Decisions in Java -Boolean Values & Expressions

Boolean Values & Variables

In order to make decisions, Java uses the concept of true and false, which are *boolean values*. Just as is the case with other primitive data types, we can create boolean variables to hold these values.

boolean readyToProgram = true;

Boolean Expressions

A boolean expression is similar to a mathematical expression, except that the result is true or false, rather than a numeric value. To create a boolean expression, we use the relational operators to compare the values of various data types, such as integers, floats, characters, or strings, using a relational expression.

Relational Operator	Meaning	Example	Result
==	is equal to	5 == 5	TRUE
!=	is not equal to	5 != 5	FALSE
<	is less than	3 < 7	TRUE
<=	is less than or equal to	4 <= 4	TRUE
>	is greater than	3 > 7	FALSE
>=	is greater than or equal to	7 >= 3	TRUE

The following rules apply to the use of relational operators with different data types:

- 1. Values of any of the primitive numeric data types (e.g., int, float, and all their variations) can be used with any of the relational operators.
- 2. Boolean values can only be tested as "equal to" or "not equal to".
- 3. Values of type char are ordered according to the Unicode encoding system. A character the occurs earlier in the system is "less than" a character that occurs later in the system. You can research full details of the Unicode system online.
 - a) For alphabetic characters, this means that 'a' is less than 'z', and 'A' is less than 'Z', as expected.
 - b) In the Unicode system, all uppercase letters occur earlier than all lowercase letters. Thus we get the relational ordering of:

```
'A' < 'B' < 'C' < ... < 'Z' < 'a' < 'b' < 'c' < ... <'z'
```

c) Representing numbers as characters, such as when you type on a keyboard, keeps the same ordering, so that '0' < '1' < '2' < ... < '9'.

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The following program demonstrates the creation and output of boolean variables.

```
class BooleanOutput
{
    public static void main (String [] args)
    {
        boolean x = false;
        boolean y = true;
        System.out.println("x: " + x + " y: " + y);
    }
}
```

Boolean Operators

It is possible to combine two or more *boolean values, variables, or expressions* into a more complicated boolean expression using the *boolean operators*. Unlike the *relational operators*, the boolean operators can only work on boolean values. You can use a relational operator to compare any data type, which forms a boolean expression. Multiple boolean expressions can be combined using boolean operators.

The boolean operators are summarized in the following table.

boolean value		not p	p AND q	p OR q	
p	q	!p	p && q	p II q	
TRUE	TRUE	FALSE	TRUE	TRUE	
TRUE	FALSE	FALSE	FALSE	TRUE	
FALSE	TRUE	TRUE	FALSE	TRUE	
FALSE	FALSE	TRUE	FALSE	FALSE	

- 1. !p (not p) has the true/false value opposite to p.
- 2. p & & q (p AND q) is true if and only if both p and q are both true.
- 3. $p \mid | q$ (p OR q) is true if p is true, q is true, or both p and q are true.

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Exercises

1. For each of the legal boolean expressions, state its value. For each illegal expression, state the reason that it is illegal.

(a)
$$(2 + (-5)) != 3$$

(b)
$$'Q' == 'q'$$

(c)
$$'m' < = 'p'$$

$$(f)$$
 $(7/3) = 2$

$$(g)$$
 false $== 0$

(h)
$$(25 \% 4) >= 1$$

2. State, with reasons, what this program will print (figure out your answer **before** trying to run the program!)

```
class BooleanVariables
{
    public static void main (String [] args)
    {
        boolean perhaps, maybe;
        perhaps = 4 < 5;
        maybe = -17 % 4 == 1;
        System.out.println("perhaps: " + perhaps);
        System.out.println("maybe: " + maybe);
    }
}</pre>
```

3. For each expression, state whether it is true or false.

(d) '5' < 'v'

4. Determine the value of each expression.

(b)
$$F' > B' + 3$$

(c)
$$-6\%3 < 0$$

(d) (int)
$$1.1 * 0.9 \le 0$$

(e)
$$(2 + 3 < 6) == true$$

(f)
$$(2 * 3) < 5 != true$$

5. Evaluate each expression, assuming the following declarations have been made.

(a) !p

(b) p || q

(c) p && r

(d) !(q && s)

(e) !q && s

- (f) s & & !q
- (g) p || !s
- (h) !p && !q
- (i) s || (!q && r)
- (j) p == (q || r)

Character Set with its Integer Equivalent

33	Char	Decimal	Notes	Char	Decimal	Notes	Char	Decimal	Notes
SACLAMATION Q 81 Upper case R	!	33	=	P	80	upper case P	~	126	tilde
# 35 Sharp,				Q	81	upper case Q			
# 35 number sign	"	34	-	R	82	upper case R			
\$ 36 dollar sign	#	35	* ·		83	upper case S			
37	\$	36	_			upper case T			
## 38 ampersand 39 apostrophe X 88 upper case N 40			_						
39	&	38	ampersand						
1	•	39	apostrophe						
right	,	40	left						
1	(40	parenthesis						
)	41	-	Z	90				
# 42 saterisk			-]	91	=			
# 43 plus , 44 comma	*	42		,	0.0				
1	+	43	plus	\	92	not slash!			
- 45 minus	,	44	comma	1	93				
	-	45	minus	_					
A		46	period	^	94	-			
Second S	/	47			95				
1				_		grave,			
2 50 digit 2 a 97 lower case a 3 51 digit 3 b 98 lower case b 4 52 digit 4 c 99 lower case c 5 53 digit 5 d 100 lower case c 6 54 digit 6 e 101 lower case f 6 54 digit 7 f 102 lower case f 8 56 digit 8 g 103 lower case g 9 57 digit 9 h 104 lower case h : 58 colon i 105 lower case i ; 59 semicolon j 106 lower case j < 60 less than k 107 lower case k = 61 equals l 108 lower case h > 62 greater than m 109 lower case m question n 110 lower case n mark o 111 lower case n question n 110 lower case p upper case A q 113 lower case p upper case B r 114 lower case p d upper case B r 114 lower case r C 67 upper case B r 114 lower case r G 10 upper case B r 114 lower case r G 11 lower case u Upper case B r 114 lower case u Upper case B r 114 lower case u Upper case B r 115 lower case u Upper case B r 116 lower case u Upper case B r 117 lower case u Upper case B r 118 lower case u Upper case B r 119 lower case u Upper case B r 116 lower case u Upper case B r 117 lower case u Upper case B r 118 lower case v Upper case B r 119 lower case w Upper case B r 110 lower case w Upper case G r 119 lower case x Upper case G r 120 lower case x Upper case M r 120 lower case x			=	`	96	=			
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