Building Java Programs

Chapter 4

Lecture 4-1: `if` and `if/else` Statements

reading: 4.2

self-check: #4-5, 7, 10, 11

exercises: #7

videos: Ch. 4 #2-4

Loops with `if/else`

- `if/else` statements can be used with loops or methods:

```
int evenSum = 0;
int oddSum = 0;

for (int i = 1; i <= 10; i++) {
    if (i % 2 == 0) {
        evenSum = evenSum + i;
    } else {
        oddSum = oddSum + i;
    }
}

System.out.println("Even sum: " + evenSum);
System.out.println("Odd sum: " + oddSum);
```

Nested `if/else`

reading: 4.2, 4.5

self-check: #6, 8, 9, 24-27

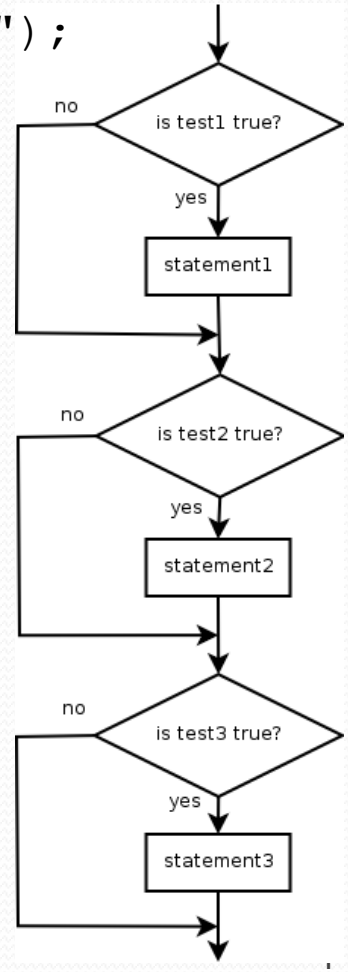
exercises: #10-14

videos: Ch. 4 #4

Sequential `if` bug

- What's wrong with the following code?

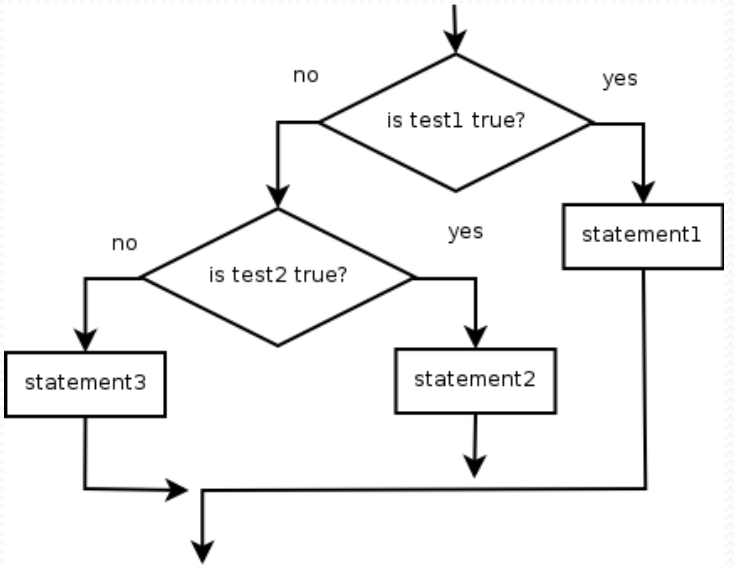
```
Scanner console = new Scanner(System.in);
System.out.print("What percentage did you earn? ");
int percent = console.nextInt();
if (percent >= 90) {
    System.out.println("You got an A!");
}
if (percent >= 80) {
    System.out.println("You got a B!");
}
if (percent >= 70) {
    System.out.println("You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



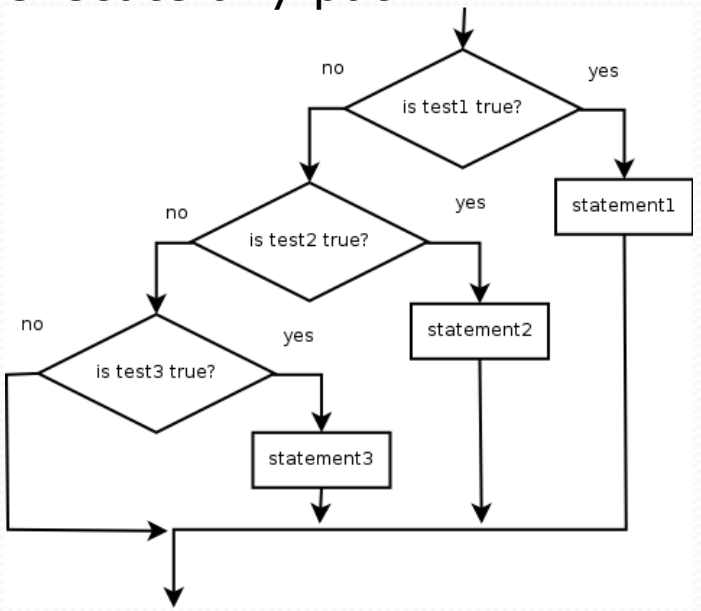
- Example:

```
if (number > 0) {
    System.out.println("Positive");
} else if (number < 0) {
    System.out.println("Negative");
} else {
    System.out.println("Zero");
}
```

Nested `if/else/if`

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

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



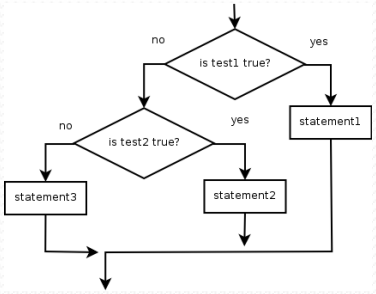
- Example:

```
if (place == 1) {
    System.out.println("You win the gold medal!");
} else if (place == 2) {
    System.out.println("You win a silver medal!");
} else if (place == 3) {
    System.out.println("You earned a bronze medal.");
}
```

Structures

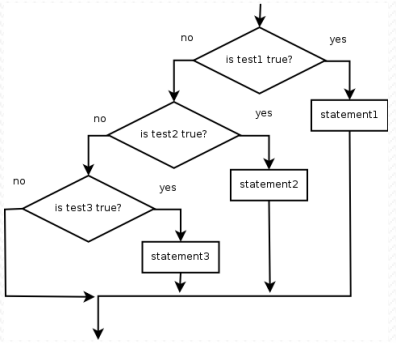
- Exactly 1 path: (mutually exclusive)

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



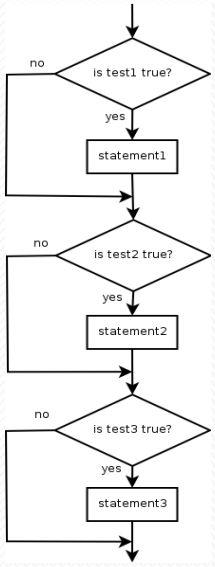
- 0 or 1 path:

```
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`?

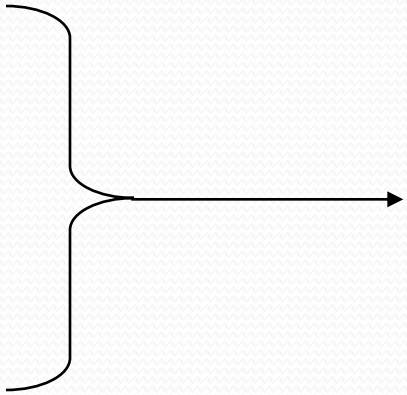
- **(1) if/if/if (2) nested if/else (3) nested if/else/if**
  - Reading the user's GPA and printing whether the student is on the dean's list (3.8 to 4.0) or honor roll (3.5 to 3.8).
    - **(3)** nested `if / else if`
  - Printing whether a number is even or odd.
    - **(N/A)** simple `if / else`
  - Printing whether a user is lower-class, middle-class, or upper-class based on their income.
    - **(2)** nested `if / else if / else`
  - Reading a number from the user and printing whether it is divisible by 2, 3, and/or 5.
    - **(1)** sequential `if / if / if`
  - Printing a grade of A, B, C, D, or F based on a percentage.
    - **(2)** nested `if / else if / else if / else if / else`

Factoring `if/else` code

- **factoring**: extracting common/redundant code
  - Factoring `if/else` code can reduce the size of `if/else` statements or eliminate the need for `if/else` altogether.

- Example:

```
if (a == 1) {
    x = 3;
} else if (a == 2) {
    x = 6;
    y++;
} else {  // a == 3
    x = 9;
}
```



```
x = 3 * a;
if (a == 2) {
    y++;
}
```

Code in need of factoring

```
if (money < 500) {
    System.out.println("You have, $" + money + " left.");
    System.out.print("Caution!  Bet carefully.");
    System.out.print("How much do you want to bet? ");
    bet = console.nextInt();
} else if (money < 1000) {
    System.out.println("You have, $" + money + " left.");
    System.out.print("Consider betting moderately.");
    System.out.print("How much do you want to bet? ");
    bet = console.nextInt();
} else {
    System.out.println("You have, $" + money + " left.");
    System.out.print("You may bet liberally.");
    System.out.print("How much do you want to bet? ");
    bet = console.nextInt();
}
```

Code after factoring

```
System.out.println("You have, $" + money + " left.");

if (money < 500) {
    System.out.print("Caution!  Bet carefully.");
} else if (money < 1000) {
    System.out.print("Consider betting moderately.");
} else {
    System.out.print("You may bet liberally.");
}

System.out.print("How much do you want to bet? ");
bet = console.nextInt();
```

- If the start of each branch is the same, move it *before* the `if/else`.
- If the end of each branch is the same, move it *after* the `if/else`.
- If similar but code exists in each branch, look for patterns.

The "dangling `if`" problem

- What can be improved about the following code?

```
if (x < 0) {
    System.out.println("x is negative");
} else if (x >= 0) {
    System.out.println("x is non-negative");
}
```

- The second `if` test is unnecessary and can be removed:

```
if (x < 0) {
    System.out.println("x is negative");
} else {
    System.out.println("x is non-negative");
}
```

  - This is also relevant in methods that use `if` with `return`...

if/else with return

- Methods can return different values using `if/else`:

```
// Returns the largest of the three given integers.
public static int max3(int a, int b, int c) {
    if (a >= b && a >= c) {
        return a;
    } else if (b >= c && b >= a) {
        return b;
    } else {
        return c;
    }
}
```

  - Whichever path the code enters, it will return the appropriate value.
  - Returning a value causes a method to immediately exit.
  - All code paths must reach a `return` statement.
    - All paths must also return a value of the same type.

All paths must return

```
public static int max3(int a, int b, int c) {
    if (a >= b && a >= c) {
        return a;
    } else if (b >= c && b >= a) {
        return b;
    }
    // Error: not all paths return a value
}
```

- The following also does not compile:

```
public static int max3(int a, int b, int c) {
    if (a >= b && a >= c) {
        return a;
    } else if (b >= c && b >= a) {
        return b;
    } else if (c >= a && c >= b) {
        return c;
    }
}
```

  - The compiler thinks `if/else/if` code might skip all paths.

`if/else` question

A person's body mass index (BMI) is defined to be:

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

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 the following output:

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

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 body mass index = 27.87
overweight
Person #2 body mass index = 23.49
normal
Difference = 4.38
```

if/else answer

```
// This program computes two people's body mass index (BMI)
// and compares them.  The code uses parameters and 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.printf("Difference = %.2f\n", Math.abs(bmi1 - bmi2));

    }

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

Scanner BMI solution, cont.

```
// 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 BMIbased 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.printf("Person #%d body mass index = %.2f\n", number, 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");
    }
}

}
```

`if/else`, `return` question

- Write a method `countFactors` that returns the number of factors of an integer.
  - `countFactors(24)` returns `8` because 1, 2, 3, 4, 6, 8, 12, and 24 are factors of 24.

- Write a program that prompts the user for a maximum integer and prints all prime numbers up to that max.

```
Maximum number? 52
2 3 5 7 11 13 17 19 23 29 31 37 41 43 47
15 primes (28.84%)
```

if/else, return answer 1

```
// Prompts for a maximum number and prints each prime up to that maximum.
import java.util.*;

public class Primes {
    public static void main(String[] args) {
        // read max from user
        Scanner console = new Scanner(System.in);
        System.out.print("Maximum number? ");
        int max = console.nextInt();
        printPrimes(max);
    }

    // Prints all prime numbers up to the given maximum.
    public static void printPrimes(int max) {
        int primes = 0;
        for (int i = 2; i <= max; i++) {
            if (countFactors(i) == 2) {        // i is prime
                System.out.print(i + " ");
                primes++;
            }
        }
        System.out.println();

        double percent = 100.0 * primes / max;
        System.out.printf("%d primes (%.2f%%)\n", primes, percent);
    }
```

if/else, return answer 2

```
    ...

    // Returns how many factors the given number has.
    public static int countFactors(int number) {
        int count = 0;
        for (int i = 1; i <= number; i++) {
            if (number % i == 0) {
                count++;  // i is a factor of number
            }
        }
        return count;
    }
}
```