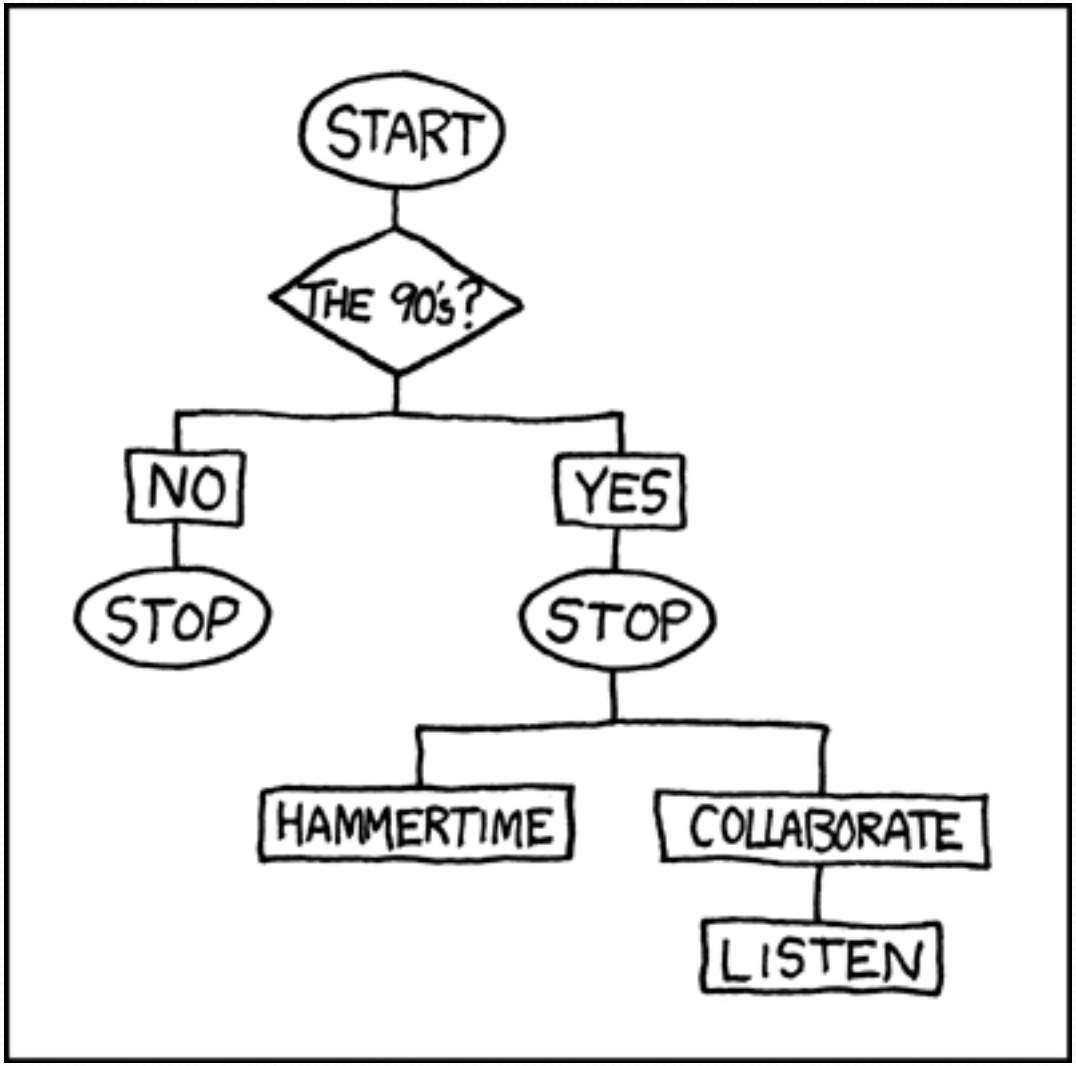
Building Java Programs

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

reading: 3.3 – 3.4, 4.1, 4.5


START
THE 90's?
NO
YES
STOP
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".

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.

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

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

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

  - Example:

```
Scanner console = new Scanner(System.in);
```

`Scanner` methods

Method	Description
`nextInt()`	reads an `int` from the user and returns it
`nextDouble()`	reads a `double` from the user
`next()`	reads a one-word `String` from the user
`nextLine()`	reads a one-*line* `String` from the user

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

```
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.

Scanner example

```
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!");
    }
}
```

age	12
years	53

- Console (user input underlined):

```
How old are you? 12
53 years until retirement!
```

Scanner example 2

```
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.

```
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?

```
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;
}
```

Can’t return multiple values!

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

public 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

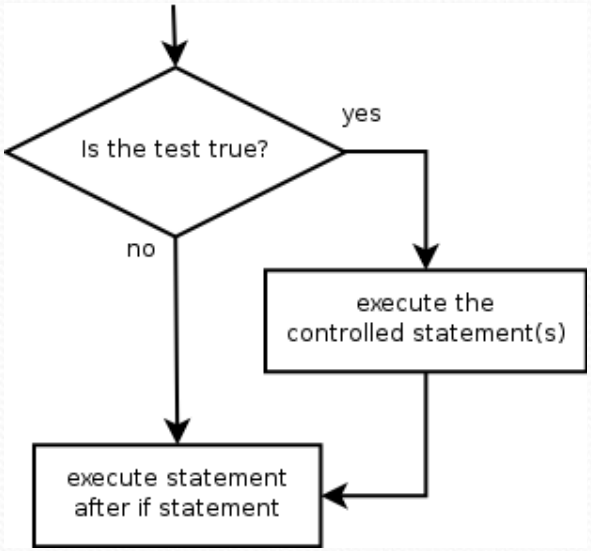
- "If you eat your vegetables, then you can have dessert."

- "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

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



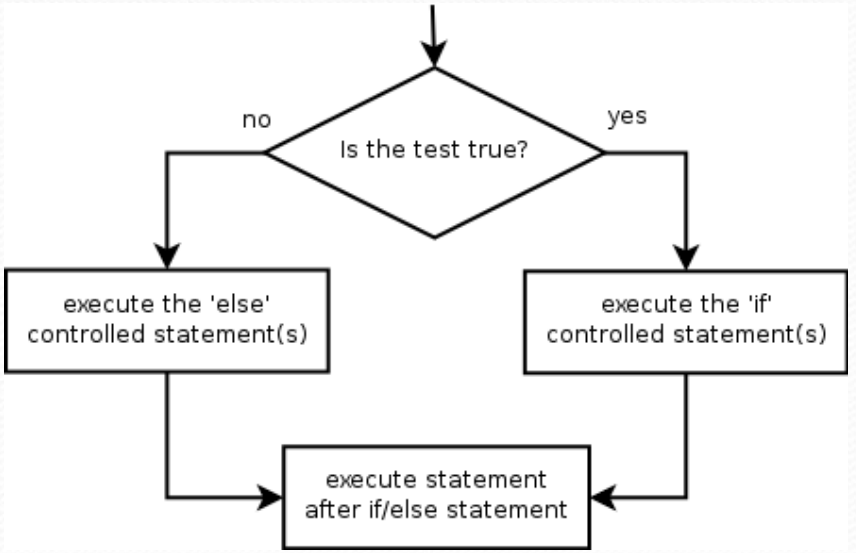
- Example:

```
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:

```
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.

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

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

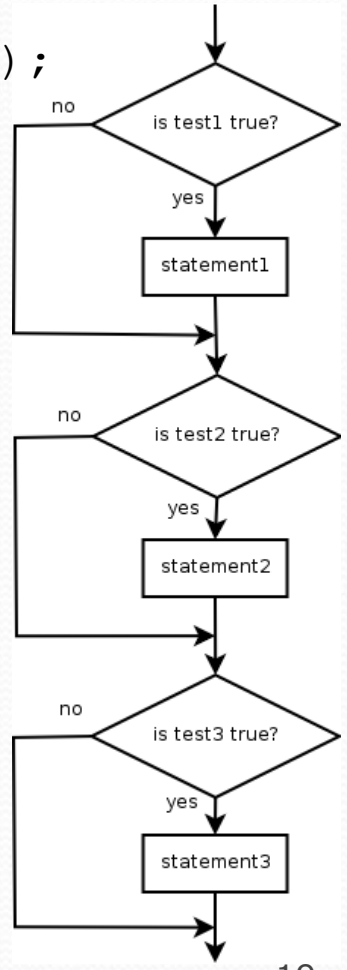
- Tests use *relational operators*:

Operator	Meaning	Example	Value
==	equals	1 + 1 == 2	true
!=	does not equal	3.2 != 2.5	true
<	less than	10 < 5	false
>	greater than	10 > 5	true
<=	less than or equal to	126 <= 100	false
>=	greater than or equal to	5.0 >= 5.0	true

Misuse of `if`

- What's wrong with the following code?

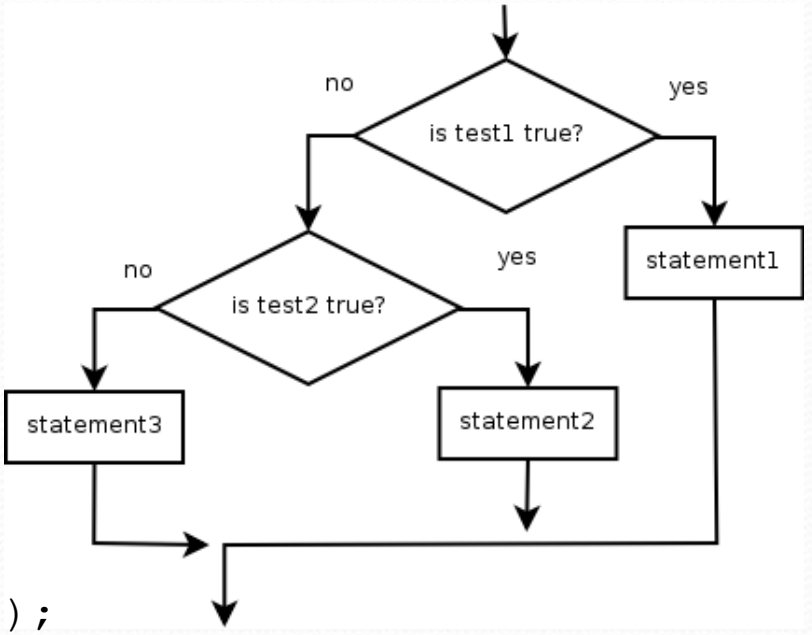
```
Scanner console = new Scanner(System.in);
System.out.print("What percentage did you earn? ");
int percent = console.nextInt();
if (percent >= 90) {
    System.out.println("You got an A!");
}
if (percent >= 80) {
    System.out.println("You got a B!");
}
if (percent >= 70) {
    System.out.println("You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

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



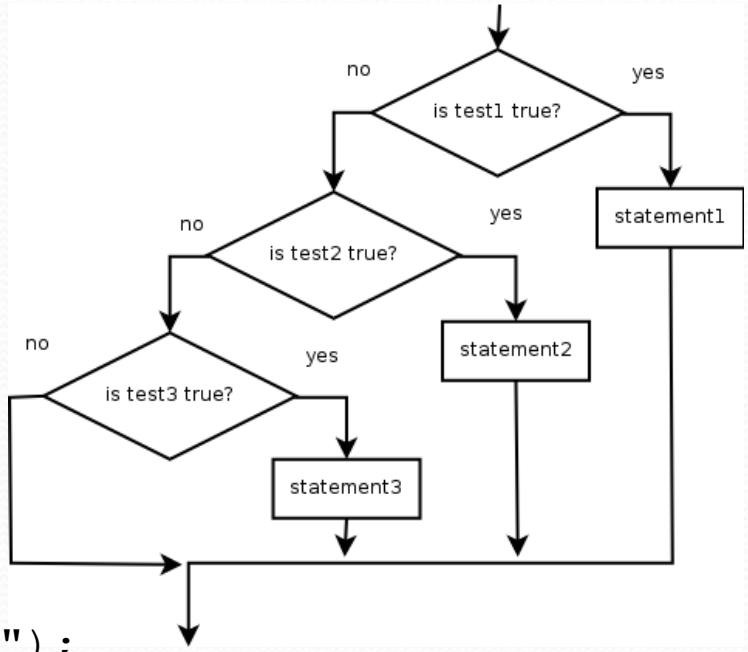
- Example:

```
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.

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



- Example:

```
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)*

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

- 0 or 1 path *(mutually exclusive)*

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

- 0, 1, or many paths *(independent tests; not exclusive)*

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

Which nested `if/else`?

- **(1) if/if/if (2) nested if/else (3) nested if/else/if**
  - Whether a user is lower, middle, or upper-class based on income.
    - **(2)** nested `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):

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

BMI	Weight class
below 18.5	underweight
18.5 - 24.9	normal
25.0 - 29.9	overweight
30.0 and up	obese

- 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
```

Nested `if/else` answer

```
// 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!

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

```
int z = Math.max(x, y);
```

```
double d = a;
if (b < d) {
    d = b;
}
if (c < d) {
    d = c;
}
```

```
double d = Math.min(a, Math.min(b, c));
```