Advanced if/else & Cumulative Sum

Subset of the Supplement Lesson slides from: Building Java Programs, Chapter 4
by Stuart Reges and Marty Stepp (http://www.buildingjavaprograms.com/)

Questions to consider

- What are the advantages of using Returns?
- What do we have to consider when returning a value in a series of nested if/else’s?
- What additional Operators do we need to make our if conditions (tests) more useful?

`if/else` with `return`

```
// Returns the larger of the two given integers.
public static int max(int a, int b) {
    if (a > b) {
        return a;
    } else {
        return b;
    }
}
```

- Methods can return different values using `if/else`
  - Whichever path the code enters, it will return that value.
  - Returning a value causes a method to immediately exit.
  - All paths through the code must reach a `return` statement.

All paths must return

```
public static int max(int a, int b) {
    if (a > b) {
        return a;
    }
    // Error: not all paths return a value
}
```

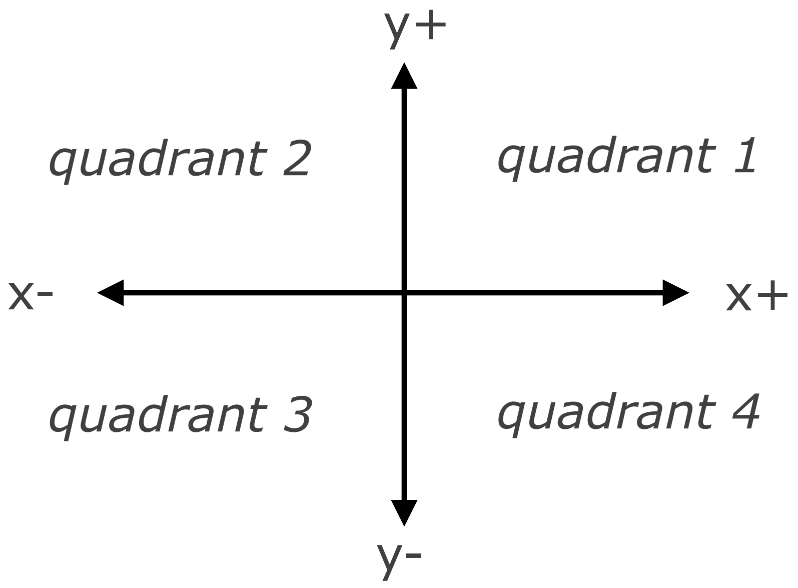
- The following also does not compile:

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

  - The compiler thinks `if/else/if` code might skip all paths, even though mathematically it must choose one or the other.

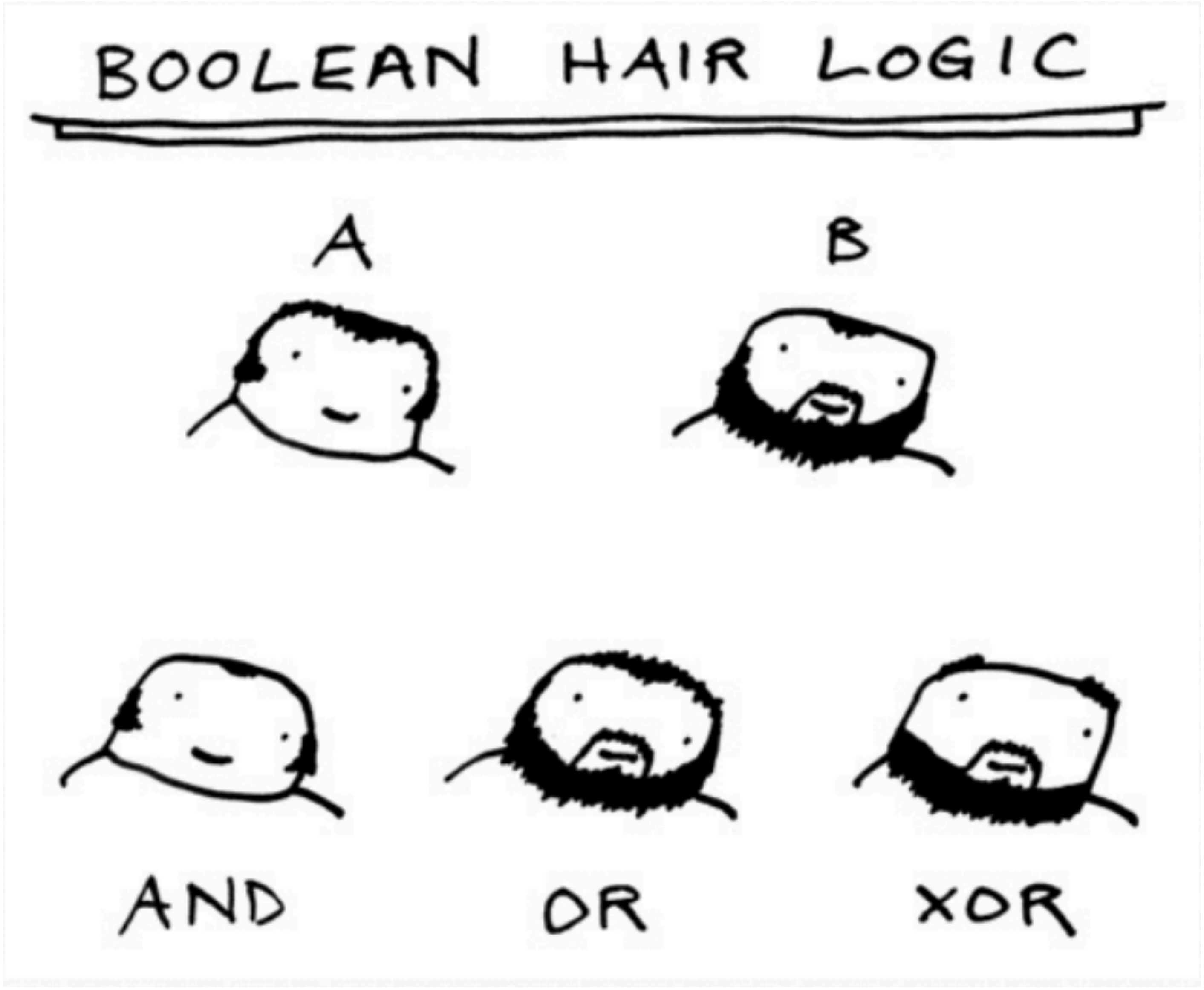
`if/else, return` question

- Write a method `quadrant` that accepts a pair of real numbers *x* and *y* and returns the quadrant for that point:



  – Example: `quadrant(-4.2, 17.3)` returns `2`
    - If the point falls directly on either axis, return `0`.

Logic



Logical operators

- Tests can be combined using *logical operators*:

Operator	Description	Example	Result
`&&`	and	`(2 == 3) && (-1 < 5)`	`false`
`||`	or	`(2 == 3) || (-1 < 5)`	`true`
`!`	not	`!(2 == 3)`	`true`

- "Truth tables" for each, used with logical values *p* and *q*:

p	**q**	**p && q**	**p || q**
`true`	`true`	`true`	`true`
`true`	`false`	`false`	`true`
`false`	`true`	`false`	`true`
`false`	`false`	`false`	`false`

p	**!p**
`true`	`false`
`false`	`true`

Evaluating logic expressions

- Relational operators have lower precedence than math.

```
5 * 7 >= 3 + 5 * (7 - 1)
5 * 7 >= 3 + 5 * 6
35    >= 3 + 30
35    >= 33
true
```

- Relational operators cannot be "chained" as in algebra.

```
2 <= x <= 10
true   <= 10
error!
```

(assume that `x` is `15`)

  - Instead, combine multiple tests with `&&` or `||`

```
2 <= x && x <= 10
true   && false
false
```

Logical questions

- What is the result of each of the following expressions?

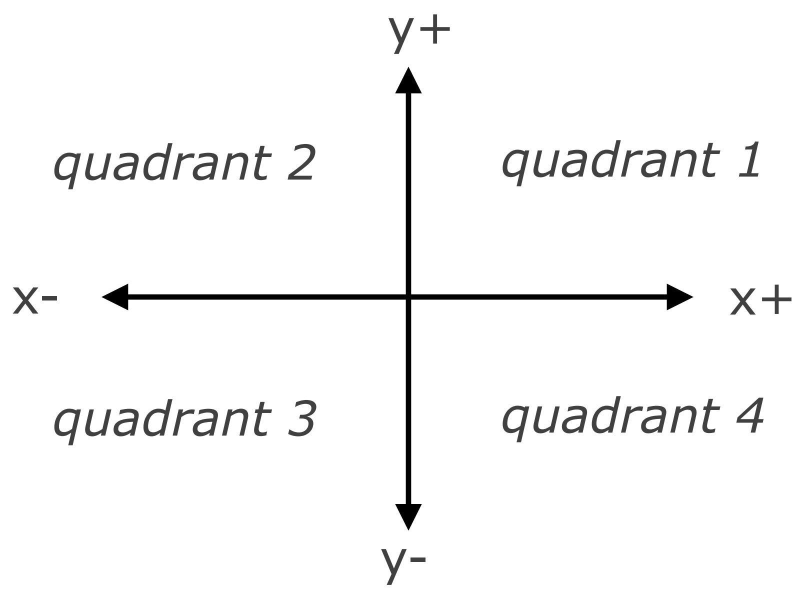
```
int x = 42;
int y = 17;
int z = 25;
```

```
A:  y < x && y <= z
B:  x % 2 == y % 2 || x % 2 == z % 2
C:  x <= y + z && x >= y + z
D:  !(x < y && x < z)
E:  (x + y) % 2 == 0 || !((z - y) % 2 == 0)
```

  - Answers: A: `true`, B: `false`, C: `true`, D: `true`, E:`false`

`if/else, return` question

- Write a method `quadrant` that accepts a pair of real numbers *x* and *y* and returns the quadrant for that point:



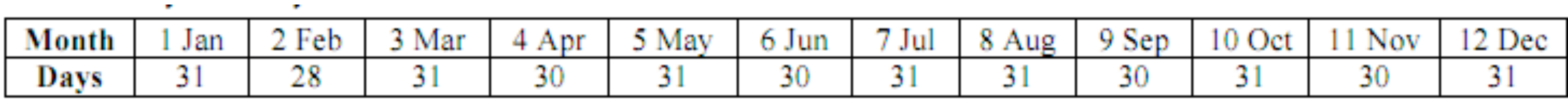
  - Example: `quadrant(-4.2, 17.3)` returns `2`
    - If the point falls directly on either axis, return `0`.

if/else, return answer

```
public static int quadrant(double x, double y) {
    if (x > 0 && y > 0) {
        return 1;
    } else if (x < 0 && y > 0) {
        return 2;
    } else if (x < 0 && y < 0) {
        return 3;
    } else if (x > 0 && y < 0) {
        return 4;
    } else {       // at least one coordinate equals 0
        return 0;
    }
}
```

Code Sample Example

- Write a method `daysInMonth` that accepts an integer representing the month and returns the number of days in that month.
- Assume there are no leap years



Month	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec
Days	31	28	31	30	31	30	31	31	30	31	30	31

- Examples:

  `daysInMonth(2)` returns `28`

  `daysInMonth(5)` returns `31`

Cumulative algorithms

Cumulative?

- **What does “cumulative” mean?**

  To increase by successive additions. Accumulation.
- **What kind of problems are solved accumulating values?**

  Series, summation for averages, approximation for Pi, etc.
- **What does any cumulative activity start with?**

  An initial value (that’s key!)

Adding many numbers

- How would you find the sum of all integers from 1-1000?

```
// This may require a lot of typing
int sum = 1 + 2 + 3 + 4 + ... ;
System.out.println("The sum is " + sum);
```

- What if we want the sum from 1 - 1,000,000?
  Or the sum up to any maximum?
  - How can we generalize the above code?

Cumulative sum loop

```java
int sum = 0;
for (int i = 1; i <= 1000; i++) {
    sum = sum + i;
}
System.out.println("The sum is " + sum);
```

- **cumulative sum**: A variable that keeps a sum in progress and is updated repeatedly until summing is finished.
  - The `sum` in the above code is an attempt at a cumulative sum.
  - Cumulative sum variables must be declared *outside* the loops that update them, so that they will still exist after the loop.

Cumulative product

- This cumulative idea can be used with other operators:

```
int product = 1;
for (int i = 1; i <= 20; i++) {
    product = product * 2;
}
System.out.println("2 ^ 20 = " + product);
```

  – How would we make the base and exponent adjustable?

`Scanner` and cumul. sum

- We can do a cumulative sum of user input:

```
Scanner console = new Scanner(System.in);
int sum = 0;
for (int i = 1; i <= 100; i++) {
    System.out.print("Type a number: ");
    sum = sum + console.nextInt();
}
System.out.println("The sum is " + sum);
```

- What if we wanted to first specify how many values are to be read in and then also print out the average of the values?

Let's code this...

Factoring `if/else` code

- **factoring**: Extracting common/redundant code.
  - Can reduce or eliminate redundancy from `if/else` code.

- Example:

```
if (a == 1) {
    System.out.println(a);
    x = 3;
    b = b + x;
} else if (a == 2) {
    System.out.println(a);
    x = 6;
    y = y + 10;
    b = b + x;
} else {  // a == 3
    System.out.println(a);
    x = 9;
    b = b + x;
}
```

$\longrightarrow$

```
System.out.println(a);
x = 3 * a;
if (a == 2) {
    y = y + 10;
}
b = b + x;
```