APS106

UNIVERSITY OF TORONTO

Booleans, Logic, & Conditional “if” Statements.

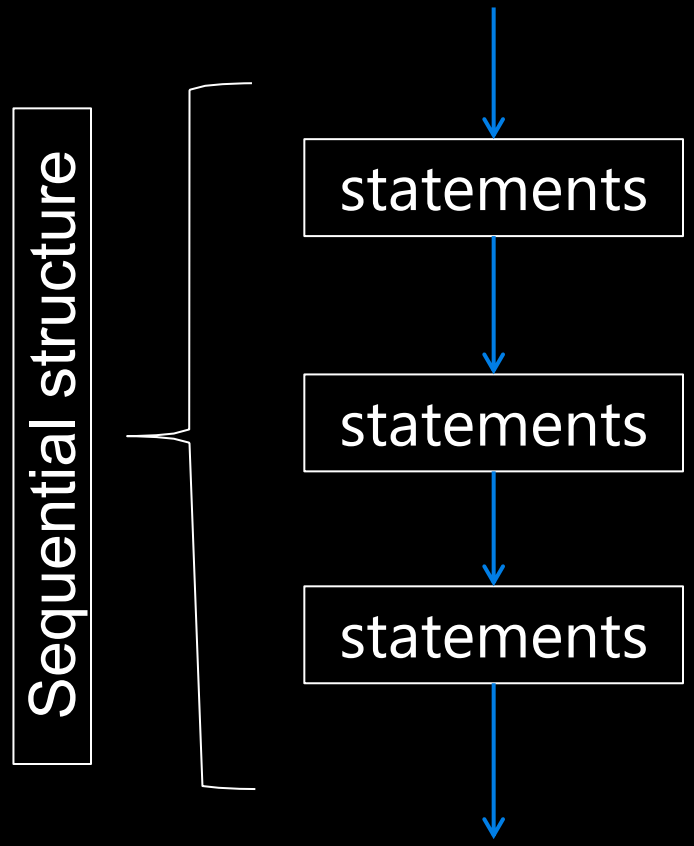
Week 3 | Lecture 1 (3.1)

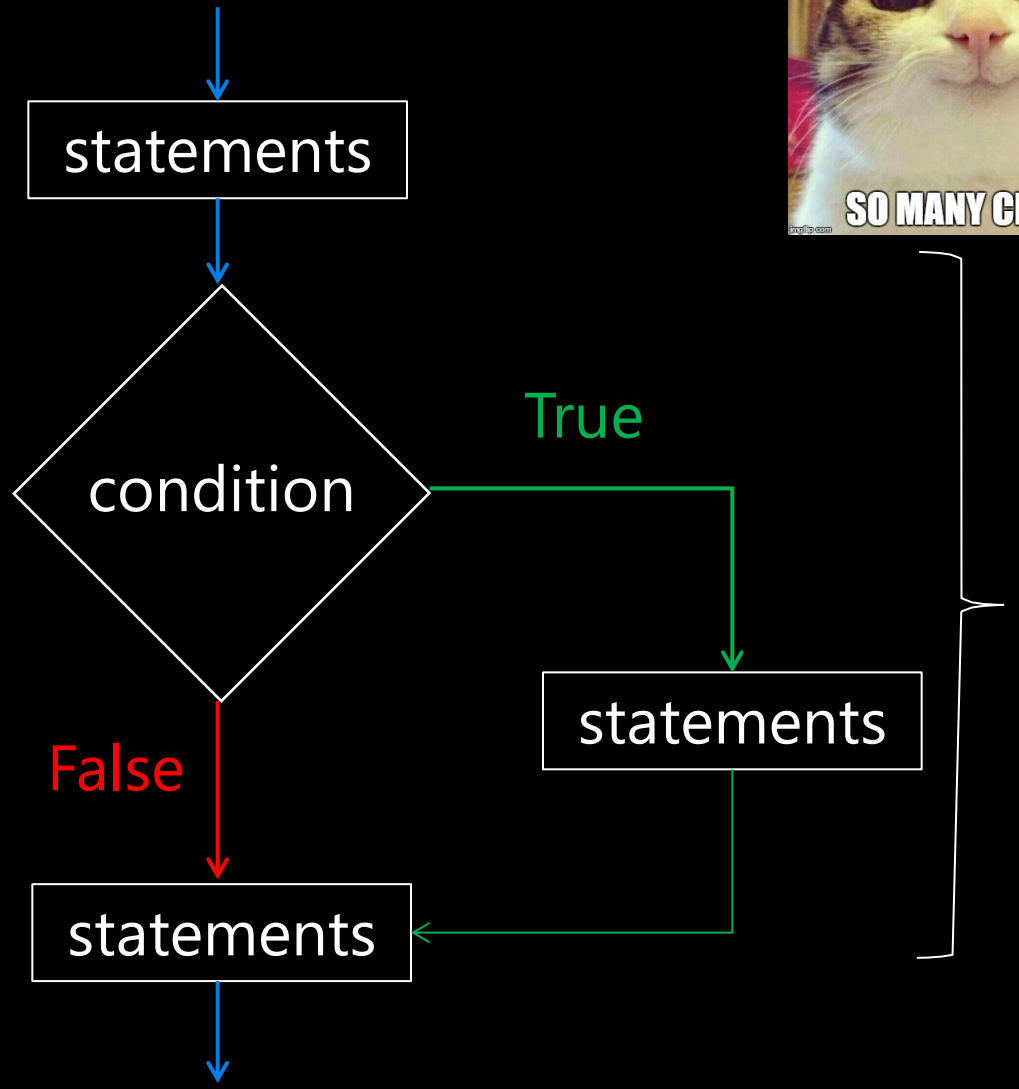
if nothing else, write #cleancode

This Week's Content

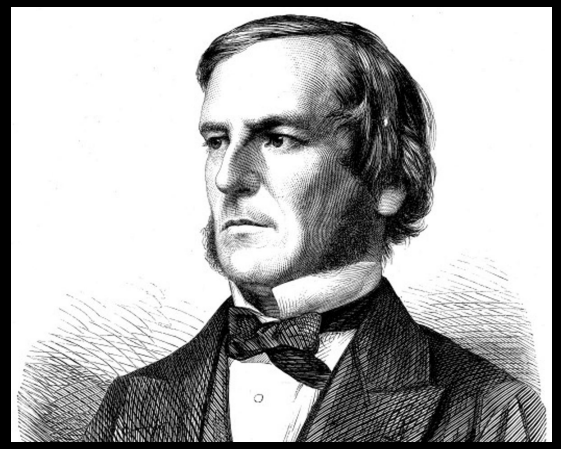
- **Lecture 3.1**
  - **Booleans, Logic, & Conditional if Statements**
- **Lecture 3.2**
  - String Comparisons and More on if Statements
- **Lecture 3.3**
  - Design Problem: Rock, Paper, Scissors, Lizard, Spock!

Making Choices





Boolean Type

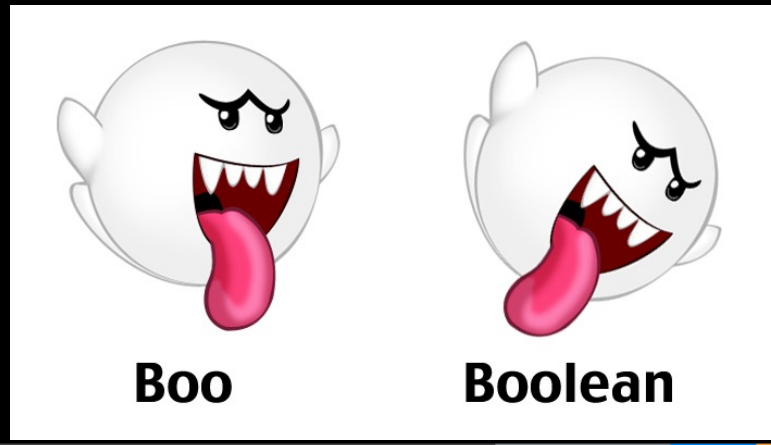


- Named after George Boole (mid-1800s)
  - Boolean algebra and Boolean logic
  - Laid the foundation for information age and computer science
- Python type bool has only two possible values: True and False

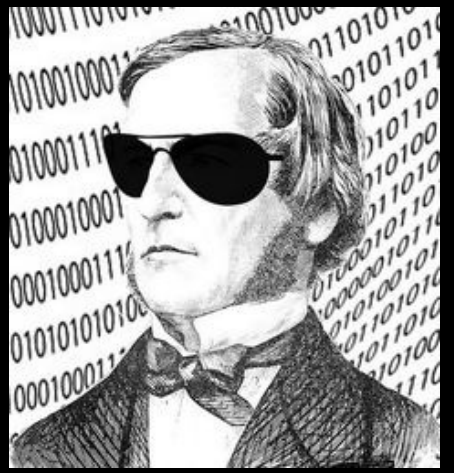
```
>>> state = True
>>> state
True
```

```
>>> state = False
>>> state
False
```

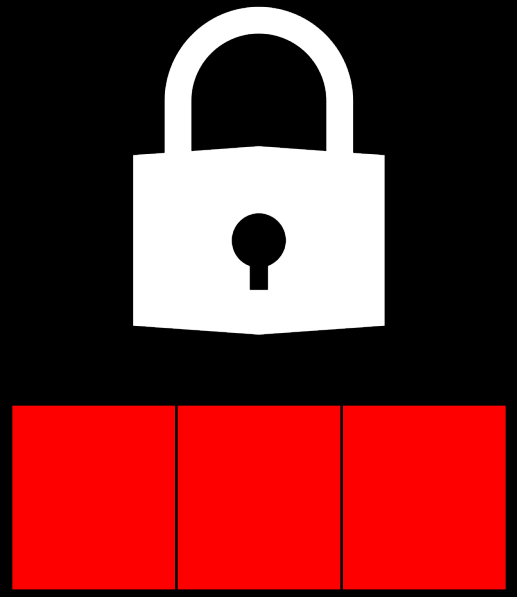
"bool" is a sub-type of "int", where True == 1, False == 0



Boolean Example / "Wordle" Break



Cool Boole

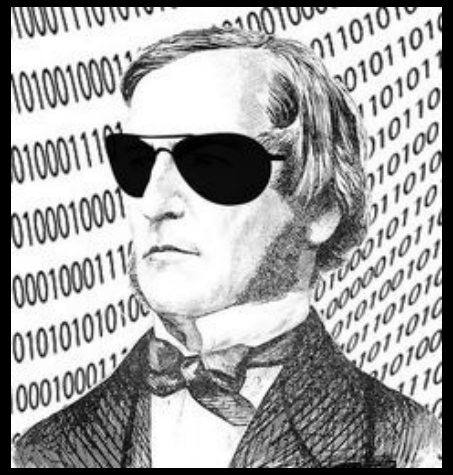


CODE

Crack the code!

6	8	2	One number is correct and well placed
6	1	4	One number is correct but wrong place
2	0	6	Two numbers are correct but wrong places
7	3	8	Nothing is correct
8	7	0	One number is correct but wrong place

Boolean Example / “Wordle” Break



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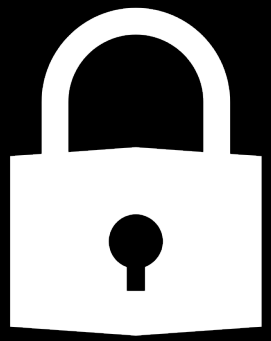

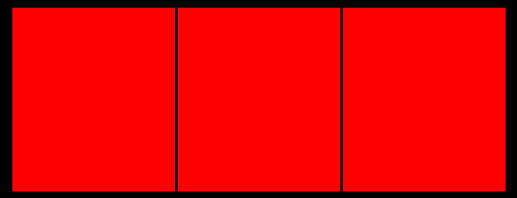

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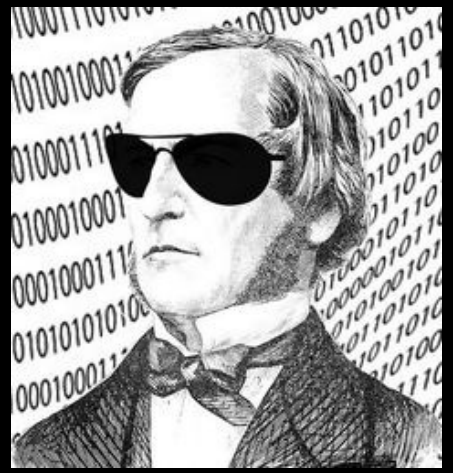

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Relational Operators

- Relational (or comparison) operators take two values (examples: int, float, str) and produce a bool value (True or False)

Description	Operator	Example	Result
Less than	<	3<4	True
Greater than	>	3>4	False
Equal to	==	3==4	False
Less than or equal to	<=	3<=4	True
Greater than or equal to	>=	3>=4	False
Not equal to	!=	3!=4	True

Boolean Expressions

Boolean Values

Python uses == for equality, because = is used for assignment

Using Python as your (bool) Calculator

- Let's take a look at how this works in Python!
  - Boolean type
  - Relational (or comparison) operators

Open your notebook

Click Link:
1. Introducing Booleans

Logical Operators

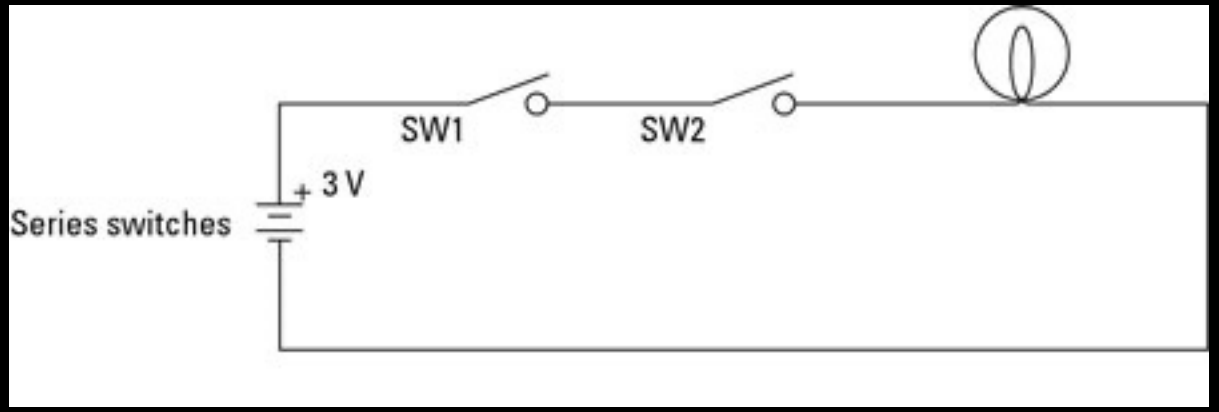
- Take Boolean operands and evaluate to Boolean values

expr1	expr2	expr1 and expr2	expr1 or expr2	not expr1
True	True	True	True	False
True	False	False	True	False
False	True	False	True	True
False	False	False	False	True

The and Operator

- Binary operator
- The expression left and right produces:
  - True if **both** left and right are True
  - False otherwise

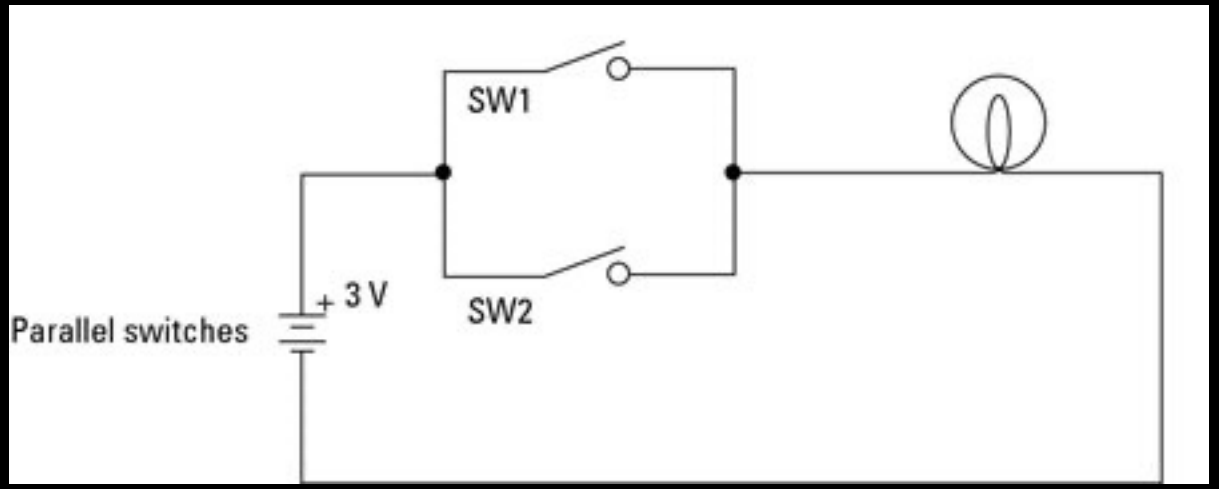
Switch 1 AND Switch 2 must be on for light to turn on



The or Operator

- Binary operator
- The expression left or right produces:
  - True if **either** left or right are True
  - False only if both are False

Switch 1 OR Switch 2 must be on for light to turn on



The not Operator

- not Binary operator (see what I did there?)
- Results in a Boolean value which is the opposite of the operand value
- An expression involving not produces:
  - True if the original value is False
  - False if the original value is True

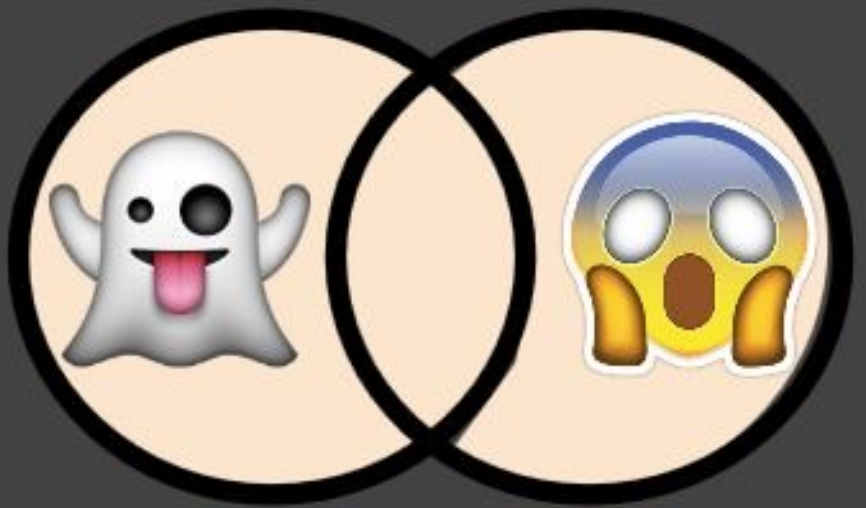
BOO-lean operators

Ghost
NOT
Scream

Scream
NOT
Ghost

Ghost
AND
Scream

Scream
OR
Ghost



Order of Precedence

- We can override precedence with brackets
- In general, brackets should be added to make things easier to read and understand

Operator	Precedence
not	highest
and	
or	lowest

All the Operators!

1. Arithmetic (+, -, /, etc.)
2. Relational (<, ==, etc.)
3. Logical/Boolean (not, and, or)

- Precedence when combining
  - Arithmetic operators have higher precedence than relational operators
  - Relational operators have higher precedence than Logical/Boolean operators
  - All relational operators have the same precedence (i.e. read left to right)

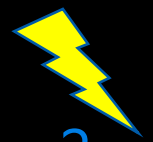
Coding Time!

- Let's go experiment with some of what we just saw
  - Logical operators (and, or, not)
  - Order of precedence

Open your notebook

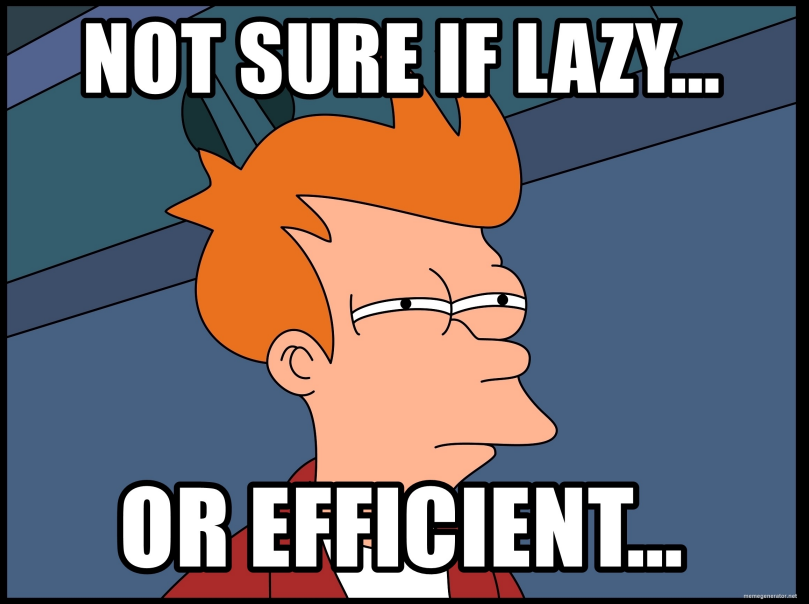
Click Link:
2. Logical Operators

Binary Operators

- Rules for evaluation
  1. Evaluate the left operand (i.e. expression) to a value and replace that operand expression with that value
     
     POSSIBLE SHORT CIRCUIT
  2. Evaluate the right operand (i.e. expression) to a value and replace that operand expression with that value
  3. Apply the operator to the two resultant values

Short-Circuit (Lazy) Evaluation

- The or operator evaluates to True if and only if at least one operand is True
  - If the first operand is True, the second condition will not be checked!
- The and operator evalutes to False if and only if at least one operator is False
  - If the first operand is False, the second condition will not be checked!
- Similar to how in a Multiple Choice Question on a test, if you for sure know the answer is A, you can save time not reading B, C, D, and E!



Coding Time!

- Let's go experiment with some of what we just saw
  - Short-circuit (lazy) evaluation

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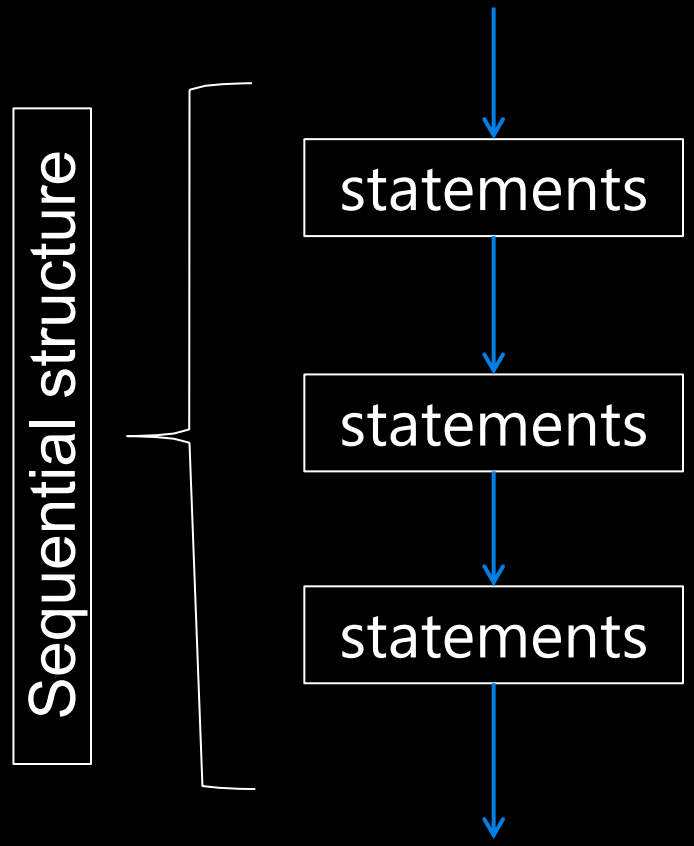
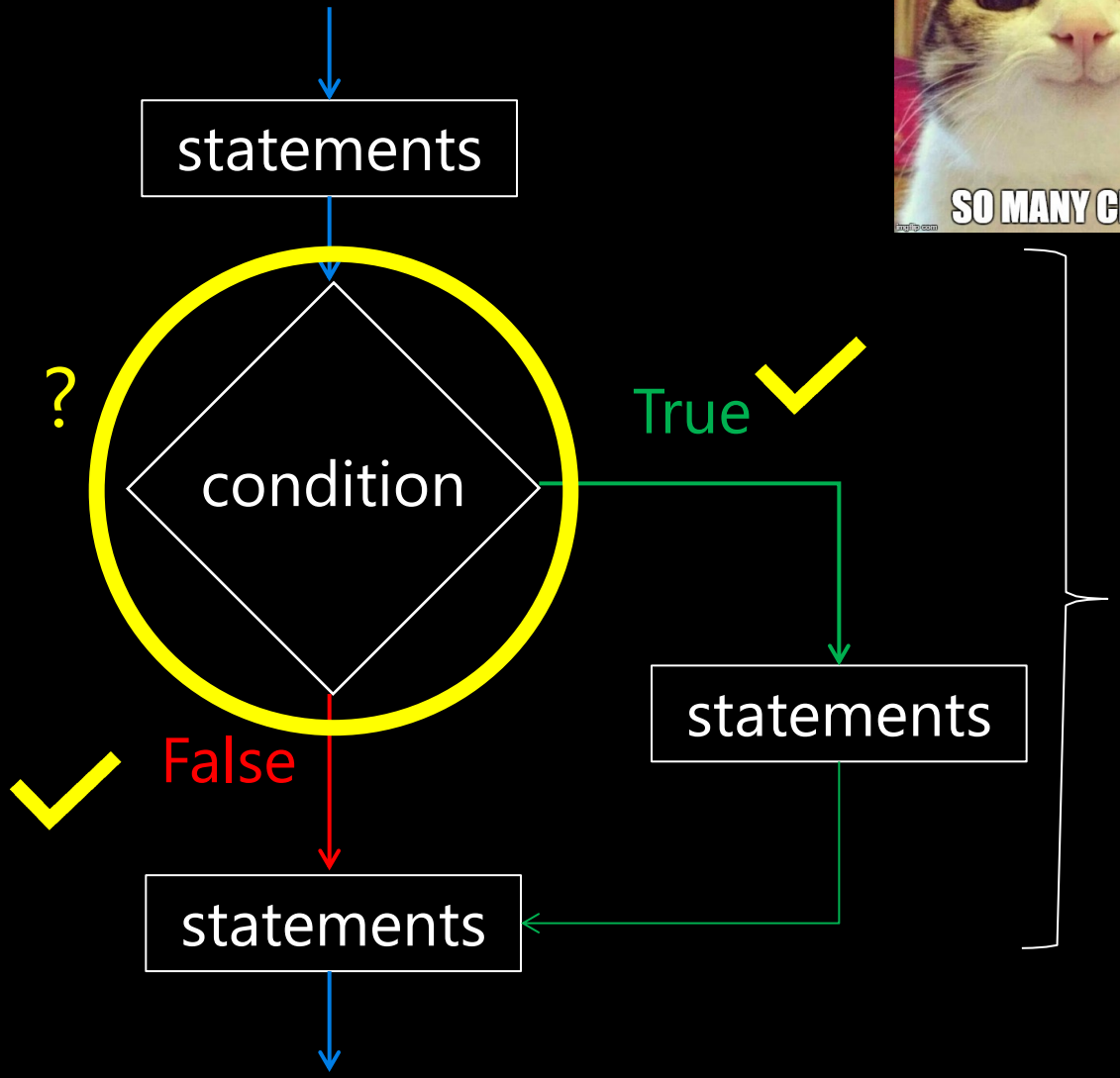
Click Link:
3. Lazy Evaluation

Making Choices





The if statement

- A general form of an if statement is as follows:

```
if expression:
    body
```

- The “body” only executes if the if statement is true
- if statements are always followed by a colon (:)
  - This is how Python knows you are creating a new block of code.
  - Indenting four spaces tells Python what lines of code are in that block

if Statement Example

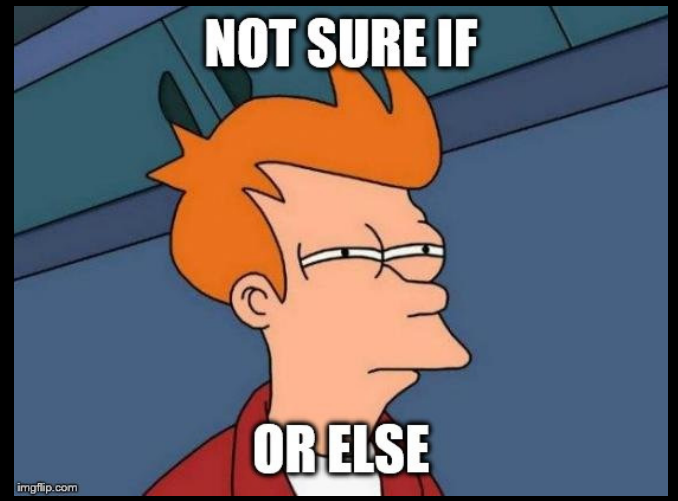
```
grade = 51
if grade < 50:
    print("You failed APS106…")
if grade >= 50:
    print("Hooray you passed!")


Hooray you passed!
```

Adding the else statement

- A more general form of the if conditional statement is:

```
if expression:
    body1
else:
    body2
```



- ONLY 1 of body1 or body2 will be executed.
  - if statement is True, executes body1
  - if statement is False, executes body2

if-else Statement Example

```
grade = 51
if grade <= 50:
    print("You failed APS106…")
else:
    print("Hooray you passed!")
```

```
Hooray you passed!
```

Let's Code!

- Let's go experiment with some of what we just saw
  - if statements
  - Using the else keyword

Open your notebook

Click Link:
4. Introducing if statements

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