

Lecture Set 4: Evaluation Order

Today:

- More assignment operators
- Precedence and short-circuiting



CMSC 131 Spring 2007
Jan Plante (adapted from Bonnie Dorri)

Expressions

- Java “phrases” that yield values

e.g.

`x`

`x + 1 - y`

`x == y && z == 0`

`foo.equals (“cat”)`

- Expressions have values (int, boolean, etc.)
- Expressions can be assigned to variables, appear inside other expressions, etc.

CMSC 131 Spring 2007
Jan Plante (adapted from Bonnie Dorri)

1



Expressions and Side Effects

- Some expressions can also alter the values of variables

e.g. `x=1`

- `x=1` is an expression?

- Yes!
- Value is result of evaluation right-hand side of `=`
- It also alters the value of `x`

- Such alterations are called **side effects**

CMSC 131 Spring 2007
Jan Plante (adapted from Bonnie Dorri)

2



Are the Following Legal?

- `int x, y;`
`x = y = 1;`

Yes. Result assigns 1 to `x` and to `y`

- `int x = 0, y = 1;`
`boolean b = false;`
`if (b = (x <= y)) {`
 `x = y;`
`}`

Yes. Result assigns `true` to `b` and 1 to `x`

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

3

Other Expressions with Side Effects

- Java includes abbreviations for common forms of assignment
- Example: **increment** operations (Basically equivalent to `x = x + 1`)
`++x` "Pre-increment"

Increments `x`, returns the new value of `x`

`x++` "Post-increment"

Increments `x`, returns the old value of `x`

- Same or Different

- `x == x++` always true
- `x == ++x` never true

- Compare

- `x++ * y++`
- `++x * ++y`
- `++x * y++`
- `x++ * ++y`

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

4

Other Assignment Operators

- Example: **decrement** operations (Basically equivalent to `x = x - 1`)
`--x` "Pre-decrement"

Decrements `x`, returns the new value of `x`

`x--` "Post-decrement"

Decrements `x`, returns the old value of `x`

- General modification by constant

- General form: `<var> <op with=> <constant>`

- Examples

<code>x += 2</code>	equivalent to	<code>x = x + 2</code>
<code>x -= 2</code>	equivalent to	<code>x = x - 2</code>
<code>x *= 2</code>	equivalent to	<code>x = x * 2</code>
<code>x /= 2</code>	equivalent to	<code>x = x / 2</code>

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

5

Precedence



- Explains how to evaluate expressions
 - What is value of $1 - 2 + 3 * 4$?
 - Precedence rules** answer this question
 - Higher-precedence operators evaluated first
 - Example from math: "Please, Excuse my Dear Aunt Sally" or PEMDAS
 - Multiple and divide (higher precedence) before you add and subtract (lower precedence)
- Java follows "Aunt Sally's Rules" ... but what about other operators?

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

6

Java Precedence Rules



- parentheses: ()
 - unary ops: $+x$ $-x$ $++x$ $--x$ $x++$ $x--$ $!x$
 - multiply/divide: $*$ $/$ $\%$
 - add/subtract: $+$ $-$
 - comparisons: $<$ $>$ $<=$ $>=$
 - equality: $==$ $!=$
 - logical and: $\&\&$
 - logical or: $||$
 - assignments: $=$ $+=$ $*=$ $/=$ $\%=$ (only these are right to left associative)
- increasing precedence

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

7

Examples



- $x * y + -z$
Equivalent to $(x * y) + (-z)$
- $(x <= y \ \&\& \ y <= z \ || \ w > z)$
Equivalent to $((x <= y) \ \&\& \ (y <= z)) \ || \ (w > z)$
- What is value of $1 - 2 + 3 * 4$?
 $1 - 2 + 3 * 4$
 $= (1 - 2) + (3 * 4)$
 $= (1 - 2) + 12$
 $= -1 + 12$
 $= 11$

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

8

Should You Rely on Precedence?



- No!
- The only ones people can remember are
 - "Please Excuse My Dear Aunt Sally"
 - PEMDAS
- Bad
`if (2 * x++ < 5 * z + 3 && -w != x / 2)`
- Better
`if (2 * (x++) < ((5 * z) + 3)) && ((-w) != (x / 2))`

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

9

Short-circuiting



- As soon as Java knows an answer – it quits evaluating the expression.
- What does Java print?
`int x = 0, y = 1;`
`if ((y > 1) && (++x == 0)) {`
 `--y;`
`}`
`System.out.println (x);`
- 0
- Why?
 - `y > 1` is false
 - The result of `&&` will be false, regardless of second expression
 - Java therefore does not evaluate second expression of `&&`
- This treatment of `&&`, `||` is called **short-circuiting**
 - Subexpressions evaluated from left to right
 - Evaluation stops when value of over-all expression is determined

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

10

Examples



- What does Java print?
`int x = 0, y = 1;`
`if ((y >= 1) && (++x == 0)) {`
 `--y;`
`}`
`System.out.println (x);`
- 1
- What does Java print?
`int x = 0, y = 1;`
`if ( ((y > 1) && (++x == 0))`
 `||`
 `((y == 1) && (x++ == 0)) ) {`
 `--y;`
`}`
`System.out.println (y);`
`System.out.println (x);`
- 0
- 1

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

11

Examples (cont.)



- What does Java print?

```
int x = 0, y = 0;
while (x++ <= 4)
    y += x;
System.out.println (y);
```

- 15

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

12

Programming with Side-Effects



Generally:

- Side effects in conditions are hard to understand
- Good programming practice
 - Conditions should be side-effect-free
 - Side effects should be in "stand-alone statements"
- Major Goal: Strive to create the most readable and maintainable code.

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

13

Primitive Types and their Hierarchy



- double
- float
- long
- int
- short
- byte

```
int x = 7.2;
double y = 6;
```

- Changing to something else Further Up this list is acceptable
 - called "Widening Conversion"
- Changing to Something else Further Down this list is not acceptable
 - called "Narrowing Conversion"
- Explicit casting needed for when you want a downcast

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorri)

14

Type Casting



Which of the following are legal?

- `int x = 3.5;`
Illegal: 3.5 is not an int
- `float x = 3;`
Legal: 3 is an int, which is also a float
- `long i = 3;`
Legal: 3 is an int, which is also a long
- `byte x = 155;`
Illegal: 155 is too big to be a byte (> 127)
- `double d = 3.14159F;`
Legal: 3.14159F is a float, which is also a double

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

15

Mixed Expressions



- What is result of
`float x = 3 / 4;`
 - x assigned value 0.0F
 - Why?
 - 3, 4 are ints
 - So integer / operation is used, yielding 0, before upcasting is performed
- To get floating point result, use explicit casting
`float x = (float) 3 / (float) 4;`
 - Assigns x the value 0.75F
- Can also do following
`float x = (float) 3 / 4;`
 - Why?
 - `(float) 3` returns a value type float (3.0F)
 - 4 is an int
 - In this case, Java compiler uses widening conversion on "lower" type (here, int) to obtain values in same type before computing operation

CMSC 131 Spring 2007
Jan Plane (adapted from Bonnie Dorr)

16
