Variables in Java I

- Variables are used to store information.
- The information can come from many sources:
  1. It is often provided by the user. (It is read by the program.)
  2. It can be temporary data that we need to store to solve a particular problem.
- Variables have type. The type of a variable describes what kind of data we can store in it. A string variable can only store strings, an int variable only integers, a double variable only real numbers, etc.

Variables in Java II

- We must declare a variable before we can use it. The declaration gives the name of the variable and its type:
  int hello;
  double bob;
  String message;
- We use assignment statements to store data into a variable:
  hello = 5;
  bob = 5.5;
  message = "Hello Dolly!"
- We can also initialize a variable directly in the declaration:
  int hello = 5;
  String message = "Hello Dolly!"
Variables in Java III

- Variable values can be used:
  ```
  System.out.println(hello);
  bob = bob + 5.5;
  ```

- Only certain types of assignments are legal:
  1. ints can be assigned to ints, doubles to doubles, Strings to Strings, etc.
  2. ints can be assigned to doubles; the integer is automatically converted to a real number.

- Variables must be initialized (given an initial value) before they can be used.
  These statements are wrong:
  ```
  int hello, bob;
  System.out.println(hello);
  bob = bob + 5.5;
  ```

Slide 2–4

class Assign {
    public static void main (String [] args) {
        int hello;
        double bob;
        String message;

        hello = 54;
        bob = 45.6;
        message = "Hello Dolly!";

        System.out.println("hello = " + hello);
        System.out.println("bob = " + bob);
        System.out.println("message = " + message);
    }
}

Slide 2–5

- What does the compiler print when given this program?

```java
class Type {
    public static void main (String [] args) {
        int jane = 5;
        double bob = 45.6;
        String message = "Jane Dolly!";

        jane = bob;
        jane = message;

        bob = jane;
        bob = message;

        message = bob;
        message = jane;

        int john, sally;
        john = john + sally;

        int karl = 54;
        karl = karl + 56;
    }
}
```
public class java.io.PrintStream extends java.io.FilterOutputStream {
    public void flush();

    public void print(boolean b);
    public void print(char c);
    public void print(char s[]);
    public void print(double d);
    public void print(float f);
    public void print(int i);
    public void print(long l);
    public void print(Object obj);
    public void println(String s);
    public void println();

    public void println(boolean b);
    public void println(char c);
    public void println(char s[]);
    public void println(double d);
    public void println(float f);
    public void println(int i);
    public void println(long l);
    public void println(Object obj);
    public void println(String s);
}

Arithmetic Operations

- Java has the standard built-in arithmetic operators:
  \[
  a + b \quad \text{Add a and b.}
  \]
  \[
  a - b \quad \text{Subtract a and b.}
  \]
  \[
  a \times b \quad \text{Multiply a and b.}
  \]
  \[
  a/b \quad \text{Divide a and b, i.e. } \frac{a}{b}.
  \]
  \[
  a\%b \quad \text{Remainder when a is divided by b, i.e. } a - b \times \lfloor \frac{a}{b} \rfloor.
  \]
- If both a and b are integers then the result of \(a \oplus b\) is an integer (\(\oplus\) is one of +, −, ∗, /).
- If a or b (or both) are real numbers then the result of \(a \oplus b\) is a real number.

- What will the output be from the program in the next slide?
The Class Math

- Java has most common mathematical operators (+, -, /, *, etc.) built into the language.
- Other standard mathematical functions (trigonometric, exponentiation, etc.) are supplied by a standard, built-in class called Math.

```java
public final class java.lang.Math
    extends java.lang.Object {
    public final static double E=...;
    public final static double PI=...;

    public static int max(int a, int b);
    public static int min(int a, int b);
    public static int round(float a);

    public static double abs(double a);

    public static double ceil(double a);
    public static double floor(double a);

    public static double exp(double a);
    public static double log(double a);
    public static double pow(double a, double b);
    public static double sqrt(double a);

    public static double max(double a, double b);
    public static double min(double a, double b);
    public static double random();

    public static double acos(double a);
    public static double asin(double a);
    public static double atan(double a);
    public static double atan2(double a, double b);

    public static double cos(double a);
    public static double sin(double a);
    public static double tan(double a);
}
```

Class Math Problem #1—#2

1. Write a program which "shows" that

\[ x^y = e^{y \ln x} \]

by trying the formula for some values of \( x \) and \( y \).

2. Do the same thing, but this time choose \( x \) and \( y \) to be random numbers between 5.0 and 20.0.

(Note: Math.random() returns a double between 0.0 and 1.0.)
- These are the operations provided by the class `Input`. There are operations for reading strings, integers, and reals. If you don’t provide a prompt, a default prompt will be given.

```java
class Input {
    public static String toText(String prompt) {
        // ...
    }

    public static int toInt(String prompt) {
        // ...
    }

    public static int toInt() {
        return toInt("Enter an integer");
    }

    public static double toDouble(String prompt) {
        // ...
    }

    public static double toDouble() {
        return toDouble("Enter a double");
    }
}
```

- Most programs interact with the user in some way. We have already seen how printing to the screen using `System.out.println` allows us the program to provide information to the user.

- You will be provided with two classes called `Input`. Which one to use depends on which system you use.

- `Input` provides methods for getting information from the user.

- `Input.toText("Prompt")` will print `Prompt` on the screen (or put up a window with "Prompt" in it) and allow the user to enter a text (string). That string will then be returned to the program.

---

### Class Input Problem

1. Karl, Lisa, and Peter are playing a game and want a program to help to figure out who’s winning. Write a program that reads Karl’s, Lisa’s, and Peter’s scores and writes the highest score.

```bash
cmdtool - /usr/local/bin/tcsh
java InMax.java
java InMax
Enter Karl's Score: 34
Enter Lisa's Score: 67
Enter Peter's Score: 22
The highest score is 67
```
Choice in Java

- Real programs make choices. Depending on some condition, we either do one thing, or another. Such conditions are called **Boolean Expressions**.

- In Java we write:
  
  ```java
  if (Condition)
  DoThis;
  ```

- We can compare numbers to numbers and strings to strings, but not numbers to strings. What's the result of the program fragment below?

  ```java
  int i = 15;
  String s = "Hello";
  double d = 15.5;
  if (i == 15) System.out.println("i is 15");
  if (d == 15) System.out.println("d is 15");
  if (s == "Bye") System.out.println("s is Bye");
  if (s == i) System.out.println("s is 15");
  ```

---

**Choice Problem**

Write a program which

1. reads in the names of two tri-athletes, and their three individual scores,
2. Computes and writes out the two total scores and the name of the winner, if any.
<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>H</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>/<em>I</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>/<em>J</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>/<em>K</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td></td>
</tr>
</tbody>
</table>

Output="The highest score is 47"

<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>L</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td>&quot;None&quot;</td>
</tr>
<tr>
<td>/<em>M</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td>&quot;None&quot;</td>
</tr>
<tr>
<td>/<em>N</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td>&quot;Lisa&quot;</td>
</tr>
<tr>
<td>/<em>O</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>47</td>
<td>&quot;Lisa&quot;</td>
</tr>
</tbody>
</table>

Output="Lisa wins!!"

---

<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>A</em>/</td>
<td>&quot;Bart&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output="Enter the 1st contestant’s name:"

<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>B</em>/</td>
<td>&quot;Bart&quot;</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output="Enter the 1st contestant’s 3 scores:"

<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>C</em>/</td>
<td>&quot;Bart&quot;</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/<em>D</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/<em>E</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output="Enter the 2nd contestant’s name:"

<table>
<thead>
<tr>
<th>Program Point</th>
<th>First-Contestant</th>
<th>FirstContestantScore</th>
<th>Second-Contestant</th>
<th>SecondContestantScore</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>/<em>F</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>/<em>G</em>/</td>
<td>&quot;Bart&quot;</td>
<td>30</td>
<td>&quot;Lisa&quot;</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>