# Selections

CSE160: Computer Science A: Honors

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- Computing the Area of a Circle:

```
import java.util.Scanner;
public class ComputeArea {
  public static void main(String[] args) {
    Scanner input = new Scanner(System.in);
    System.out.print("Enter a radius: ");
    double radius = input.nextDouble();
    double area = radius * radius * 3.14159;
    // Display results
    System.out.println("The area for the circle"
      + " of radius " + radius + " is " + area);
  }
}
```

**What if the user enters a negative value (i.e., an invalid value)?**

**The area for a circle with a negative radius does not make sense.**

# Motivation

If the user enterred a negative value for radius in ComputeArea.java, then you don't want the program to compute the area, but to inform the user that their input was incorrect.

- Computing the Area of a Circle:

```
import java.util.Scanner;
public class ComputeAreaNew {
  public static void main(String[] args) {
    Scanner input = new Scanner(System.in);
    System.out.print("Enter a radius: ");
    double radius = input.nextDouble();
    if(radius >= 0){
      double area = radius * radius * 3.14159;
      System.out.println("The area for the circle"
        + " of radius " + radius + " is " + area);
    } else //{
      System.out.println("The radius is negative."
         + " The area cannot be computed.");
    // }
  }
}
```

# The Comparison Operators and `boolean` Type

- Often in a programs you need to compare values:

  e.g., if `x` is greater than `y` then ...

- Java provides six ***comparison operators*** (also called relational operators) to compare two values: `<`, `<=`, `>`, `>=`, `==` and `!=`
  - The result of the comparison is a Boolean value: `true` or `false`. For example,

```
boolean b = (1 > 2);
```

`b` is `false` after the statement.

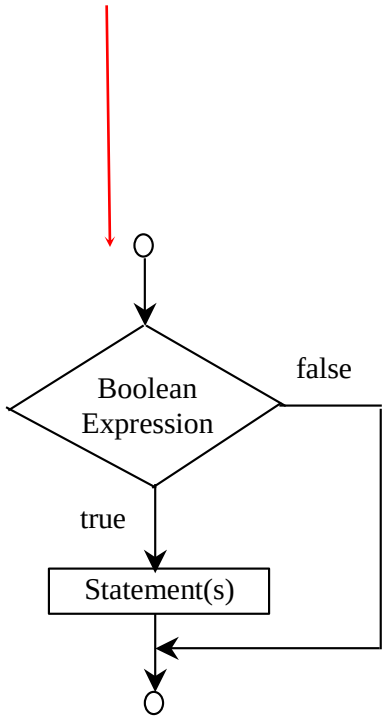
# Comparison Operators

| *Operator* | *Name* |
|---|---|
| < | less than |
| <= | less than or equal to |
| > | greater than |
| >= | greater than or equal to |
| == | equal to |
| != | not equal to |

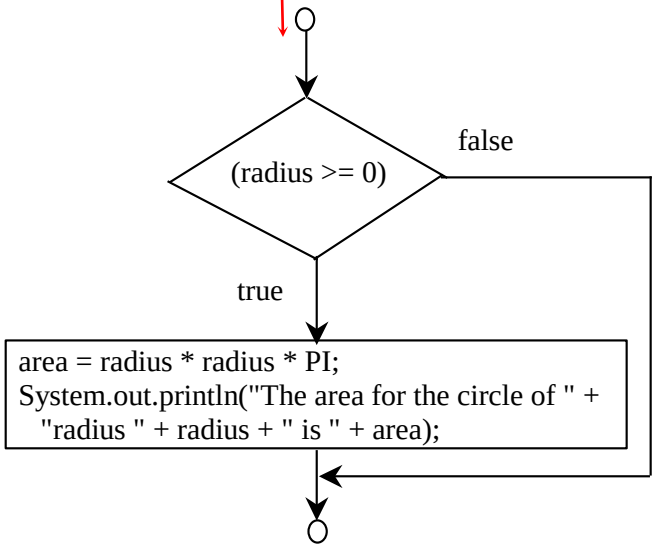
# One-way `if` Statements

```
if (boolean-
  expression) {
   statement(s);
}
```

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




(A)




(B)

# One-way `if` Statements

Condition containment is necessary!

```
if i > 0 {
  System.out.println("i is positive");
}
```

(a) Wrong

```
if (i > 0) {
  System.out.println("i is positive");
}
```

(b) Correct

Block containment is not necessary for a **single** statement!

```
if (i > 0) {
  System.out.println("i is positive");
}
```

(a)

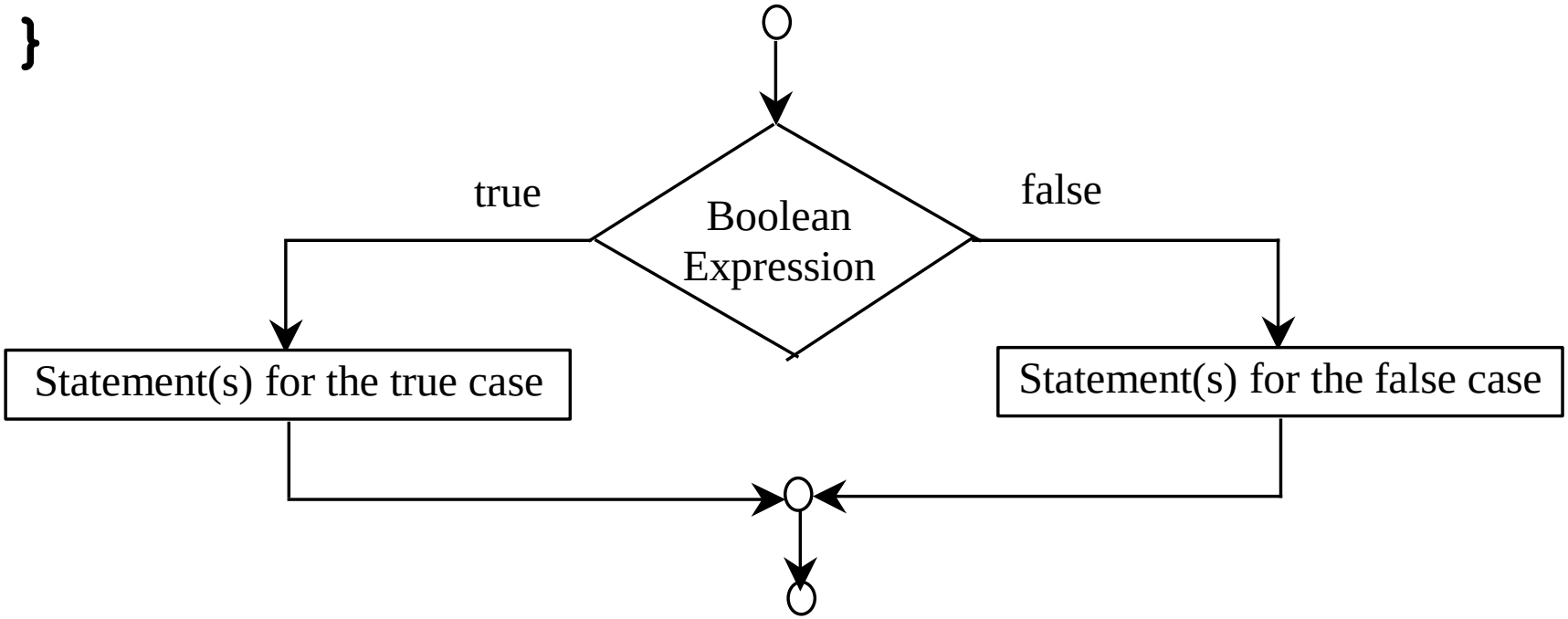
Equivalent

```
if (i > 0)
  System.out.println("i is positive");
```

(b)

# Two-way `if` Statement

```
if (boolean-expression) {
  statement(s)-for-the-true-case;
} else {
  statement(s)-for-the-false-case;
}
```



# Two-way `if` Example

```
if (radius >= 0) {
  double area = radius * radius * 3.1415;
  System.out.println("The area for the"
    + " circle of radius " + radius
    + " is " + area);
} else
  System.out.println("Negative input");
```

# Multiple Alternative if Statements

Indentation in Java is not required, but a good programming style.

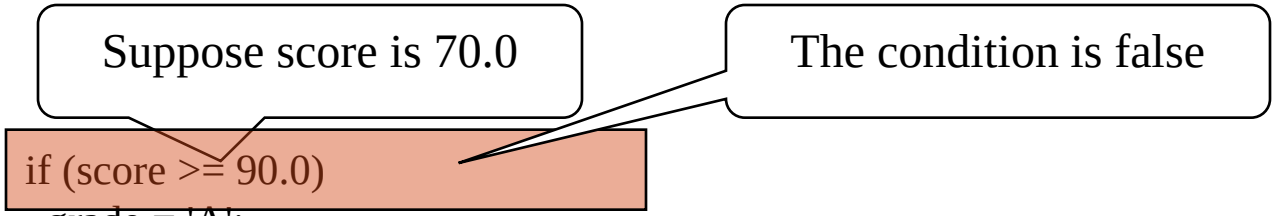
```
if (score >= 90.0)
  grade = 'A';
else
  if (score >= 80.0)
    grade = 'B';
  else
    if (score >= 70.0)
      grade = 'C';
    else
      if (score >= 60.0)
        grade = 'D';
      else
        grade = 'F';
```

Equivalent

**Indentation exception** for cascading if-else-if statements:

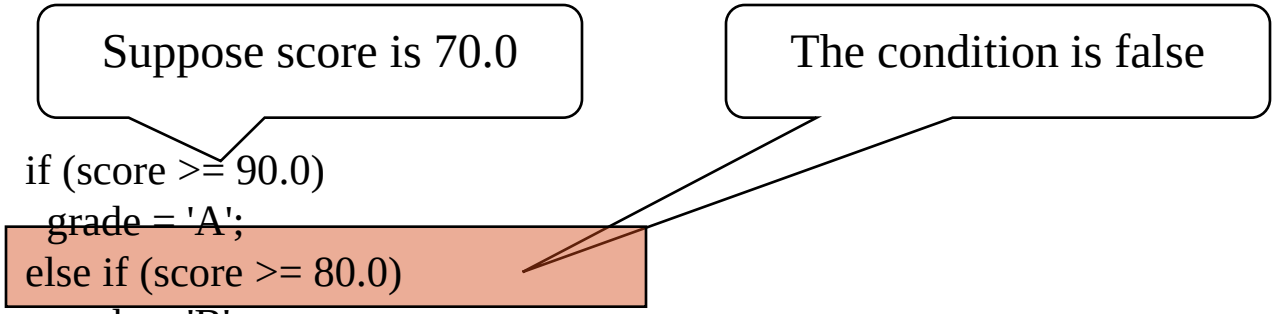
```
if (score >= 90.0)
  grade = 'A';
else if (score >= 80.0)
  grade = 'B';
else if (score >= 70.0)
  grade = 'C';
else if (score >= 60.0)
  grade = 'D';
else
  grade = 'F';
```

# Trace if-else statement



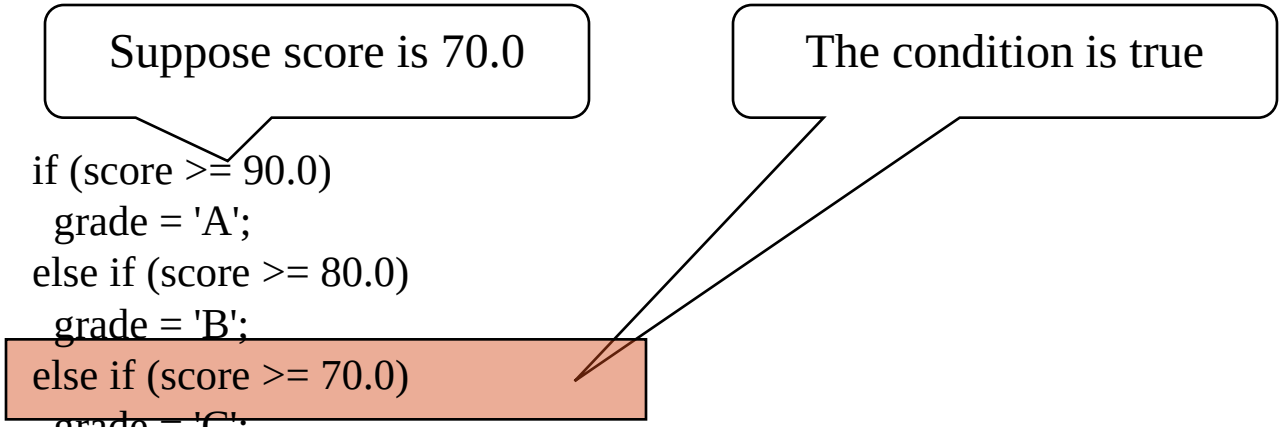

```
if (score >= 90.0)
  grade = 'A';
else if (score >= 80.0)
  grade = 'B';
else if (score >= 70.0)
  grade = 'C';
else if (score >= 60.0)
  grade = 'D';
else
  grade = 'F';
```

# Trace if-else statement

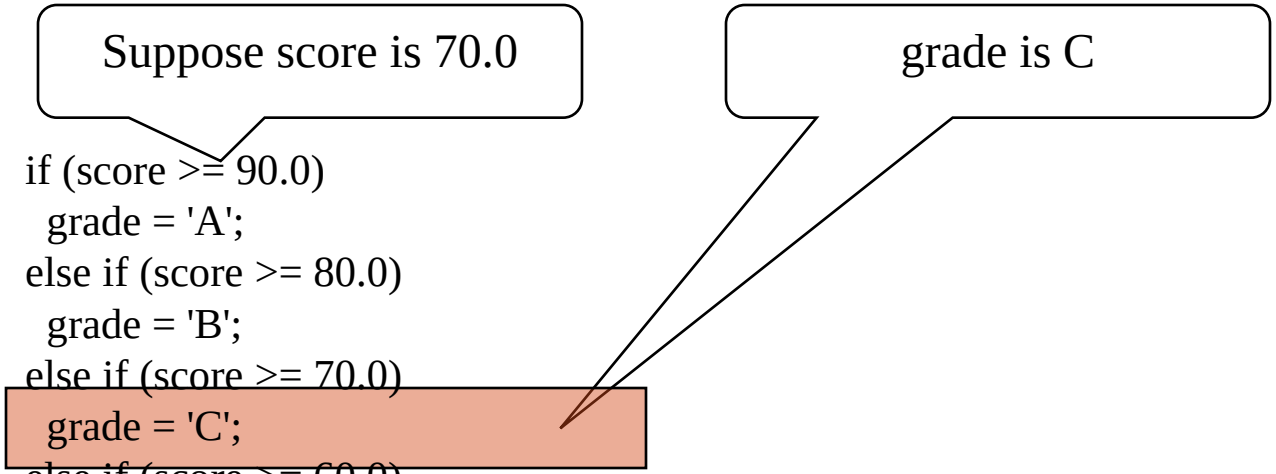



```
if (score >= 90.0)
  grade = 'A';
else if (score >= 80.0)
  grade = 'B';
else if (score >= 70.0)
  grade = 'C';
else if (score >= 60.0)
  grade = 'D';
else
  grade = 'F';
```

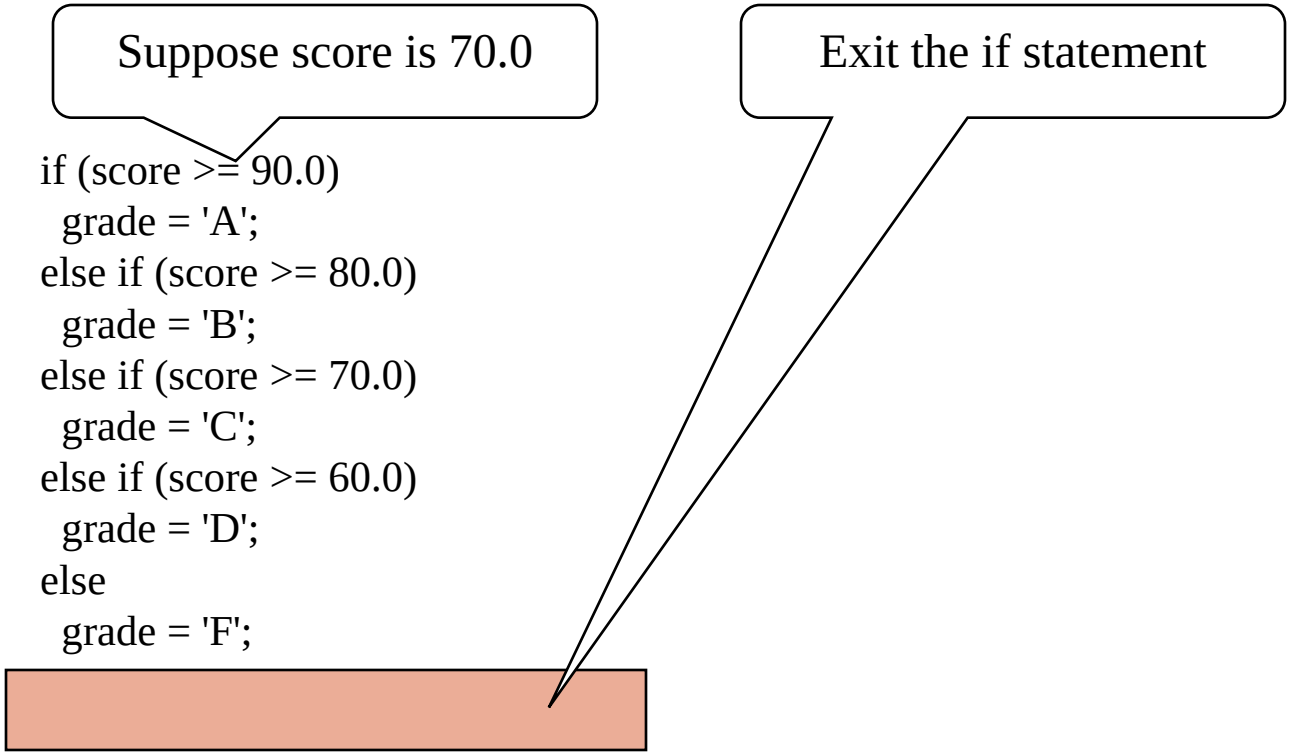
# Trace if-else statement



# Trace if-else statement



# Trace if-else statement



# if … else

Inconsistent indentation can get us confused, so the rule is that the else clause matches the most recent if clause in the same block.

```
int i = 1;
int j = 2;
int k = 3;

if (i > j)
  if (i > k)
    System.out.println("A");
else
    System.out.println("B");
```

(a)

Wrong indentation

Equivalent

```
int i = 1;
int j = 2;
int k = 3;

if (i > j)
  if (i > k)
    System.out.println("A");
  else
    System.out.println("B");
```

(b)

Correct indentation

This does not print anything!

# if … else

To force the else clause to match the first if clause, you must add a pair of braces:

```
int i = 1;
int j = 2;
int k = 3;
if (i > j) {
  if (i > k)
    System.out.println("A");
} else
  System.out.println("B");
```

This code prints B.

# Common Error

- Adding a semicolon at the end of an if clause is a common mistake (often occurs when you use the next-line block style):

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

Wrong

  - It is not a compilation error and it is not a runtime error
  - It is a logic error because ";" is a statement (the no-operation/no-op statement)

# What's wrong here?

```
System.out.print("Enter your total cholesterol level: ");
int totalCholesterol= input.nextInt();

if (totalCholesterol>= 200)
  System.out.println("Your cholesterol is too high.");
  System.out.println("You need to lower that.");
else
  System.out.println("Good, eat away!");
```

# What's wrong here?

```
System.out.print("Enter your total cholesterol level: ");
int totalCholesterol= input.nextInt();

if (totalCholesterol>= 200)
  System.out.println("Your cholesterol is too high.");
System.out.println("You need to lower that.");
else // SYNTAX ERROR HERE: this else does not match any if
  System.out.println("Good, eat away!");
```

# What's wrong here?

```
System.out.print("Enter your total cholesterol level: ");
int totalCholesterol= input.nextInt();


if (totalCholesterol>= 200) { // Now it is correct
  System.out.println("Your cholesterol is too high.");
  System.out.println("You need to lower that.");
} else
  System.out.println("Good, eat away!");
```

# Why is this worse?

```
System.out.print("Enter your total cholesterol level:");
int totalCholesterol= input.nextInt();

if (totalCholesterol>= 200)
  System.out.println("Your cholesterol is too high.");
  System.out.println("You need to lower that.");
```

# Why is this worse?

```
System.out.print("Enter your total cholesterol level:");
int totalCholesterol= input.nextInt();

if (totalCholesterol>= 200)
  System.out.println("Your cholesterol is too high.");
System.out.println("You need to lower that.");
// NO SYNTAX ERROR
// NO RUNTIME ERROR
// It is a Bug/logical error because it says to lower
//  the cholesterol even if it is fine.
```

# Why is this worse?

```
System.out.print("Enter your total cholesterol level: ");
int totalCholesterol= input.nextInt();


if (totalCholesterol>= 200){ // correct
  System.out.println("Your cholesterol is too high.");
  System.out.println("You need to lower that.");
}
```

# What about complex conditions?

- For example: Computing Taxes: the income tax rate is calculated based on the filing status and taxable income (so, we need multiple / complex logical conditions)
  - There are four filing statuses: single filers, married filing jointly, married filing separately, and head of household combined with earnings.

| Marginal Tax Rate | Single (0) | Married Filing Jointly or Qualified Widow(er) (1) | Married Filing Separately (2) | Head of Household (3) |
|---|---|---|---|---|
| 10% | $0 – $8,350 | $0 – $16,700 | $0 – $8,350 | $0 – $11,950 |
| 15% | $8,351– $33,950 | $16,701 – $67,900 | $8,351 – $33,950 | $11,951 – $45,500 |
| 25% | $33,951 – $82,250 | $67,901 – $137,050 | $33,951 – $68,525 | $45,501 – $117,450 |
| 28% | $82,251 – $171,550 | $137,051 – $208,850 | $68,525 – $104,425 | $117,451 – $190,200 |
| 33% | $171,551 – $372,950 | $208,851 – $372,950 | $104,426 – $186,475 | $190,201 - $372,950 |
| 35% | $372,951+ | $372,951+ | $186,476+ | $372,951+ |

# Logical Operators

| *Operator* | *Name* |
|---|---|
| ! | not |
| && | and |
| \|\| | or |
| ^ | exclusive or |

# Truth Table for Operator !

| p | !p | Example (assume age = 24, gender = 'F') |
|---|---|---|
| `true` | `false` | !(age > 18) is false, because (age > 18) is true. |
| `false` | `true` | !(gender != 'F') is true, because (grade != 'F') is false. |

# Truth Table for Operator &&

| p1 | p2 | p1 && p2 | Example (assume age = 24, gender = 'F') |
|---|---|---|---|
| false | false | false | (age > 18) && (gender == 'F') is true, because (age > 18) and (gender == 'F') are both true. |
| false | true | false | |
| true | false | false | (age > 18) && (gender != 'F') is false, because (gender != 'F') is false. |
| true | true | true | |

# Truth Table for Operator ||

| p1 | p2 | p1 \|\| p2 | Example (assume age = 24, gender = 'F') |
|---|---|---|---|
| false | false | false | (age > 34) \|\| (gender == 'F') is true, because (gender == 'F') is true. |
| false | true | true | |
| true | false | true | (age > 34) \|\| (gender == 'M') is false, because (age > 34) and (gender == 'M') are both false. |
| true | true | true | |

# Truth Table for Operator ^

| p1 | p2 | p1 ^ p2 | Example (assume age = 24, gender = 'F') |
|---|---|---|---|
| false | false | false | (age > 34) ^ (gender == 'F') is true, because (age > 34) is false but (gender == 'F') is true. |
| false | true | true | |
| true | false | true | (age > 34) ^ (gender == 'M') is false, because (age > 34) and (gender == 'M') are both false. |
| true | true | false | |

p1 ^ p2 = p1 != p2

# Logical Operators Examples

- What is the result?

```
boolean result;
result = (5 <= 9);                  // true
result = !(5 <= 9);                 // false
result = (3.9 > 3.19);              //true
result = ('a' == 'A');              //false
result = (5 <= 9 && 8 > 9); //false
result = (5 <= 9 || 8 > 9); //true
```

# Logical Operators Examples

```
System.out.println("Is " + number
  + " divisible by 2 and 3? "
  + ((number % 2 == 0) && (number % 3 == 0)));

System.out.println("Is " + number
  + " divisible by 2 or 3? "
  + ((number % 2 == 0) || (number % 3 == 0)));

 System.out.println("Is " + number
  + " divisible by 2 or 3, but not both? "
  + ((number % 2 == 0) ^ (number % 3 == 0)));
```

# Determining Leap Year

Consider a program that prompts the user to enter a year as an int value and checks if it is a leap year.

A year is a leap year if it is divisible by 4 but not by 100, or it is divisible by 400.

```
(year % 4 == 0 && year % 100 != 0)
  || year % 400 == 0
```

# Determining Leap Year

```
(year % 4 == 0 && year % 100 != 0) || year % 400 == 0
```

2000: leap?

(true && false) || true = false || true = true

1900: leap?

(true && false) || false = false || false = false

2026: leap?

(false && NA) || false = false || false = false

2020: leap?

(true && true) || NA= true || NA= true

# The unconditional & and | Operators

- false && p2 (it does not execute p2) = false
  - && is called short-cut operator
    - if the first operand is false, the conjunction is immediately false (skips the evaluation of the second operand)
  - sometimes is what we want, e.g.:

ref!=null && ref.property==value

    - ref.property is not evaluated for null objects

# The unconditional & and | Operators

- true || p2 (it does not execute p2) = true
  - || is also a short-cut operator
    - if the first operand is true, the disjunction is immediately true (skips the evaluation of the second operand)

# The unconditional & and | Operators

If x is 1, what is x after these expressions?

```
(x > 1) && (x++ < 10)          1
```

false and NA = false

```
(x > 1) & (x++ < 10)           2
```

still evaluated

```
(1 == x) || (10 > x++)?        1
```

true or NA = true

```
(1 == x) | (10 > x++)?         2
```

still evaluated

# switch Statements

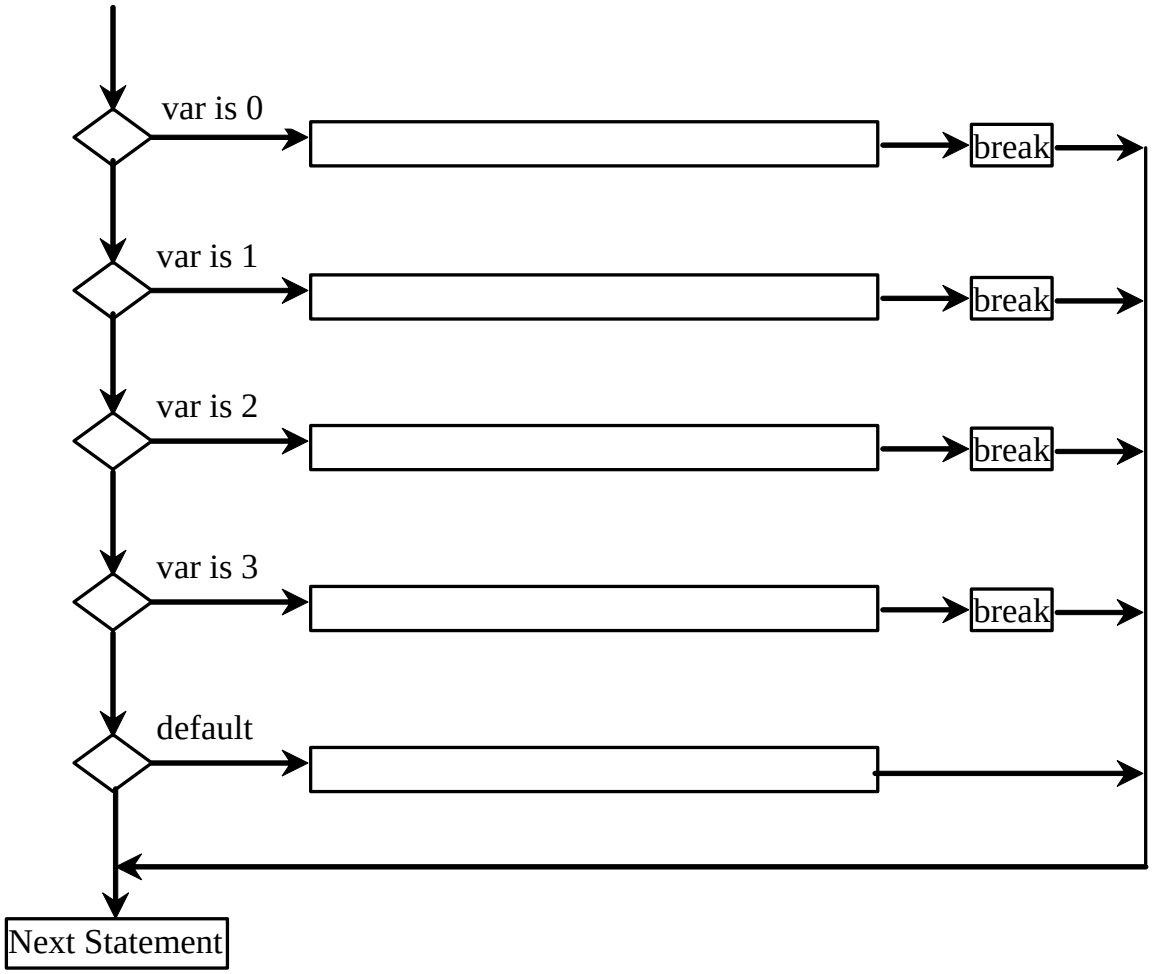
```
switch (var) {
   case 0:          ...;
                    break;
   case 1:          ...;
                    break;
   case 2:          ...;
                    break;
   case 3:          ...;
                    break;
   default:         ...;
}
```

# switch Statements

```
Good for menus:
  Enter an option:
  A = burger
  B = fries
  C = exit

switch(option){
case 'A': System.out.println("burger");
          break;
case 'B': System.out.println("fries");
          break;
case 'C': System.out.println("exit");
          break;
}
```

# `switch` Statement Flow Chart



# switch Statement Rules

**char, byte, short, int, String**

```
switch (switch-expression) {
  case value1:      statement(s)1;
                    break;
  case value2:      statement(s)2;
                    break;
  …
  case valueN:      statement(s)N;
                    break;
  default:          statement(s);
}
```

value1, ..., and valueN are **constant expressions** of the **same data type** as the value of the switch-expression

- constant = they cannot contain variables in the expression, such as x+y

# switch Statement Rules

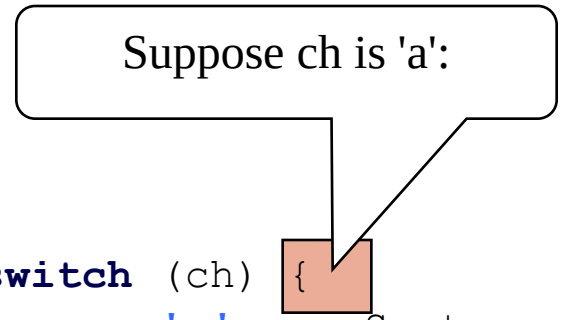
break is optional, but it terminates the remainder of the switch statement

default is optional - executed when none of the specified cases matches the switch-expression.

```
switch (switch-expression) {
  case value1:      statement(s)1;
                    break;
  case value2:      statement(s)2;
                    break;
  ...
  case valueN:      statement(s)N;
                    break;
  default:          statement(s);
}
```

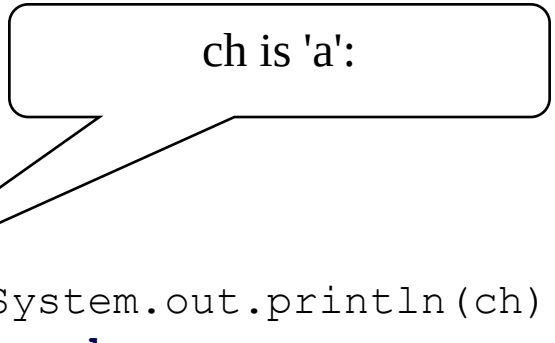
execution in sequential order

# Trace switch statement 1



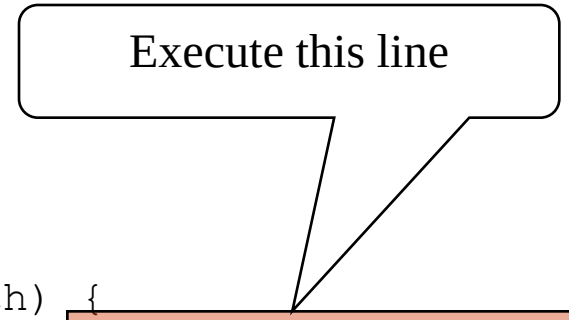

```
switch (ch) {
  case 'a':    System.out.println(ch);
               break;
  case 'b':    System.out.println(ch);
               break;
  case 'c':    System.out.println(ch);
}
```

# Trace switch statement 1




```
switch (ch) {
  case 'a':     System.out.println(ch);
                break;
  case 'b':     System.out.println(ch);
                break;
  case 'c':     System.out.println(ch);
}
```

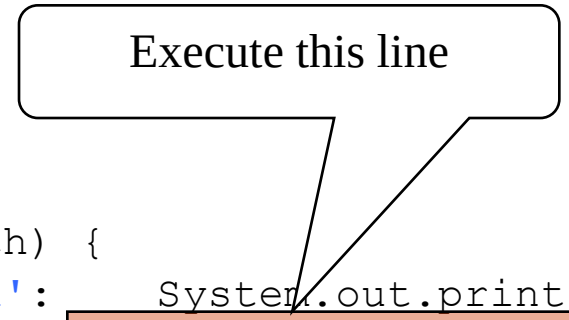
# Trace switch statement 1




```
switch (ch) {
  case 'a':    System.out.println(ch);
               break;
  case 'b':    System.out.println(ch);
               break;
  case 'c':    System.out.println(ch);
}
```

a

# Trace switch statement 1




```
switch (ch) {
  case 'a':    System.out.println(ch);
               break;
  case 'b':    System.out.println(ch);
               break;
  case 'c':    System.out.println(ch);
}
```

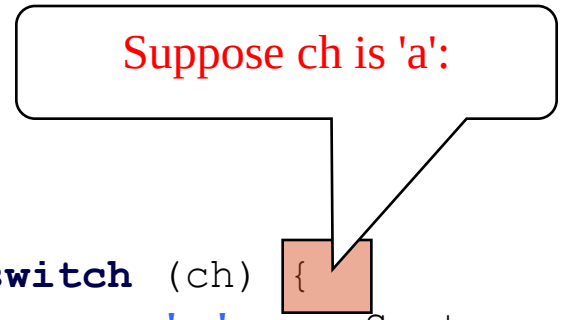
a

# Trace switch statement 1

```
switch (ch) {
  case 'a':    System.out.println(ch);
               break;
  case 'b':    System.out.println(ch);
               break;
  case 'c':    System.out.println(ch);
}
```

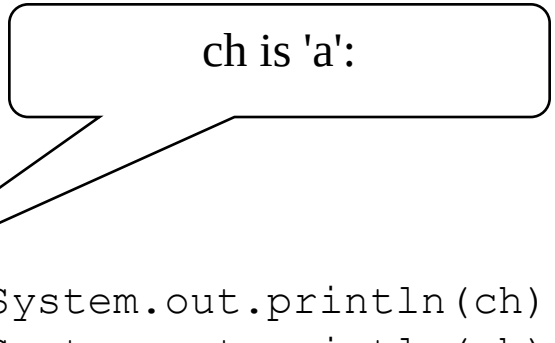
a

# Trace switch statement 2



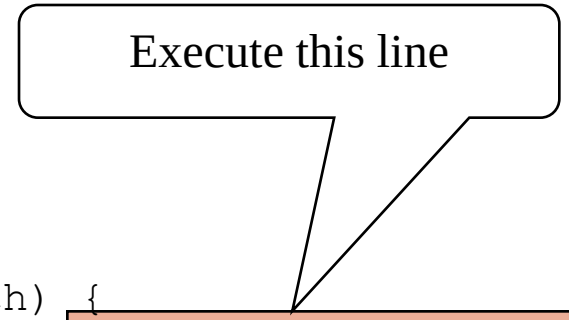

```
switch (ch) {
  case 'a':     System.out.println(ch);
  case 'b':     System.out.println(ch);
  case 'c':     System.out.println(ch);
}
```

# Trace switch statement 2




```
switch (ch) {
  case 'a':     System.out.println(ch);
  case 'b':     System.out.println(ch);
  case 'c':     System.out.println(ch);
}
```

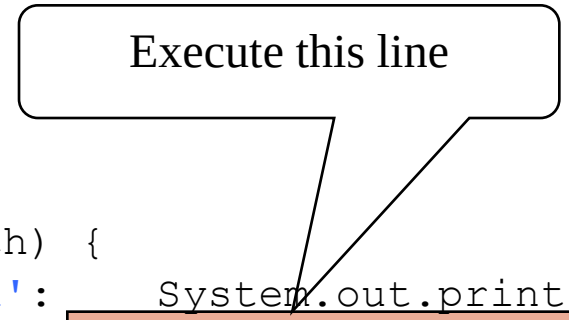
# Trace switch statement 2




```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

a

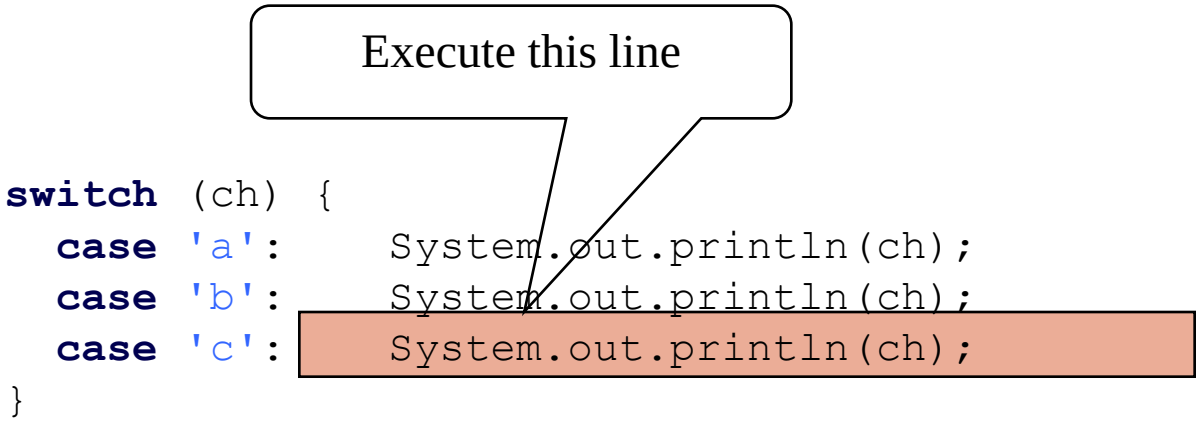
# Trace switch statement 2




```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

aa

# Trace switch statement 2



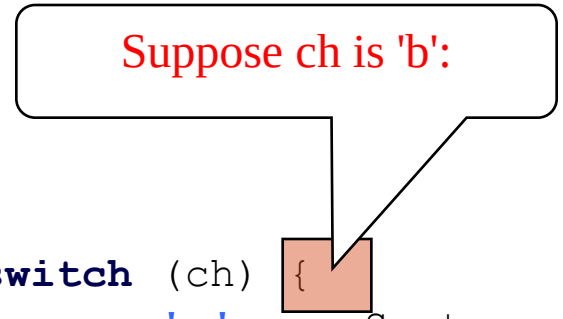

aaa

# Trace switch statement 2

```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

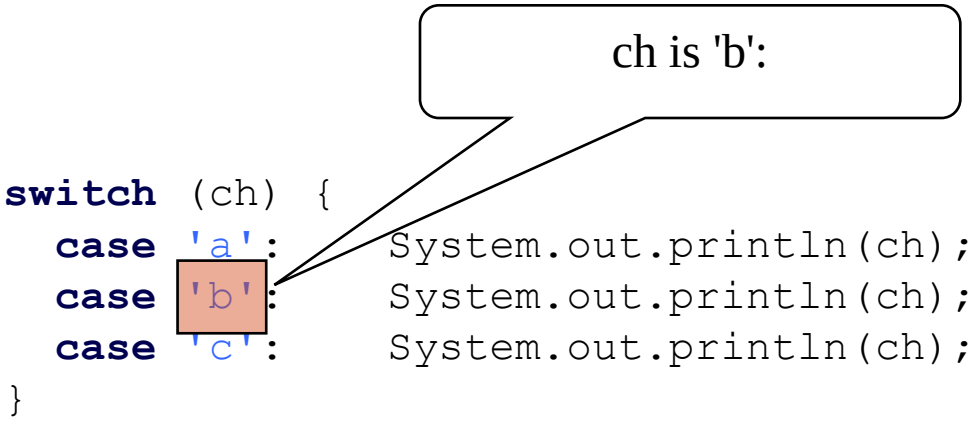
aaa

# Trace switch statement 3

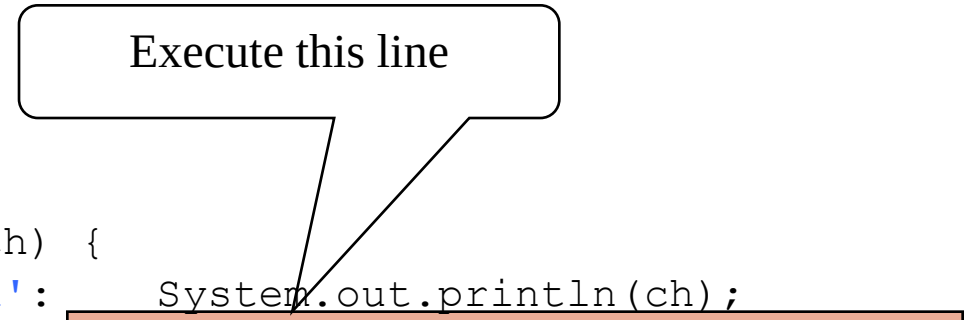



```
switch (ch) {
  case 'a':     System.out.println(ch);
  case 'b':     System.out.println(ch);
  case 'c':     System.out.println(ch);
}
```

# Trace switch statement 3



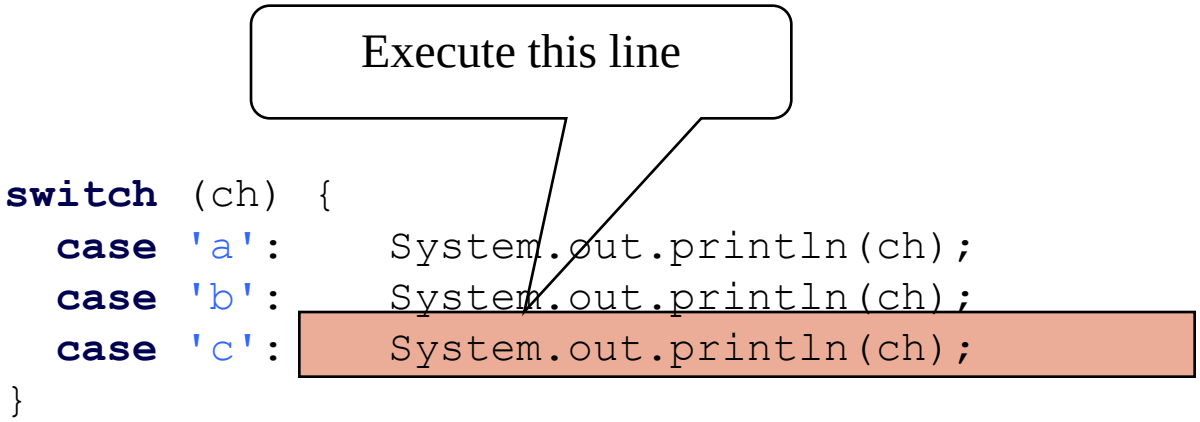
# Trace switch statement 3




```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

b

# Trace switch statement 3



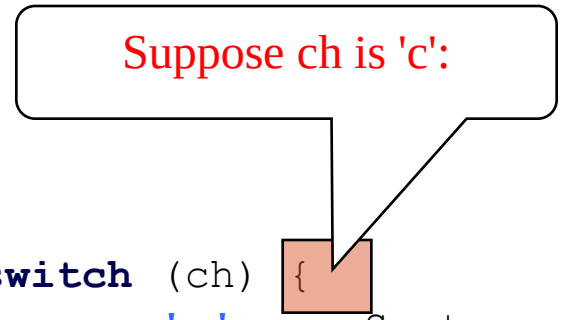

bb

# Trace switch statement 3

```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

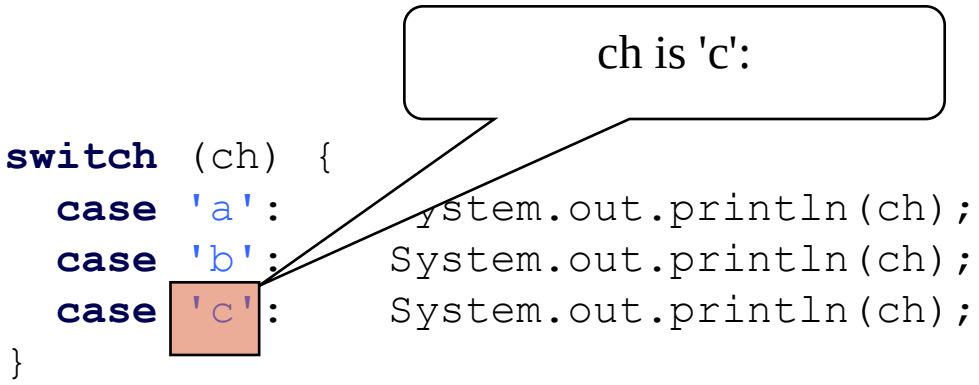
bb

# Trace switch statement 4

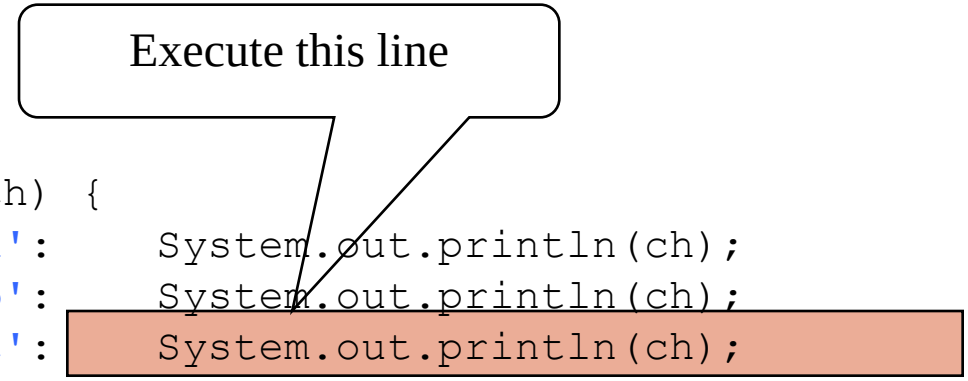



```
switch (ch) {
  case 'a':     System.out.println(ch);
  case 'b':     System.out.println(ch);
  case 'c':     System.out.println(ch);
}
```

# Trace switch statement 4



# Trace switch statement 4




```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

c

# Trace switch statement 4

```
switch (ch) {
  case 'a':    System.out.println(ch);
  case 'b':    System.out.println(ch);
  case 'c':    System.out.println(ch);
}
```

c

# Conditional Operator

```
if (x > 0)
   y = 1;
else
   y = -1;
```

is equivalent to

```
y = (x > 0) ? 1 : -1;
```

- Conditional Operator expression form:
  **(boolean-expression) ? expression1 : expression2**

# Conditional Operator

```
System.out.println(
(num % 2 == 0)? num + " is even" :num + " is odd");
```

```
System.out.println( num +
 ((num % 2 == 0)? " is even" : " is odd"));
```

# Operator Precedence

1. var++, var--
2. +, - (Unary plus and minus), ++var,--var
3. (type) Casting
4. ! (Not)
5. *, /, % (Multiplication, division, and remainder)
6. +, - (Binary addition and subtraction)
7. <, <=, >, >= (Comparison)
8. ==, !=; (Equality)
9. ^ (Exclusive OR)
10. && (Conditional AND) Short-circuit AND
11. || (Conditional OR) Short-circuit OR
12. =, +=, -=, *=, /=, %= (Assignment operator)

# Example

Applying the operator precedence, associativity rules and left-to-right execution, the expression 3 + 4 * 4 > 5 * (4 + 3) - 1 is evaluated as follows:

```
3 + 4 * 4 > 5 * (4 + 3) - 1

3 + 16 > 5 * (4 + 3) - 1

19 > 5 * (4 + 3) - 1

19 > 5 * 7 - 1

19 > 35 - 1

19 > 34

false
```

# Operator Associativity

All binary operators except assignment operators are ***left-associative***.

Example:

10 - 5 - 4 = (10 - 5) - 4 = 5 - 4 = 1

The assignment operators are ***right-associative***.

Example:

a = b += c = 5;

is equivalent to a = (b += (c = 5));

# ChangeMaker Example Revisited

```
System.out.print("Input change amount (1-99):");
originalAmount= scanner.readInt();
if (originalAmount< 1 || originalAmount> 99)
  System.out.println("ERROR: Out of range.");
else{
  numQuarters= originalAmount/ 25;
  remainder = originalAmount% 25;
  numDimes= remainder / 10;
  remainder = remainder % 10;
  numNickels= remainder / 5;
  numPennies= remainder % 5;
  if (numQuarters!= 0) // Do not print if zero
       System.out.println(numQuarters+ " quarters");
  if (numDimes!= 0)// Do not print if zero
       System.out.println(numDimes+ " dimes");
  if (numNickels!= 0)// Do not print if zero
       System.out.println(numNickels+ " nickels");
  if (numPennies!= 0)// Do not print if zero
       System.out.println(numPennies+ " pennies");
}
```

# ChangeMaker Example Revisited

- Nested ifs:

```
if (numQuarters!= 0){ // Do not print if zero
  System.out.print(numQuarters+ " quarter");
  if (numQuarters== 1) // Do not print s if one
       System.out.println( );
  else
       System.out.println("s"); // print s if more
}
```