Building Java Programs

Chapter 4
Lecture 4-1: Scanner; if/else

reading: 3.3 – 3.4, 4.1, 4.5
START

THE 90's?

NO
- STOP

YES
- STOP

HAMMERTIME

COLLABORATE
- LISTEN
Interactive Programs with Scanner

reading: 3.3 - 3.4
Interactive programs

- We have written programs that print console output.

- It is also possible to read *input* from the console.
  - The user types the input into the console.
  - The program uses the input to do something.
  - Such a program is called an *interactive program*. 
Interactive programs

- Interactive programs can be challenging.
  - Computers and users think in very different ways.
  - Users tend to “misbehave”.

![Comic strip showing the dilemma of designing an intuitive product interface versus requiring users to select from a large number of poorly documented commands, each of which must be typed exactly right on the first try.](image-url)
Scanner

- **Scanner**: An object that can read input from many sources.
  - Communicates with `System.in`
  - Can also read from files (Ch. 6), web sites, databases, etc...

- The **Scanner class is found in the java.util package.**

```java
import java.util.*;  // so you can use Scanner
```

- **Constructing a Scanner object to read console input:**

```java
Scanner name = new Scanner(System.in);
```

- **Example:**

```java
Scanner console = new Scanner(System.in);
```
### Scanner methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>nextInt()</code></td>
<td>reads an int from the user and returns it</td>
</tr>
<tr>
<td><code>nextDouble()</code></td>
<td>reads a double from the user</td>
</tr>
<tr>
<td><code>next()</code></td>
<td>reads a one-word String from the user</td>
</tr>
<tr>
<td><code>nextLine()</code></td>
<td>reads a one-line String from the user</td>
</tr>
</tbody>
</table>

- Each method waits until the user presses Enter.
  - The value typed by the user is returned.

```java
System.out.print("How old are you? ");  // prompt
int age = console.nextInt();
System.out.println("You typed "+ age);
```

- **prompt**: A message telling the user what input to type.
import java.util.*; // so that I can use Scanner

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

        System.out.print("How old are you? ");
        int age = console.nextInt();

        int years = 65 - age;
        System.out.println(years + " years until retirement!");
    }
}

- Console (user input underlined):
  How old are you? 12
  53 years until retirement!
import java.util.*; // so that I can use Scanner
public class ScannerMultiply{
    public static void main(String[] args) {  
        Scanner console = new Scanner(System.in);
        System.out.print("Please type two numbers: ");
        int num1 = console.nextInt();
        int num2 = console.nextInt();
        int product = num1 * num2;
        System.out.println("The product is "+ product);
    }
}

• Output (user input underlined):
  Please type two numbers: 8 6
  The product is 48

• The Scanner can read multiple values from one line.
Input tokens

- **token**: A unit of user input, as read by the `Scanner`.
  - Tokens are separated by *whitespace* (spaces, tabs, new lines).
  - How many tokens appear on the following line of input?
    23  John Smith  42.0  "Hello world"  $2.50  "  19"

- When a token is not the type you ask for, it crashes.

```java
System.out.print("What is your age? ");
int age = console.nextInt();
```

Output:

What is your age? **Timmy**
java.util.InputMismatchException
    at java.util.Scanner.next(Unknown Source)
    at java.util.Scanner.nextInt(Unknown Source)
    ...
Scanners as parameters

• If many methods need to read input, declare a Scanner in main and pass it to the other methods as a parameter.

    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        int sum = readSum3(console);
        System.out.println("The sum is " + sum);
    }

    // Prompts for 3 numbers and returns their sum.
    public static int readSum3(Scanner console) {
        System.out.print("Type 3 numbers: ");
        int num1 = console.nextInt();
        int num2 = console.nextInt();
        int num3 = console.nextInt();
        return num1 + num2 + num3;
    }
Program puzzle

Consider changing the output to include the minimum value:

Type 3 numbers: 8 6 13
The average is 9.0
The minimum value is 6

How would we change the previous program?

```java
public static void main(String[] args) {
    Scanner console = new Scanner(System.in);
    int sum = readSum3(console);
    double average = sum / 3.0
    System.out.println("The average is " + average);
    // What goes here?
}

public static int readSum3(Scanner console) {
    System.out.print("Type 3 numbers: ");
    int num1 = console.nextInt();
    int num2 = console.nextInt();
    int num3 = console.nextInt();
    return num1 + num2 + num3;
}
```
import java.util.*;   // so that I can use Scanner

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

        System.out.print("Type 3 numbers: ");
        int num1 = console.nextInt();
        int num2 = console.nextInt();
        int num3 = console.nextInt();

        double average = (num1 + num2 + num3) / 3.0;
        System.out.println("The average is "+ average);
        System.out.println("The minimum value is "+
            Math.min(num1, Math.min(num2, num3)));
    }
}
The if/else statement

reading: 4.1, 4.6
Conditionals

• “If you eat your vegetables, then you can have dessert.”

• “If you do your homework, then you may go outside to play, or else you’ll be grounded for life.”
The if statement

Executes a block of statements only if a test is true

```java
if (test) {
    statement;
    ...
    statement;
}
```

- Example:
  ```java
double gpa = console.nextDouble();
if (gpa >= 3.0) {
    System.out.println("Good job! Here’s a cookie.");
}
```
The **if/else** statement

*Executes one block if a test is true, another if false*

if (test) {
    statement(s);
} else {
    statement(s);
}

- Example:
  ```java
  double gpa = console.nextDouble();
  if (gpa >= 3.0) {
      System.out.println("Good job! Here’s a cookie.");
  } else {
      System.out.println("No cookie for you!");
  }
  ```
Relational expressions

• *if* statements and *for* loops both use logical tests.

  ```java
  for (int i = 1; i <= 10; i++) { ...
  if (i <= 10) { ...
  ```

• These are Boolean expressions, seen in Ch. 5.

• Tests use *relational operators*:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Meaning</th>
<th>Example</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>==</code></td>
<td>equals</td>
<td><code>1 + 1 == 2</code></td>
<td>true</td>
</tr>
<tr>
<td><code>!=</code></td>
<td>does not equal</td>
<td><code>3.2 != 2.5</code></td>
<td>true</td>
</tr>
<tr>
<td><code>&lt;</code></td>
<td>less than</td>
<td><code>10 &lt; 5</code></td>
<td>false</td>
</tr>
<tr>
<td><code>&gt;</code></td>
<td>greater than</td>
<td><code>10 &gt; 5</code></td>
<td>true</td>
</tr>
<tr>
<td><code>&lt;=</code></td>
<td>less than or equal to</td>
<td><code>126 &lt;= 100</code></td>
<td>false</td>
</tr>
<tr>
<td><code>&gt;=</code></td>
<td>greater than or equal to</td>
<td><code>5.0 &gt;= 5.0</code></td>
<td>true</td>
</tr>
</tbody>
</table>
Misuse of `if`

- What's wrong with the following code?

```java
Scanner console = new Scanner(System.in);
System.out.print("What percentage did you earn? ");
int percent = console.nextInt();
if (percent >= 90) {
    System.out.println("You got an A!" );
}
if (percent >= 80) {
    System.out.println("You got a B!" );
}
if (percent >= 70) {
    System.out.println("You got a C!" );
}
if (percent >= 60) {
    System.out.println("You got a D!" );
}
if (percent < 60) {
    System.out.println("You got an F!" );
}
... 
```
Nested if/else

Chooses between outcomes using many tests

```java
if (test) {
    statement(s);
} else if (test) {
    statement(s);
} else {
    statement(s);
}
```

• Example:

```java
if (x > 0) {
    System.out.println("Positive");
} else if (x < 0) {
    System.out.println("Negative");
} else {
    System.out.println("Zero");
}
```
Nested if/else/if

- If it ends with `else`, exactly one path must be taken.
- If it ends with `if`, the code might not execute any path.

```java
if (test) {
    statement(s);
} else if (test) {
    statement(s);
} else if (test) {
    statement(s);
}
```

- Example:

```java
if (place == 1) {
    System.out.println("Gold medal!");
} else if (place == 2) {
    System.out.println("If you're not first, you're last!");
} else if (place == 3) {
    System.out.println("What comes after last place?");
}
```
Summary: if structures

- **exactly 1 path**  
  *mutually exclusive*
  ```java
  if (test) {
    statement(s);
  } else if (test) {
    statement(s);
  } else {
    statement(s);
  }
  ```

- **0 or 1 path**  
  *mutually exclusive*
  ```java
  if (test) {
    statement(s);
  } else if (test) {
    statement(s);
  } else if (test) {
    statement(s);
  }
  ```

- **0, 1, or many paths**  
  *independent tests; not exclusive*
  ```java
  if (test) {
    statement(s);
  }
  if (test) {
    statement(s);
  }
  if (test) {
    statement(s);
  }
  ```
Which nested if/else?

- (1) if/if/if  
  - Whether a user is lower, middle, or upper-class based on income.
  - (2) nested if / else if / else

- (2) nested if / else if / else if / else if / else

- Whether you made the dean's list (GPA ≥ 3.8) or honor roll (3.5-3.8).
  - (3) nested if / else if

- Whether a number is divisible by 2, 3, and/or 5.
  - (1) sequential if / if / if

- Computing a grade of A, B, C, D, or F based on a percentage.
  - (2) nested if / else if / else if / else if / else
Nested if/else question

Formula for body mass index (BMI):

\[
BMI = \frac{weight}{height^2} \times 703
\]

<table>
<thead>
<tr>
<th>BMI</th>
<th>Weight class</th>
</tr>
</thead>
<tbody>
<tr>
<td>below 18.5</td>
<td>underweight</td>
</tr>
<tr>
<td>18.5 - 24.9</td>
<td>normal</td>
</tr>
<tr>
<td>25.0 - 29.9</td>
<td>overweight</td>
</tr>
<tr>
<td>30.0 and up</td>
<td>obese</td>
</tr>
</tbody>
</table>

- Write a program that produces output like the following:

This program reads data for two people and computes their body mass index (BMI).

Enter next person's information:
height (in inches)? 70.0
weight (in pounds)? 194.25

Enter next person's information:
height (in inches)? 62.5
weight (in pounds)? 130.5

Person 1 BMI = 27.868928571428572
overweight
Person 2 BMI = 23.485824
normal
Difference = 4.3831045714285715
// This program computes two people's body mass index (BMI) and
// compares them. The code uses Scanner for input, and parameters/returns.

import java.util.*; // so that I can use Scanner

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

    double bmi1 = person(console);
    double bmi2 = person(console);

    // report overall results
    report(1, bmi1);
    report(2, bmi2);
    System.out.println("Difference = " + Math.abs(bmi1 - bmi2));
  }

  // prints a welcome message explaining the program
  public static void introduction() {
    System.out.println("This program reads data for two people and");
    System.out.println("computes their body mass index (BMI)."));
    System.out.println();
  }

  ...
Nested if/else, cont'd.

// reads information for one person, computes their BMI, and returns it
public static double person(Scanner console) {
    System.out.println("Enter next person's information:");
    System.out.print("height (in inches)? ");
    double height = console.nextDouble();
    System.out.print("weight (in pounds)? ");
    double weight = console.nextDouble();
    System.out.println();
    double bodyMass = bmi(height, weight);
    return bodyMass;
}

// Computes/returns a person's BMI based on their height and weight.
public static double bmi(double height, double weight) {
    return (weight * 703 / height / height);
}

// Outputs information about a person's BMI and weight status.
public static void report(int number, double bmi) {
    System.out.println("Person "+ number + " BMI = " + bmi);
    if (bmi < 18.5) {
        System.out.println("underweight");
    } else if (bmi < 25) {
        System.out.println("normal");
    } else if (bmi < 30) {
        System.out.println("overweight");
    } else {
        System.out.println("obese");
    }
}
The if/else hammer

- Just because you learned a new construct does not mean that every new problem has to be solved using that construct!

```java
int z;
if (x > y) {
    z = x;
} else {
    z = y;
}
```

```java
double d = a;
double d = Math.min(a, Math.min(b, c));
if (b < d) {
    d = b;
}
if (c < d) {
    d = c;
}
```