

Operator Precedence and Associativity

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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

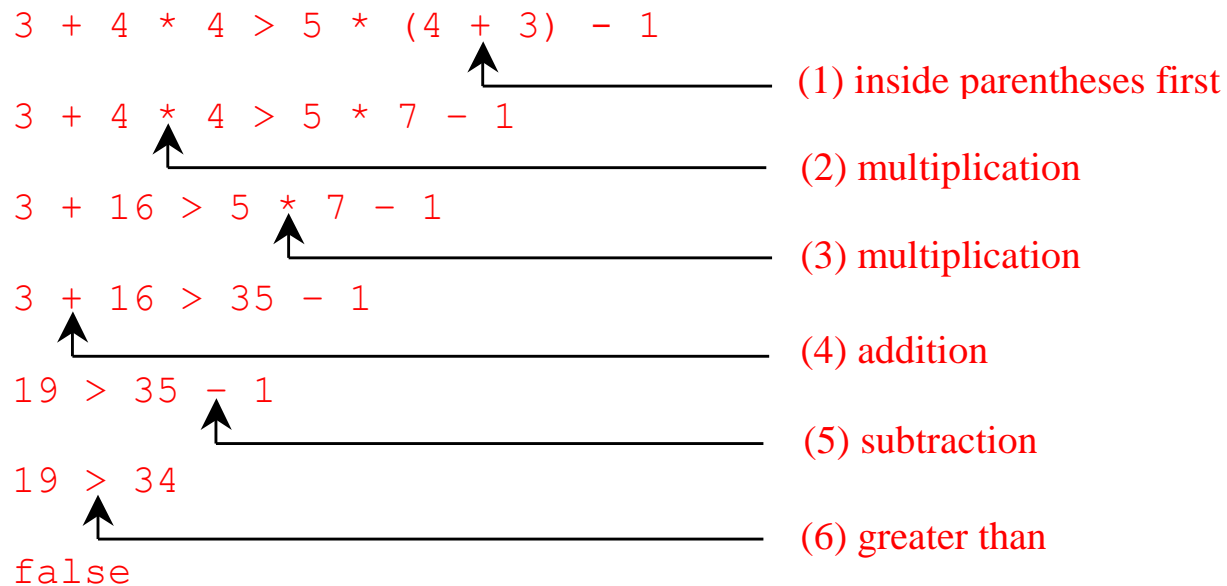
- The expression in the parentheses is evaluated first.
 - Parentheses can be nested, in which case the expression in the inner parentheses is executed first.
- When evaluating an expression without parentheses, the operators are applied according to the precedence rule and the associativity rule.
- 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?