# Operator Precedence and Associativity

Hui Chen

Department of Computer & Information Science

Brooklyn College

#### Objectives

■ To examine the rules governing operator precedence and associativity (§3.15)

#### Outline

- Discussed
  - Boolean data type and Boolean expressions
  - If-statements (one-way, two-way, multi-way, and nested if-statements) and their flow charts
  - Common errors and pitfalls
  - 3 ("big") programming problems (subtraction quiz, compute BMI, compute taxes)
  - Logical operators and two more ("big") programming problems (LeapYear, Lottery)
  - Switch statement
  - Conditional operators
- Operator precedence and associativity rules

#### **Operator Precedence**

- var++, var--
- +, (Unary plus and minus), ++var,--var
- (type) Casting
- ! (Not)
- \*, /, % (Multiplication, division, and remainder)
- +, (Binary addition and subtraction)
- <, <=, >, >= (Relational operators)
- ==, !=; (Equality)
- ^ (Exclusive OR)
- && (Conditional AND) Short-circuit AND
- || (Conditional OR) Short-circuit OR
- =, +=, -=, \*=, /=, %= (Assignment operator)

## Operator Precedence and Associativity

- The expression in the parentheses is evaluated first.
  - Parentheses can be nested, in which case the expression in the inner parentheses is executed first.
- When evaluating an expression without parentheses, the operators are applied according to the precedence rule and the associativity rule.
- If operators with the same precedence are next to each other, their associativity determines the order of evaluation.

#### **Operator Associativity**

- When two operators with the same precedence are evaluated, the associativity of the operators determines the order of evaluation.
- All binary operators except assignment operators are left-associative.

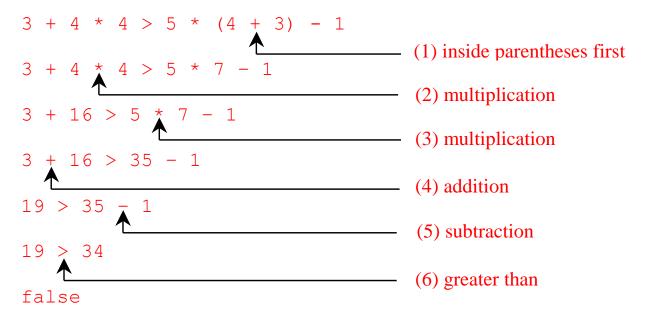
$$a - b + c - d$$
 is equivalent to  $((a - b) + c) - d$ 

Assignment operators are right-associative.

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

### Example

 Applying the operator precedence and associativity rule, the expression 3 + 4 \* 4 > 5 \* (4 + 3) - 1 is evaluated as follows:



#### **Operator Evaluation Order**

 Supplement III.A in the textbook, "Advanced discussions on how an expression is evaluated in the JVM."

### Debugging

- Bugs
  - Logic errors are called bugs.
- Debugging
  - The process of finding and correcting errors is called debugging.
- Debugging approaches
  - A common approach to debugging is to use a combination of methods to narrow down to the part of the program where the bug is located.
  - You can hand-trace the program (i.e., catch errors by reading the program), or
  - you can insert print statements in order to show the values of the variables or the execution flow of the program.
  - Note that This approach might work for a short, simple program (like the programs we are writing now). But for a large, complex program, the most effective approach for debugging is to use a debugger utility.

### Questions?