

Selections



EECS2030 B: Advanced
Object Oriented Programming
Fall 2019

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Learning Outcomes



- The Boolean Data Type
- `if` Statement
- Compound vs. Primitive Statement
- Common Errors and Pitfalls
- Logical Operations

Motivating Examples (1.1)



```
1 import java.util.Scanner;
2 public class ComputeArea {
3     public static void main(String[] args) {
4         Scanner input = new Scanner(System.in);
5         final double PI = 3.14;
6         System.out.println("Enter the radius of a circle:");
7         double radiusFromUser = input.nextDouble();
8         double area = radiusFromUser * radiusFromUser * PI;
9         System.out.print("Circle with radius " + radiusFromUser);
10        System.out.println(" has an area of " + area);
11    }
12 }
```

- When the above Java class is run as a Java Application, **Line 4** is executed first, followed by executing **Line 5**, ..., and ended with executing **Line 10**.
- In **Line 7**, the radius value comes from the user. Any problems?

Motivating Examples (1.2)



- If the user enters a positive radius value as expected:

```
Enter the radius of a circle:
3
Circle with radius 3.0 has an area of 28.26
```

- However, if the user enters a negative radius value:

```
Enter the radius of a circle:
-3
Circle with radius -3.0 has an area of 28.26
```

In this case, the area should *not* have been calculated!

- We need a mechanism to take **selective actions**:
Act differently in response to *valid* and *invalid* input values.

Motivating Examples (2.1)

Problem: Take an integer value from the user, then output a message indicating if the number is negative, zero, or positive.

- Here is an example run of the program:

```
Enter a number:
5
You just entered a positive number.
```

- Here is another example run of the program:

```
Enter a number:
-5
You just entered a negative number.
```

- Your solution program must accommodate *all* possibilities!

Motivating Examples (2.2)

- So far, you only learned about writing programs that are executed line by line, top to bottom.
- In general, we need a mechanism to allow the program to:
 - Check a list of *conditions*; and
 - Branch* its execution accordingly.
- e.g., To solve the above problem, we have 3 possible branches:
 - If** the user input is negative, then we execute the first branch that prints `You just entered a negative number.`
 - If** the user input is zero, then we execute the second branch that prints `You just entered zero.`
 - If** the user input is positive, then we execute the third branch that prints `You just entered a positive number.`

The boolean Data Type

- A (data) type denotes a set of related *runtime values*.
- We need a **data type** whose values suggest either a condition *holds*, or it *does not hold*, so that we can take selective actions.
- The Java **boolean** type consists of 2 **literal values**: *true*, *false*
- All **relational expressions** have the boolean type.

Math Symbol	Java Operator	Example (<i>r</i> is 5)	Result
\leq	<code><=</code>	<code>r <= 5</code>	<i>true</i>
\geq	<code>>=</code>	<code>r >= 5</code>	<i>true</i>
$=$	<code>==</code>	<code>r == 5</code>	<i>true</i>
$<$	<code><</code>	<code>r < 5</code>	<i>false</i>
$>$	<code>></code>	<code>r > 5</code>	<i>false</i>
\neq	<code>!=</code>	<code>r != 5</code>	<i>false</i>

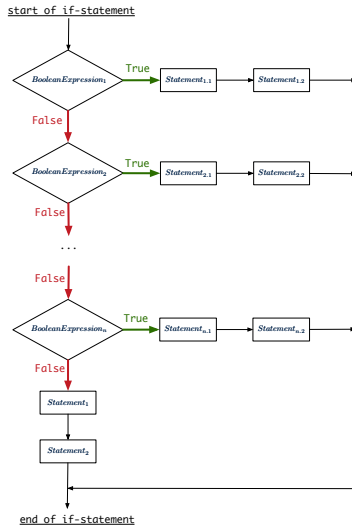
Note. You may do the following rewritings:

$x \leq y$	$x > y$	$x \neq y$	$x == y$
$!(x > y)$	$!(x \leq y)$	$!(x == y)$	$!(x \neq y)$

Syntax of if Statement

```
if ( BooleanExpression1 ) { /* Mandatory */
    Statement1,1; Statement2,1;
}
else if ( BooleanExpression2 ) { /* Optional */
    Statement2,1; Statement2,2;
}
... /* as many else-if branches as you like */
else if ( BooleanExpressionn ) { /* Optional */
    Statementn,1; Statementn,2;
}
else { /* Optional */
    /* when all previous branching conditions are false */
    Statement1; Statement2;
}
```

Semantics of if Statement (1.1)



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Semantics of if Statement (2.1.1)

Only first satisfying branch *executed*; later branches *ignored*.

```
int i = -4;
if(i < 0) {
    System.out.println("i is negative");
}
else if(i < 10) {
    System.out.println("i is less than than 10");
}
else if(i == 10) {
    System.out.println("i is equal to 10");
}
else {
    System.out.println("i is greater than 10");
}
```

i is negative

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Semantics of if Statement (1.2)

Consider a **single if statement** as consisting of:

- An if branch
- A (possibly empty) list of else if branches
- An optional else branch

At **runtime**:

- Branches of the if statement are *executed* from top to bottom.
- We only evaluate the **condition** of a branch if those conditions of its **preceding branches** evaluate to *false*.
- The **first** branch whose **condition** evaluates to *true* gets its body (i.e., code wrapped within { and }) *executed*.
 - After this execution, all *later* branches are *ignored*.

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Semantics of if Statement (2.1.2)

Only first satisfying branch *executed*; later branches *ignored*.

```
int i = 5;
if(i < 0) {
    System.out.println("i is negative");
}
else if(i < 10) {
    System.out.println("i is less than than 10");
}
else if(i == 10) {
    System.out.println("i is equal to 10");
}
else {
    System.out.println("i is greater than 10");
}
```

i is less than 10

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Semantics of if Statement (2.2)



No satisfying branches, and no `else` part, then *nothing* is executed.

```
int i = 12;
if(i < 0) {
    System.out.println("i is negative");
}
else if(i < 10) {
    System.out.println("i is less than than 10");
}
else if(i == 10) {
    System.out.println("i is equal to 10");
}
```

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Semantics of if Statement (2.3)



No satisfying branches, then `else` part, if there, is *executed*.

```
int i = 12;
if(i < 0) {
    System.out.println("i is negative");
}
else if(i < 10) {
    System.out.println("i is less than than 10");
}
else if(i == 10) {
    System.out.println("i is equal to 10");
}
else {
    System.out.println("i is greater than 10");
}
```

```
i is greater than 10
```

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Two-Way if Statement without else Part



```
if (radius >= 0) {
    area = radius * radius * PI;
    System.out.println("Area for the circle of is " + area);
}
```

An `if` statement with the missing `else` part is equivalent to an `if` statement with an `else` part that does nothing.

```
if (radius >= 0) {
    area = radius * radius * PI;
    System.out.println("Area for the circle of is " + area);
}
else {
    /* Do nothing. */
}
```

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Multi-Way if Statement with else Part



```
if (score >= 80.0) {
    System.out.println("A");
}
else if (score >= 70.0) {
    System.out.println("B");
}
else if (score >= 60.0) {
    System.out.println("C");
}
else {
    System.out.println("F");
}

if (score >= 80.0) {
    System.out.println("A");
}
else { /* score < 80.0 */
    if (score >= 70.0) {
        System.out.println("B");
    }
    else { /* score < 70.0 */
        if (score >= 60.0) {
            System.out.println("C");
        }
        else { /* score < 60.0 */
            System.out.println("F");
        }
    }
}
```

Exercise: Draw the corresponding flow charts for both programs. Convince yourself that they are equivalent.

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Multi-Way if Statement without else Part



```
String lettGrade = "F";
if (score >= 80.0) {
    letterGrade = "A";
}
else if (score >= 70.0) {
    letterGrade = "B";
}
else if (score >= 60.0) {
    letterGrade = "C";
}
```

In this case, since we already assign an initial, default value "F" to variable `letterGrade`, so when all the branch conditions evaluate to *false*, then the default value is kept.

Compare the above example with the example in slide 53.

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Case Study: Error Handling of Input Radius (2)



The same problem can be solved by checking the *condition* of valid inputs first.

```
public class ComputeArea2 {
    public static void main(String[] args) {
        System.out.println("Enter a radius value:");
        Scanner input = new Scanner(System.in);
        double radius = input.nextDouble();
        final double PI = 3.14159;
        if (radius >= 0) { /* condition of valid inputs */
            double area = radius * radius * PI;
            System.out.println("Area is " + area);
        }
        else { /* implicit: !(radius >= 0), or radius < 0 */
            System.out.println("Error: Negative radius value!");
        }
    }
}
```

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Case Study: Error Handling of Input Radius (1)



Problem: Prompt the user for the radius value of a circle. Print an error message if input number is negative; otherwise, print the calculated area.

```
public class ComputeArea {
    public static void main(String[] args) {
        System.out.println("Enter a radius value:");
        Scanner input = new Scanner(System.in);
        double radius = input.nextDouble();
        final double PI = 3.14159;
        if (radius < 0) { /* condition of invalid inputs */
            System.out.println("Error: Negative radius value!");
        }
        else { /* implicit: !(radius < 0), or radius >= 0 */
            double area = radius * radius * PI;
            System.out.println("Area is " + area);
        }
    }
}
```

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One if Stmt vs. Multiple if Stmts (1)



Question: Do these two programs behave same at runtime?

```
if(i >= 3) {System.out.println("i is >= 3");}
else if(i <= 8) {System.out.println("i is <= 8");}
```

```
if(i >= 3) {System.out.println("i is >= 3");}
if(i <= 8) {System.out.println("i is <= 8");}
```

Question: Do these two programs behave same at runtime?

```
if(i <= 3) {System.out.println("i is <= 3");}
else if(i >= 8) {System.out.println("i is >= 8");}
```

```
if(i <= 3) {System.out.println("i is <= 3");}
if(i >= 8) {System.out.println("i is >= 8");}
```

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One if Stmt vs. Multiple if Stmts (2)



```
int i = 5;
if(i >= 3) {System.out.println("i is >= 3");}
else if(i <= 8) {System.out.println("i is <= 8");}
```

```
i is >= 3
```

```
int i = 5;
if(i >= 3) {System.out.println("i is >= 3");}
if(i <= 8) {System.out.println("i is <= 8");}
```

```
i is >= 3
i is <= 8
```

Two versions behave *differently* because the two conditions $i \geq 3$ and $i \leq 8$ *may* be satisfied simultaneously.

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Scope of Variables (1)



When you declare a variable, there is a limited **scope** where the variable can be used.

- If the variable is declared directly under the `main` method, then all lines of code (including branches of `if` statements) may either *re-assign* a new value to it or *use* its value.

```
public static void main(String[] args) {
    int i = input.nextInt();
    System.out.println("i is " + i);
    if (i > 0) {
        i = i * 3; /* both use and re-assignment, why? */
    }
    else {
        i = i * -3; /* both use and re-assignment, why? */
    }
    System.out.println("3 * |i| is " + i);
}
```

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One if Stmt vs. Multiple if Stmts (3)



```
int i = 2;
if(i <= 3) {System.out.println("i is <= 3");}
else if(i >= 8) {System.out.println("i is >= 8");}
```

```
i is <= 3
```

```
int i = 2;
if(i <= 3) {System.out.println("i is <= 3");}
if(i >= 8) {System.out.println("i is >= 8");}
```

```
i is <= 3
```

Two versions behave *the same* because the two conditions $i \leq 3$ and $i \geq 8$ *cannot* be satisfied simultaneously.

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Scope of Variables (2.1)



- If the variable is declared under an `if` branch, an `else if` branch, or an `else` branch, then only lines of code appearing within that branch (i.e., its body) may either *re-assign* a new value to it or *use* its value.

```
public static void main(String[] args) {
    int i = input.nextInt();
    if (i > 0) {
        int j = i * 3; /* a new variable j */
        if (j > 10) { ... }
    }
    else {
        int j = i * -3; /* a new variable also called j */
        if (j < 10) { ... }
    }
}
```

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Scope of Variables (2.2)



- A variable declared under an `if` branch, an `else if` branch, or an `else` branch, cannot be *re-assigned* or *used* outside its scope.

```
public static void main(String[] args) {
    int i = input.nextInt();
    if (i > 0) {
        int j = i * 3; /* a new variable j */
        if (j > 10) { ... }
    }
    else {
        int k = i * -3; /* a new variable also called j */
        if (j < k) { ... }    x
    }
}
```

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Scope of Variables (2.3)



- A variable declared under an `if` branch, `else if` branch, or `else` branch, cannot be *re-assigned* or *used* outside its scope.

```
1 public static void main(String[] args) {
2     int i = input.nextInt();
3     if (i > 0) {
4         int j = i * 3; /* a new variable j */
5         if (j > 10) { ... }
6     }
7     else {
8         int j = i * -3; /* a new variable also called j */
9         if (j < 10) { ... }
10    }
11    System.out.println("i * j is " + (i * j));    x
12 }
```

- A variable **cannot** be referred to outside its declared scope.
[e.g., illegal use of `j` at L11]
- A variable **can** be used:
 - within its declared scope [e.g., use of `i` at L11]
 - within sub-scopes of its declared scope [e.g., use of `i` at L4, L8]

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Primitive Statement vs. Compound Statement



- A **statement** is a block of Java code that modifies value(s) of some variable(s).
- An assignment (`=`) statement is a *primitive statement*:
It only modifies its left-hand-side (LHS) variable.
- An `if` statement is a *compound statement*:
Each of its branches may modify more than one variables via other statements (e.g., assignments, `if` statements).

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Compound `if` Statement: Example



```
1 int x = input.nextInt();
2 int y = 0;
3 if (x >= 0) {
4     System.out.println("x is positive");
5     if (x > 10) { y = x * 2; }
6     else if (x < 10) { y = x % 2; }
7     else { y = x * x; }
8 }
9 else { /* x < 0 */
10    System.out.println("x is negative");
11    if(x < -5) { y = -x; }
12 }
```

Exercise: Draw a flow chart for the above compound statement.

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Logical Operators

- **Logical** operators are used to create **compound** Boolean expressions.
 - Similar to **arithmetic** operators for creating compound number expressions.
 - **Logical** operators can combine Boolean expressions that are built using the **relational** operators.
e.g., `1 <= x && x <= 10`
e.g., `x < 1 || x > 10`
- We consider three logical operators:

Java Operator	Description	Meaning
!	logical negation	not
&&	logical conjunction	and
	logical disjunction	or

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Logical Conjunction

- Logical **conjunction** is a **binary** operator (i.e., two operands, each being a Boolean expression).
- The conjunction is **true** only when both operands are **true**.
- If one of the operands is **false**, their conjunction is **false**.

Left Operand op1	Right Operand op2	op1 && op2
true	true	true
true	false	false
false	true	false
false	false	false

```
int age = input.nextInt();
boolean isOldEnough = age >= 45;
boolean isNotTooOld = age < 65
if (!isOldEnough) { /* young */ }
else if (isOldEnough && isNotTooOld) { /* middle-aged */ }
else { /* senior */ }
```

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Logical Negation

- Logical **negation** is a **unary** operator (i.e., one operand being a Boolean expression).
- The result is the “negated” value of its operand.

Operand op	!op
true	false
false	true

```
double radius = input.nextDouble();
boolean isPositive = radius > 0;
if (!isPositive) { /* not the case that isPositive is true */
    System.out.println("Error: radius value must be positive.");
}
else {
    System.out.println("Area is " + radius * radius * PI);
}
```

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Logical Disjunction

- Logical **disjunction** is a **binary** operator (i.e., two operands, each being a Boolean expression).
- The disjunction is **false** only when both operands are **false**.
- If one of the operands is **true**, their disjunction is **true**.

Left Operand op1	Right Operand op2	op1 op2
false	false	false
true	false	true
false	true	true
true	true	true

```
int age = input.nextInt();
boolean isSenior = age >= 65;
boolean isChild = age < 18
if (isSenior || isChild) { /* discount */ }
else { /* no discount */ }
```

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Logical Laws (1)

- The **negation** of a **strict inequality** is a **non-strict inequality**.

Relation	Negation	Equivalence
$i > j$	$!(i > j)$	$i \leq j$
$i \geq j$	$!(i \geq j)$	$i < j$
$i < j$	$!(i < j)$	$i \geq j$
$i \leq j$	$!(i \leq j)$	$i > j$

- e.g.,

<pre>if(i > j) { /* Action 1 */ } else { /* !(i > j) */ /* Action 2 */ }</pre>	equivalent to	<pre>if(i <= j) { /* Action 2 */ } else { /* !(i <= j) */ /* Action 1 */ }</pre>
--	---------------	--

- Action 1 is executed when $i > j$
- Action 2 is executed when $i \leq j$.

Logical Laws (2.2)

```
if(0 <= i && i <= 10) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is **Action 2** executed? $i < 0 \ || \ i > 10$

```
if(i < 0 && false) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is **Action 1** executed? **false**
- When is **Action 2** executed? **true** (i.e., $i \geq 0 \ || \ true$)

```
if(i < 0 && i > 10) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is **Action 1** executed? **false**
- When is **Action 2** executed? **true** (i.e., $i \geq 0 \ || \ i \leq 10$)

Lesson: Be careful not to write branching conditions that use **&&** but always evaluate to **false**.

Logical Laws (2.1)

Say we have two Boolean expressions B_1 and B_2 :

- What does **!(B₁ && B₂)** mean?
It is **not** the case that **both** B_1 and B_2 are **true**.
- What does **!B₁ || !B₂** mean?
It is **either** B_1 is **false**, B_2 is **false**, or both are **false**.
- Both expressions are equivalent! [proved by the truth table]

B_1	B_2	!(B₁ && B₂)	!B₁ !B₂
true	true	false	false
true	false	true	true
false	true	true	true
false	false	true	true

Logical Laws (3.1)

Say we have two Boolean expressions B_1 and B_2 :

- What does **!(B₁ || B₂)** mean?
It is **not** the case that **either** B_1 is **true**, B_2 is **true**, or both are **true**.
- What does **!B₁ && !B₂** mean?
Both B_1 and B_2 are **false**.
- Both expressions are equivalent! [proved by the truth table]

B_1	B_2	!(B₁ B₂)	!B₁ && !B₂
true	true	false	false
true	false	false	false
false	true	false	false
false	false	true	true

Logical Laws (3.2)

```
if(i < 0 || i > 10) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is *Action 2* executed? `0 <= i && i <= 10`

```
if(i < 0 || true) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is *Action 1* executed? `true`
- When is *Action 2* executed? `false` (i.e., `i >= 0 && false`)

```
if(i < 10 || i >= 10) { /* Action 1 */ }
else { /* Action 2 */ }
```

- When is *Action 1* executed? `true`
- When is *Action 2* executed? `false` (i.e., `i >= 10 && i < 10`)

Lesson: Be careful not to write branching conditions that use `||` but always evaluate to `true`.

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Operator Precedence

- Operators with *higher* precedence are evaluated before those with *lower* precedence.
e.g., `2 + 3 * 5`
- For the three *logical operators*, negation (`!`) has the highest precedence, then conjunction (`&&`), then disjunction (`||`).
e.g., `true || true && false` means
 - `true || (true && false)`, rather than
 - `(true || true) && false`
- When unsure, use *parentheses* to force the precedence.

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Operator Associativity

- When operators with the *same precedence* are grouped together, we evaluate them from left to right.

e.g., `1 + 2 - 3` means

`((1 + 2) - 3)`

e.g., `false || true || false` means

`((false || true) || false)`

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Short-Circuit Evaluation (1)

- Both *Logical operators* `&&` and `||` evaluate from left to right.
- Operator `&&` continues to evaluate only when operands so far evaluate to `true`.

```
if (x != 0 && y / x > 2) {
    /* do something */
}
else {
    /* print error */ }
```

- Operator `||` continues to evaluate only when operands so far evaluate to `false`.

```
if (x == 0 || y / x <= 2) {
    /* print error */
}
else {
    /* do something */ }
```

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Short-Circuit Evaluation (2)



- Both *Logical operators* `&&` and `||` evaluate from left to right.
- Short-Circuit Evaluation is not exploited: crash when `x == 0`

```
if (y / x > 2 && x != 0) {
    /* do something */
}
else {
    /* print error */
}
```

- Short-Circuit Evaluation is not exploited: crash when `x == 0`

```
if (y / x <= 2 || x == 0) {
    /* print error */
}
else {
    /* do something */
}
```

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Common Error 1: Independent `if` Statements with Overlapping Conditions



```
if (marks >= 80) {
    System.out.println("A");
}
if (marks >= 70) {
    System.out.println("B");
}
if (marks >= 60) {
    System.out.println("C");
}
else {
    System.out.println("F");
}
/* Consider marks = 84 */
```

```
if (marks >= 80) {
    System.out.println("A");
}
else if (marks >= 70) {
    System.out.println("B");
}
else if (marks >= 60) {
    System.out.println("C");
}
else {
    System.out.println("F");
}
/* Consider marks = 84 */
```

- *Conditions* in a list of `if` statements are checked **independently**.
- In a single `if` statement, **only** the *first satisfying branch* is executed.

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Overlapping Conditions: Exercise (1)



- Does this program always print exactly one line?

```
if(x < 0) { println("x < 0"); }
if(0 <= x && x < 10) { println("0 <= x < 10"); }
if(10 <= x && x < 20) { println("10 <= x < 20"); }
if(x >= 20) { println("x >= 20"); }
```

- **Yes**, because the branching conditions for the **four** `if`-statements are all **non-overlapping**.
- That is, any two of these conditions **cannot be satisfied simultaneously**:
 - `x < 0`
 - `0 <= x && x < 10`
 - `10 <= x && x < 20`
 - `x >= 20`

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Overlapping Conditions: Exercise (2)



- Does this program always print exactly one line?

```
if(x < 0) { println("x < 0"); }
else if(0 <= x && x < 10) { println("0 <= x < 10"); }
else if(10 <= x && x < 20) { println("10 <= x < 20"); }
else if(x >= 20) { println("x >= 20"); }
```

- **Yes**, because it's a **single** `if`-statement: Only **the first satisfying branch** is executed.
- But, can it be simplified?
Hint: In a single `if`-statement, a branch is executed only if **all earlier branching conditions** fail.

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Overlapping Conditions: Exercise (3)



- This simplified version is equivalent:

```
1 if(x < 0) { println("x < 0"); }
2 else if(x < 10) { println("0 <= x < 10"); }
3 else if(x < 20) { println("10 <= x < 20"); }
4 else { println("x >= 20"); }
```

- At runtime, the 2nd condition `x < 10` at **L2** is checked only when the 1st condition at **L1** **fails** (i.e., `!(x < 0)`, or equivalently, `x >= 0`).
- At runtime, the 3rd condition `x < 20` at **L3** is checked only when the 2nd condition at **L2** **fails** (i.e., `!(x < 10)`, or equivalently, `x >= 10`).
- At runtime, the else (default) branch at **L4** is reached only when the 3rd condition at **L3** **fails** (i.e., `!(x < 20)`, or equivalently, `x >= 20`).

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General vs. Specific Boolean Conditions (2)



- Say we have two overlapping conditions `x >= 5` and `x >= 0`:
- What values make both conditions **true**? [5, 6, 7, ...]
 - Which condition is more **general**? [`x >= 0`]
 - If we have a single if statement, then having this order

```
if(x >= 5) { System.out.println("x >= 5"); }
else if(x >= 0) { System.out.println("x >= 0"); }
```

is different from having this order

```
if(x >= 0) { System.out.println("x >= 0"); }
else if(x >= 5) { System.out.println("x >= 5"); }
```

- Say `x` is 5, then we have
 - What output from the first program? [`x >= 5`]
 - What output from the second program? [`x >= 0`, not **specific** enough!]
- The cause of the "**not-specific-enough**" problem of the second program is that we did not check the more **specific** condition (`x >= 5`) before checking the more **general** condition (`x >= 0`).

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General vs. Specific Boolean Conditions (1)



Two or more conditions **overlap** if they can evaluate to **true** simultaneously.

e.g., Say `marks` is declared as an integer variable:

- `marks >= 80` and `marks >= 70` overlap. [why?]
 - Values 80, 81, 82, ... make both conditions **true**
 - `marks >= 80` has **fewer** satisfying values than `marks >= 70`
 - We say `marks >= 80` is more **specific** than `marks >= 70`
 - Or, we say `marks >= 70` is more **general** than `marks >= 80`
- `marks <= 65` and `marks <= 75` overlap. [why?]
 - Values 65, 64, 63, ... make both conditions **true**
 - `marks <= 65` has **fewer** satisfying values than `marks <= 75`
 - We say `marks <= 65` is more **specific** than `marks <= 75`
 - Or, we say `marks <= 75` is more **general** than `marks <= 65`

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Common Error 2: if-elseif Statement with Most General Condition First (1)



```
if (gpa >= 2.5) {
    graduateWith = "Pass";
}
else if (gpa >= 3.5) {
    graduateWith = "Credit";
}
else if (gpa >= 4) {
    graduateWith = "Distinction";
}
else if (gpa >= 4.5) {
    graduateWith = "High Distinction" ;
}
```

The above program will:

- Not award a "High Distinction" to `gpa == 4.8`.
- Why?

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Common Error 2: if-elseif Statement with Most General Condition First (2)

- Always **"sort"** the branching conditions s.t. the more **specific** conditions are checked **before** the more **general** conditions.

```
if (gpa >= 4.5) {
    graduateWith = "High Distinction" ;
}
else if (gpa >= 4) {
    graduateWith = "Distinction";
}
else if (gpa >= 3.5) {
    graduateWith = "Credit";
}
else if (gpa >= 2.5) {
    graduateWith = "Pass";
}
else { graduateWith = "Fail"; }
```

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Common Error 3: Missing Braces (2)

Your program will **misbehave** when a block is supposed to execute **multiple statements**, but you forget to enclose them within braces.

```
final double PI = 3.1415926;
Scanner input = new Scanner(System.in);
double radius = input.nextDouble();
double area = 0;
if (radius >= 0)
    area = radius * radius * PI;
    System.out.println("Area is " + area);
```

This program will **mistakenly** print "Area is 0.0" when a **negative** number is input by the user, why? Fix?

```
if (radius >= 0) {
    area = radius * radius * PI;
    System.out.println("Area is " + area);
}
```

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Common Error 3: Missing Braces (1)

Confusingly, braces can be **omitted** if the block contains a **single** statement.

```
final double PI = 3.1415926;
Scanner input = new Scanner(System.in);
double radius = input.nextDouble();
if (radius >= 0)
    System.out.println("Area is " + radius * radius * PI);
```

In the above code, it is as if we wrote:

```
final double PI = 3.1415926;
Scanner input = new Scanner(System.in);
double radius = input.nextDouble();
if (radius >= 0) {
    System.out.println("Area is " + radius * radius * PI);
}
```

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Common Error 4: Misplaced Semicolon

Semicolon (;) in Java marks **the end of a statement** (e.g., assignment, if statement).

```
if (radius >= 0); {
    area = radius * radius * PI;
    System.out.println("Area is " + area);
}
```

This program will calculate and output the area even when the input radius is **negative**, why? Fix?

```
if (radius >= 0) {
    area = radius * radius * PI;
    System.out.println("Area is " + area);
}
```

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Common Error 5: Variable Not Properly Re-Assigned

```

1 String graduateWith = "";
2 if (gpa >= 4.5) {
3     graduateWith = "High Distinction" ; }
4 else if (gpa >= 4) {
5     graduateWith = "Distinction"; }
6 else if (gpa >= 3.5) {
7     graduateWith = "Credit"; }
8 else if (gpa >= 2.5) {
9     graduateWith = "Pass"; }

```

The above program will award "" to $gpa == 1.5$. Why?
Possible Fix 1: Change the *initial value* in Line 1 to "Fail".
Possible Fix 2: Add an *else* branch after Line 9:

```
else { graduateWith = "fail" }
```

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Compare this example with the example in slide 17.

Common Errors 6: Ambiguous else (1)

```

if (x >= 0)
    if (x > 100) {
        System.out.println("x is larger than 100");
    }
else {
    System.out.println("x is negative");
}

```

- When x is 20, this program considers it as negative. Why?
∴ else clause matches the *most recent* unmatched if clause.
∴ The above is as if we wrote:

```

if (x >= 0) {
    if (x > 100) {
        System.out.println("x is larger than 100");
    }
    else {
        System.out.println("x is negative");
    }
}

```

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Common Errors 6: Ambiguous else (2)

- Fix?

Use pairs of curly braces ({}) to force what you really mean to specify!

```

if (x >= 0) {
    if (x > 100) {
        System.out.println("x is larger than 100");
    }
}
else {
    System.out.println("x is negative");
}

```

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Common Pitfall 1: Updating Boolean Variable

```

boolean isEven;
if (number % 2 == 0) {
    isEven = true;
}
else {
    isEven = false;
}

```

Correct, but **simplifiable**: `boolean isEven = (number%2 == 0);`
Similarly, how would you simply the following?

```

if (isEven == false) {
    System.out.println("Odd Number");
}
else {
    System.out.println("Even Number");
}

```

Simplify `isEven == false` to `!isEven`

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Common Error 6: Ambiguous else (2)

Common Pitfall 1: Updating Boolean Variable