Booleans

Remix CS 2019-20

Basic Logical Operators

a == b	Checks if **a** and **b** equal to each other
a < b	Checks if **a** is less than **b**
a > b	Checks if **a** is greater than **b**
a ≤ b	Checks if **a** less than or equal to **b**
a ≥ b	Checks if **a** is greater than or equal **b**

What is a Boolean?

In computer science, a boolean is a data type that can have the value of either TRUE or FALSE.

Examples of Booleans

1. $2 < 5$ TRUE
2. $8 == (4 \cdot 2)$ TRUE
3. $4 > 7$ FALSE
4. $3 == 6$ FALSE

Compound Boolean Expressions

Booleans can be combined using logical operators to make compound boolean expressions.

Logical *and* Operator

The *and* operator combines 2 boolean expressions. The result is equal to TRUE if both are TRUE and is equal to FALSE otherwise.

Examples:

$2 < 4$ and $3 == 3$

TRUE TRUE

So the whole expression is TRUE

$4 == 5$ and $8 \geq 7$

FALSE TRUE

So the whole expression is FALSE

More Examples

1. $1 == 2$ and $4^2 > 17$
2. $(1 == 1$ and $2 \geq 3/2)$ and $2 < 7 - 2$
3. $6 < 9$ and $(2 \leq 2$ and $25^{1/2} > 11)$
4. (True and True) and (False and True)

Logical *or* Operator

The *or* operator combines 2 booleans and is equal to TRUE if at least 1 of the booleans is TRUE, and is equal to FALSE otherwise.

Examples:

2 < 4 or 3 == 3

TRUE TRUE

So the whole expression is TRUE

4 == 5 or 8 ≥ 7

FALSE TRUE

So the whole expression is TRUE

More Examples

1. $-3 == 2$ or $2^3 > 8$
2. (True or False) or False
3. $(1 == 1$ or $2 \geq 13)$ and $3 + 4 \leq 14/2$
4. $6 < -4$ or $(2 \leq 2$ and $25^{1/2} > 11)$

Logical *not* Operator

The *not* operator makes a boolean into its opposite value.

Examples:

not TRUE is equivalent to FALSE

not (2 > 1) is equivalent to FALSE

not (5 == 9) is equivalent to TRUE

Is this statement True or False

((True and 2 < 1) or 3 == 6 - 3) and (False or not (17 > 31))

Breakdown:

(True and 2 < 1) Evaluates to False

not (17 > 31) Evaluates to True

(3 == 6 - 3) Evaluates to True

Rewrite the statement as: (False or True) and (False or True)

Which is True

Review

A	B	A AND B	A OR B	NOT A
False	False			
False	True			
True	False			
True	True			

What this looks like in python....

Python Syntax

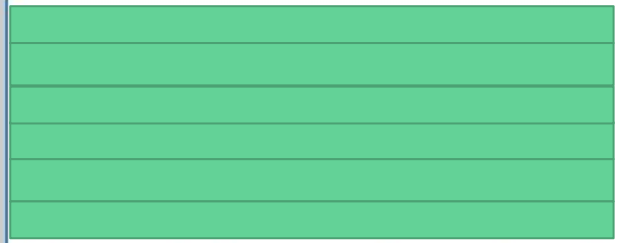
Mathematical	Python
==	==
<	<
>	>
≤	<=
≥	>=
or	or
and	and
not	not

CodeSkulptor Examples

Code

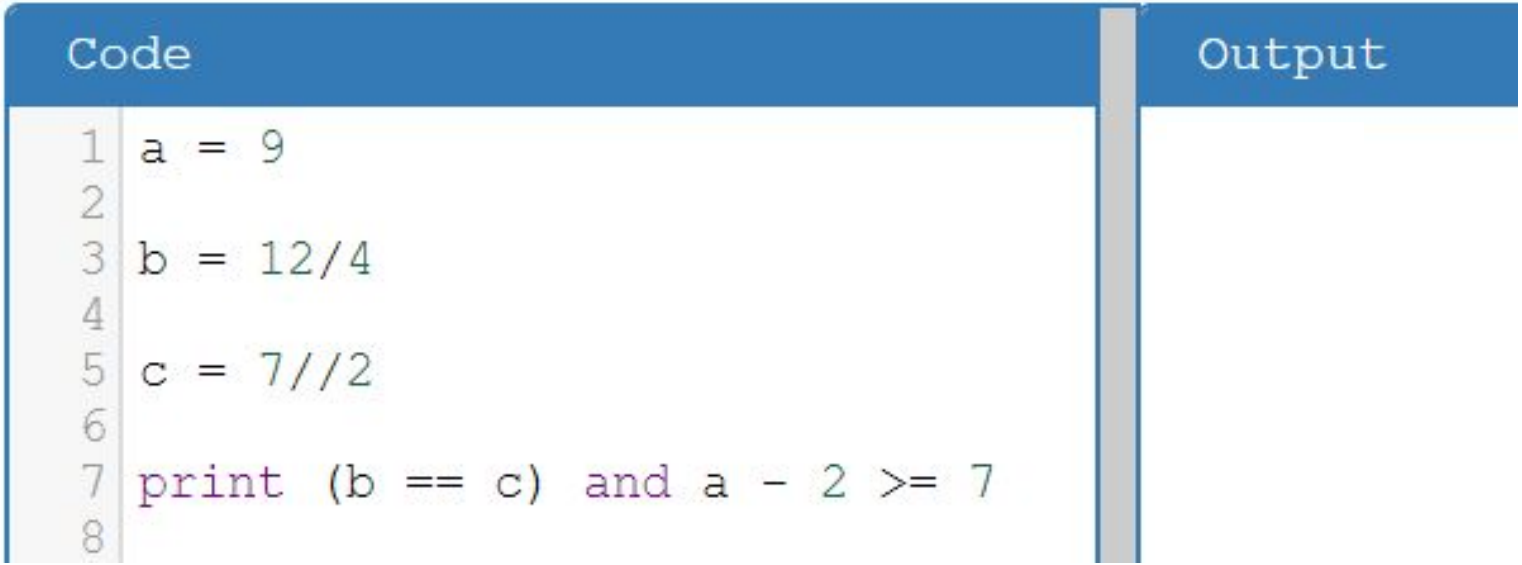
```
1  print "1 <= 8", 1 <= 8
2
3  print "2 == 2", 2 == 2
4
5  print "3 == 4*2", 3 == 4*2
6
7  print "4 > 9", 4 > 9
8
9  print "2 > 0.2 or -4 < -7", 2 > 0.2 or -4 < -7
10
11 print "1 == 7 or (2 < 3 and 9 >= 9)", 1 == 7 or (2 < 3 and 9 >= 9)
```

Output



What will the output of this code be?

(Answer on next slide)



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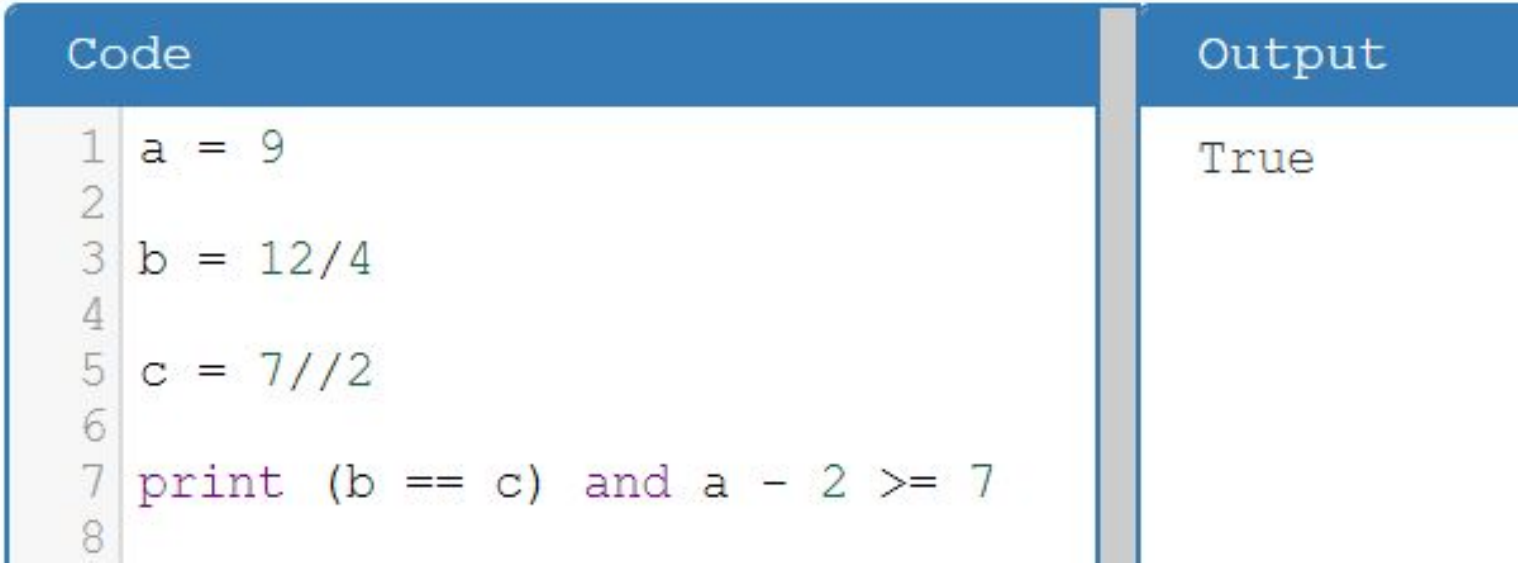

What will the output of this code be?

(Answer on next slide)

Code

```
1  a = 9
2
3  b = 12/4
4
5  c = 7//2
6
7  d = True
8
9  e = not ( a > 19)
10
11 print not e or ((c > 1 and b == 3) and b > c)
12
```

Output

What will the output of this code be?

Code

```
1  a = 9
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3  b = 12/4
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7  d = True
8
9  e = not ( a > 19)
10
11 print not e or ((c > 1 and b == 3) and b > c)
12
```

Output

```
False
```

Boolean Exercises

Kahoot:
https://create.kahoot.it/share/booleans/9064f61c-7def-46ef-ab99-b7b0ae4729c1