Suppose we have a circle with radius = 20.231.

• Computing the circumference of the circle:
  – Circumference = 2 * pi * radius
  – Code?

• Computing the area of the circle:
  – area = pi * radius²
  – Code?
Circumference and Area of Circle - code

• Suppose we have a circle with radius = 20.231.

• Computing the circumference of the circle:
  – Circumference = 2 * pi * radius
  `System.out.println(2 * Math.PI * 20.231);`
Output: 127.11512194955021

• Computing the area of the circle:
  – area = pi * radius^2
  `System.out.println(Math.PI * Math.pow(20.231, 2));`
Output: 1285.8330160806754
Circumference and Area of Circle

• Suppose we have a circle with radius = 20.231.
• Program:

```java
class hello1 {
    public static void main(String[] args) {
        System.out.println(2 * Math.PI * 20.231);
        System.out.println(Math.PI * Math.pow(20.231, 2));
    }
}
```

• Is this a good program to sell to a user?
Circumference and Area of Circle

• Suppose we have a circle with radius = 20.231.

• Program:

    public class hello1 {
        public static void main(String[] args) {
            System.out.println(2 * Math.PI * 20.231);
            System.out.println(Math.PI * Math.pow(20.231, 2));
        }
    }

• Is this a good program to sell to a user?

• No: the only way for the user to use this program is to modify the code every time, to specify the radius.

• That is bad. Users should not need to be programmers.
Circumference and Area of Circle

• Suppose we have a circle with radius = 20.231.
• Program:

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println(2 * Math.PI * 20.231);
        System.out.println(Math.PI * Math.pow(20.231, 2));
    }
}
```

• Any other issues/problems with this program?
Circumference and Area of Circle

• Suppose we have a circle with radius = 20.231.

• Program:

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println(2 * Math.PI * 20.231);
        System.out.println(Math.PI * Math.pow(20.231, 2));
    }
}
```

• Any other issues/problems with this program?
  – The radius is specified TWICE.
  – This is bad practice, introduces the risk of errors.
  – Also, more painful to change the radius, we must change it in two places.
Circumference and Area of Circle

• Suppose we have a circle with radius = 20.231.

• Program:

```java
public class hello1 {
    public static void main(String[] args) {
        System.out.println(2 * Math.PI * 20.231);
        System.out.println(Math.PI * Math.pow(20.231, 2));
    }
}
```

• Any other issues/problems with this program?

• The program is hard to read and understand.
  – If you show it to a programmer, is it clear what the program is supposed to be doing?
  – The output is just numbers, not very user-friendly.
Using Variables

public class hello1 {
    public static void main(String[] args) {
        double radius = 20.231;
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}

• This code has the same output as the previous version.

• However:
  – The radius is specified only once (better than specifying twice).
  – If you show this program to any programmer, it is fairly obvious what it does (easy to read).
Declaring a Variable

• At any point, you can create a variable, by doing a **variable declaration**.

• Syntax for variable declaration:

\[ \text{type variable\_name} = \text{initial\_value}; \]

• For example:

\begin{verbatim}
int x = 123;
int number\_of\_fingers = 5;
double radius = 20.231;
\end{verbatim}
There are many different types in Java.

However, initially, you just need to know these two:

– double
– int

You need to think carefully, and use the correct type for your variable.

For integers (positive and negative), use int.

For real numbers (e.g. 3.402), use double.
Variable Names

• The textbook describes the rules for variable names.

• Here is a simplified version:
  – variable names should start with a letter (upper or lower case).
  – variable names should only include letters, numbers, and underscores.
  – variable names are case-sensitive.
  – variable names cannot be equal to reserved words, such as `double`, `class`, `int`, `public`, ...
Using Variables

• After you declare a variable, you can use it in the rest of the code:
  – You can use its value.
  – You can change its value. This is called **assignment**.

```java
public class hello1 {
    public static void main(String[] args) {
        int candies = 5;
        System.out.println(candies);
        candies = 7;
        System.out.println(candies);
        candies = candies + 10;
        System.out.println(candies);
    }
}
```

Output:

```
5
7
17
```
Using Variables

• After you declare a variable, you can use it in the rest of the code:
  – You can use its value.
  – You can change its value. This is called assignment.

```java
public class hello1 {
    public static void main(String[] args) {
        int candies = 5;
        System.out.println(candies);
        candies = 7;
        System.out.println(candies);
        candies = candies + 10;
        System.out.println(candies);
    }
}
```

Output:
```
5
7
17
```
Declarations and Assignments

• In this program:
  – Which lines of code are declarations?
  – Which lines of code are assignments?
Declarations and Assignments

• In this program:
  – Which lines of code are declarations?
    ```java
    int candies = 5;
    ```
  – Which lines of code are assignments?
    ```java
    candies = 7;
    candies = candies + 10;
    ```

```java
public class hello1 {
    public static void main(String[] args) {
        int candies = 5;
        System.out.println(candies);
        candies = 7;
        System.out.println(candies);
        candies = candies + 10;
        System.out.println(candies);
    }
}
```

Output:

```
5
7
17
```
Returning to the Circles Program

Version with variables:

```java
public class hello1 {
    public static void main(String[] args) {
        double radius = 20.231;
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}
```

- Which lines are declarations?
- Which lines are assignments?
Returning to the Circles Program

Version with variables:

```java
public class hello1 {
    public static void main(String[] args) {
        double radius = 20.231;
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}
```

- Which lines are declarations? Shown in red.
- Which lines are assignments? None.
Returning to the Circles Program

Version with variables:

```java
public class hello1 { 
    public static void main(String[] args) { 
        double radius = 20.231;
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}
```

• Problem: the radius is hardcoded.
  – Why is this a problem?
Problem: Radius is Hardcoded

- Why is this a problem?
- Biggest reason: the user needs to be a programmer.
  - You cannot use this program without changing the program.
Solution

• Allow the user to enter the radius value as input.
import java.util.Scanner;

public class hello1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);

        System.out.printf("Please enter the radius: ");
        double radius = in.nextDouble();
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}

Revised Program with User Input

• There are several new things here:
  – the import line.
  – The Scanner object.
  – The System.out.printf method.
The **Scanner** object allows us to obtain user input.

To create a **Scanner** object, we need to:

- Put the import statement at the top of the Java file.
- Create a Scanner object, as shown in the first line of the main method:  
  ```java
  Scanner in = new Scanner(System.in);
  ```
import java.util.Scanner;

public class hello1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);

        System.out.printf("Please enter the radius: ");
        double radius = in.nextDouble();
        double circumference = 2 * Math.PI * radius;
        double area = Math.PI * Math.pow(radius, 2);
        System.out.println(circumference);
        System.out.println(area);
    }
}

• The **System.out.printf** method is a more powerful version of the **System.out.println** method.

• We will see more details in a few days.

• One difference is that **System.out.println** always prints a new line at the end, whereas **System.out.printf** does not.
println and printf

public class hello1 {
    public static void main(String[] args) {
        System.out.println("hello");
        System.out.printf("hello\n");
    }
}

• These two lines do the exact same thing:

    System.out.println("hello");
    System.out.printf("hello\n");
import java.util.Scanner;

public class example1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        System.out.printf("Please enter number of weeks: ");
        int weeks = in.nextInt();
        int days = weeks * 7;
        System.out.printf("There are %d days in %d weeks\n", days, weeks);
    }
}

Another Example: Converting Weeks to Days
import java.util.Scanner;

public class example1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        System.out.printf("Please enter the first number: ");
        double n1 = in.nextDouble();
        System.out.printf("Please enter the second number: ");
        double n2 = in.nextDouble();
        System.out.printf("Please enter the third number: ");
        double n3 = in.nextDouble();

        double average = (n1 + n2 + n3) / 3.0;
        System.out.printf("The average is %.2f\n", average);
    }
}
import java.util.Scanner;

public class example1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        System.out.printf("Please enter the first mass: ");
        double m1 = in.nextDouble();
        System.out.printf("Please enter the second mass: ");
        double m2 = in.nextDouble();
        System.out.printf("Please enter the radius: ");
        double r = in.nextDouble();

        double G = 6.694E-11;
        double gravity = G * m1 * m2 / (r * r);
        System.out.printf("The gravity force is %f\n", gravity);
    }
}
Comments

/* A program that converts weeks into days. 
   Written on 7/15/2015. */

import java.util.Scanner;

public class example1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        System.out.printf("Enter number of weeks: ");
        int weeks = in.nextInt();

        // Here is where we convert weeks into days.
        int days = weeks * 7;
        System.out.printf("Result: %d days\n", days);
    }
}

• Comments allow you to make notes on the program for yourself, and for other people reading your code.
• Comments are ignored by Java.
• Single line comments: they start with // (see line in green above)
• Multiple-line comments: they start with /*, end with */ (see lines in red)
import java.util.Scanner;

public class example1 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);  // Create scanner object.
        System.out.printf("Enter number of weeks: ");
        int weeks = in.nextInt();  // Get user input

        int days = weeks * 7;  // Converting weeks into days.

        System.out.printf("Result: %d days\n", days);
    }
}

• Comments starting with // can be placed at the end of a line (see code marked in red)
Some Guidelines

• To learn how to code, you need PRACTICE.
  – What will usually not work:
    • Listen to the lectures.
    • Go and try to do the assignments.
  – What will usually work:
    • Listen to the lectures and KEEP NOTES.
    • Actually run every piece of code that we do in class.
    • Understand every line of every piece of code we do in class.
    • Think of variations of what we do in class, and try them.
      – Predict what the variation will do, and verify by running it.
    • Then try the assignments.
Some Guidelines

• You need to understand the terminology:
  – method, string, double, ints, main class name, numerical expression, variable, declaration, assignment, newline character

• You will encounter many terms in this course. YOU NEED TO LEARN EXACTLY WHAT THEY MEAN.

• DO NOT RELY ON ENGLISH. These terms have meanings in conversational English that are only vaguely related with their meaning in programming.