# APS106

UNIVERSITY OF TORONTO

# Booleans, Logic, & Conditional "if" Statements.

**Week 3** | Lecture 1 (3.1)

**While waiting, open the Jupyter Notebook for today's lecture**

**Upcoming**

- Lab 1 Due 11:59 pm Friday.
- Lab 2 Released Thursday 6:00 pm.
- Reflection 3 Released Friday 6:00 pm.
- Tutorial and Practical sessions (in-person AND online) running all week.

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!

# Online Tutorials and Labs

- These times worked best for you!
  - TIP FOR SUCCESS: Put these in your calendar! Labs are due Friday night!
- Schedule and Zoom Links are on Quercus
  - "Tutorial Homepage"
  - "Lab Homepage"

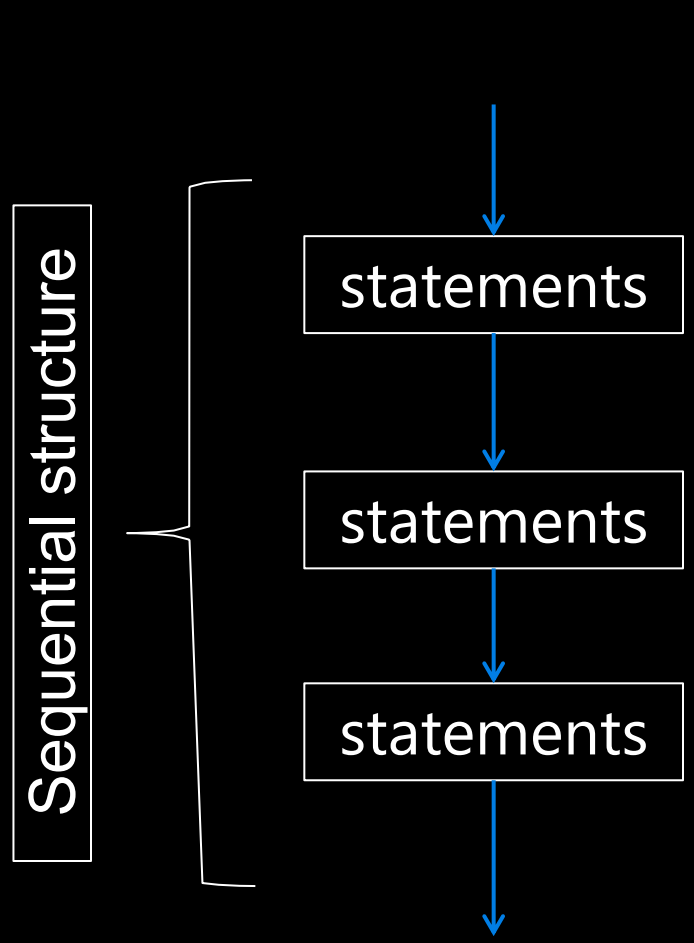
| | Time |
|---|---|
| Tutorial | Thursday 5 PM to 6 PM |
| Lab | Tuesday 6 PM to 8 PM |
| Lab | Friday 6 PM to 8 PM |

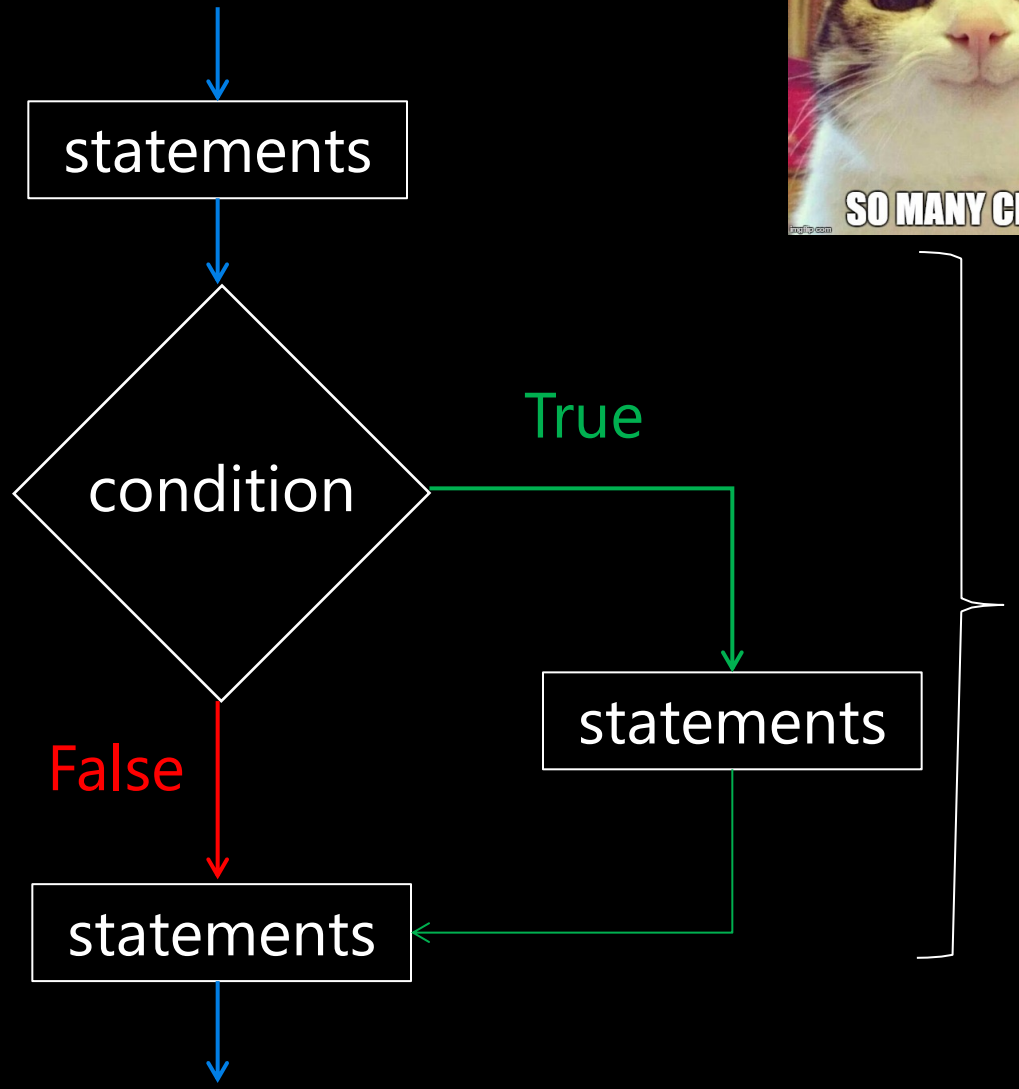
# Coffee Break with a TA!


- Extra help hours!
  - TIP FOR SUCCESS: Put in calendar, treat as a scheduled class
- Schedule and Zoom Links are on Quercus
  - "Coffee Break (Office Hours)"

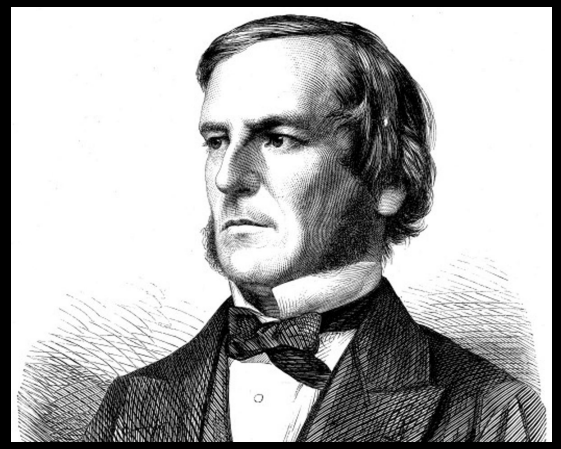
| TA | Time | Mode |
|---|---|---|
| Michael Tisi | Monday 12 PM to 1 PM | Online |
| Ali Tohidifar | Monday 6 PM to 7 PM | Online |
| Behrang Mohajer | Tuesday 11 AM to 12 PM | Online |
| Tamara Kecman | Thursday 11 AM to 12 PM | Online |
| Daniel Tovbis | Thursday 3 PM to 4 PM | In-person |

# Making Choices

# Boolean Type (bool)

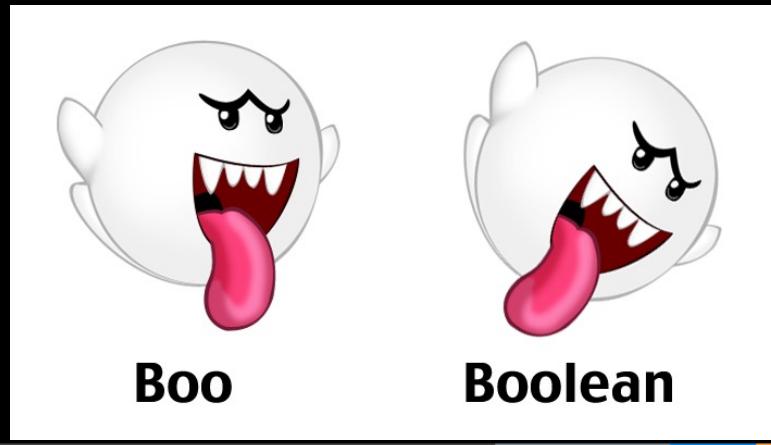


- Named after George Boole (mid-1800s)
  - Boolean algebra and Boolean logic
  - Laid the foundation for information age and computer science
- Python type bool has only two possible values: True and False

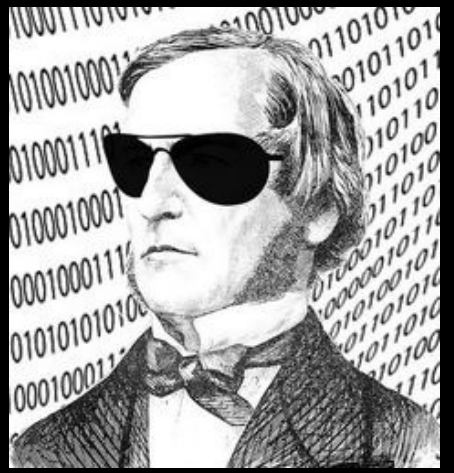
```
>>> state = True
>>> state
True
```

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

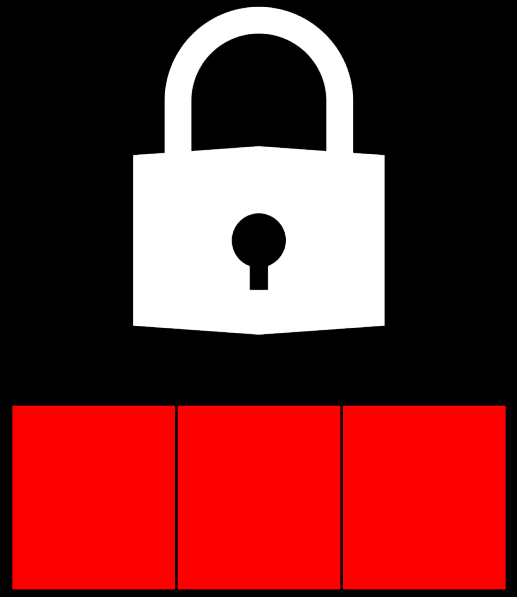
"bool" is a sub-type of "int", where True == 1, False == 0



# 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 |

# 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

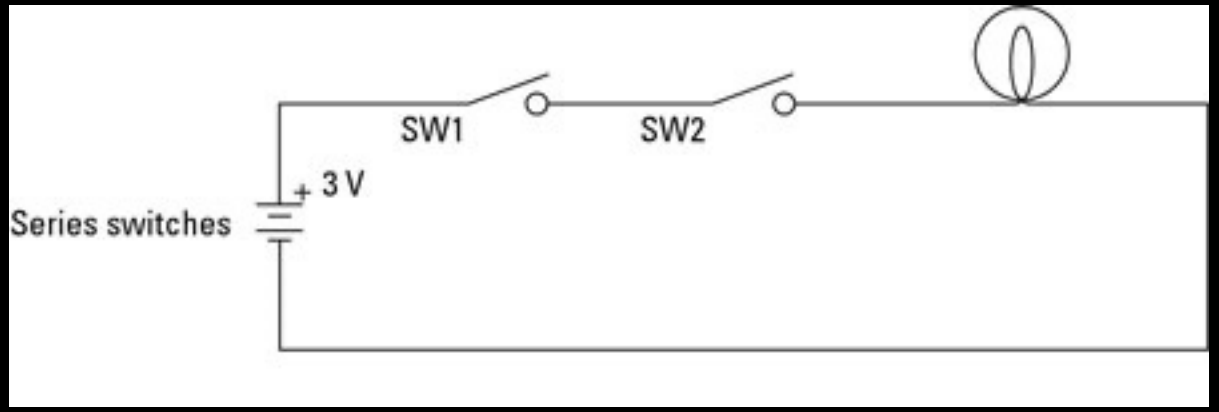
- Take Boolean operands and evaluate to Boolean values

| 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

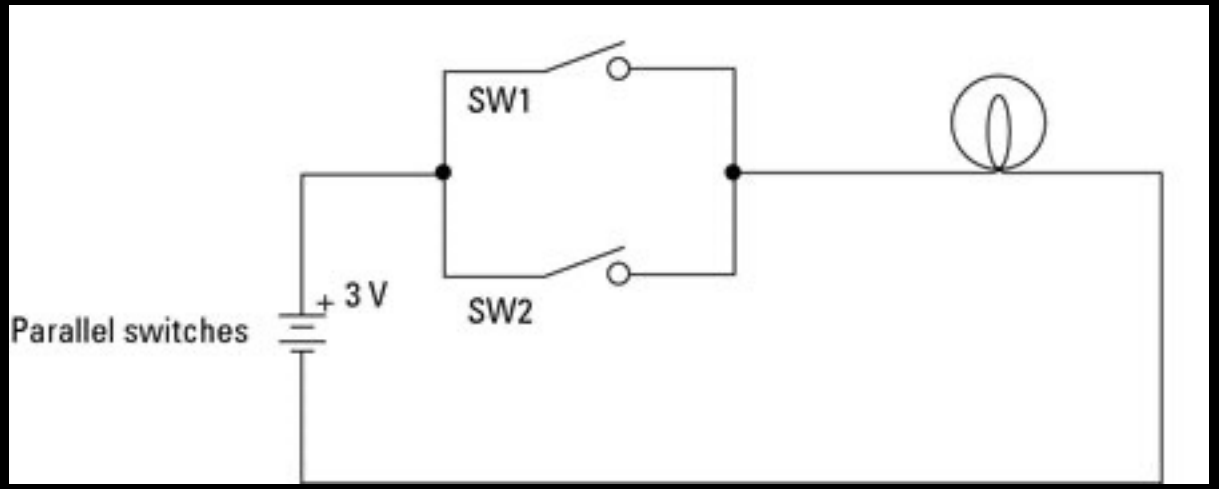
Switch 1 AND Switch 2 must be on for light to turn on



# 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

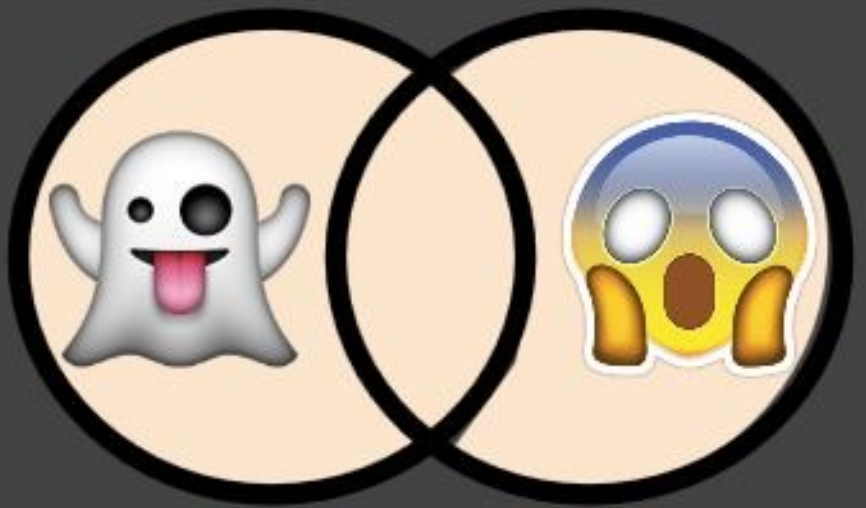
# BOO-lean operators

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)

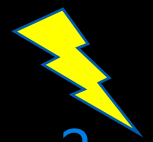
# Coding Time!

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

**Open your notebook**

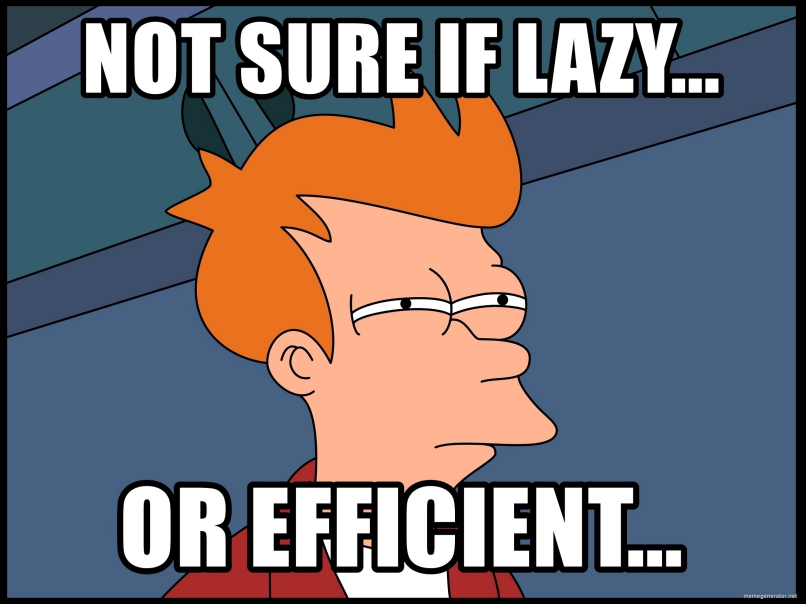
**Click Link:**
**2. Logical Operators**

# 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

- or evaluates to True iff at least one operand is True
  - operand_1 or operand_2
  - If the operand_1 is True, operand_2 will not be checked!
- and evaluates to False iff at least one operator is False
  - operand_1 and operand_2
  - If the operand_1 is False, the operand_2 will not be checked!




- Like how in a Multiple-Choice Question, if you for sure know the answer is A, you can save time not reading B, C, and D!

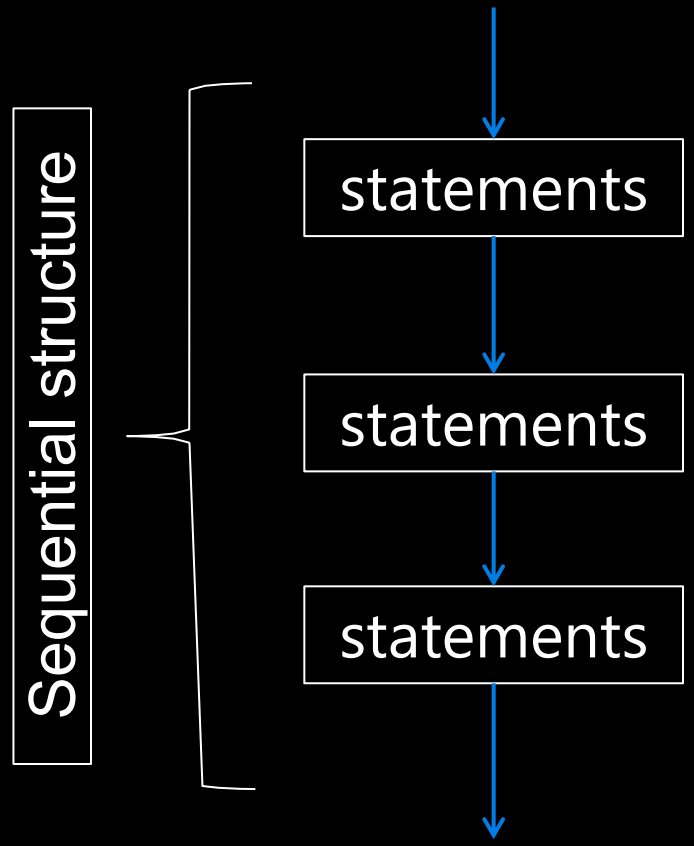
# Coding Time!

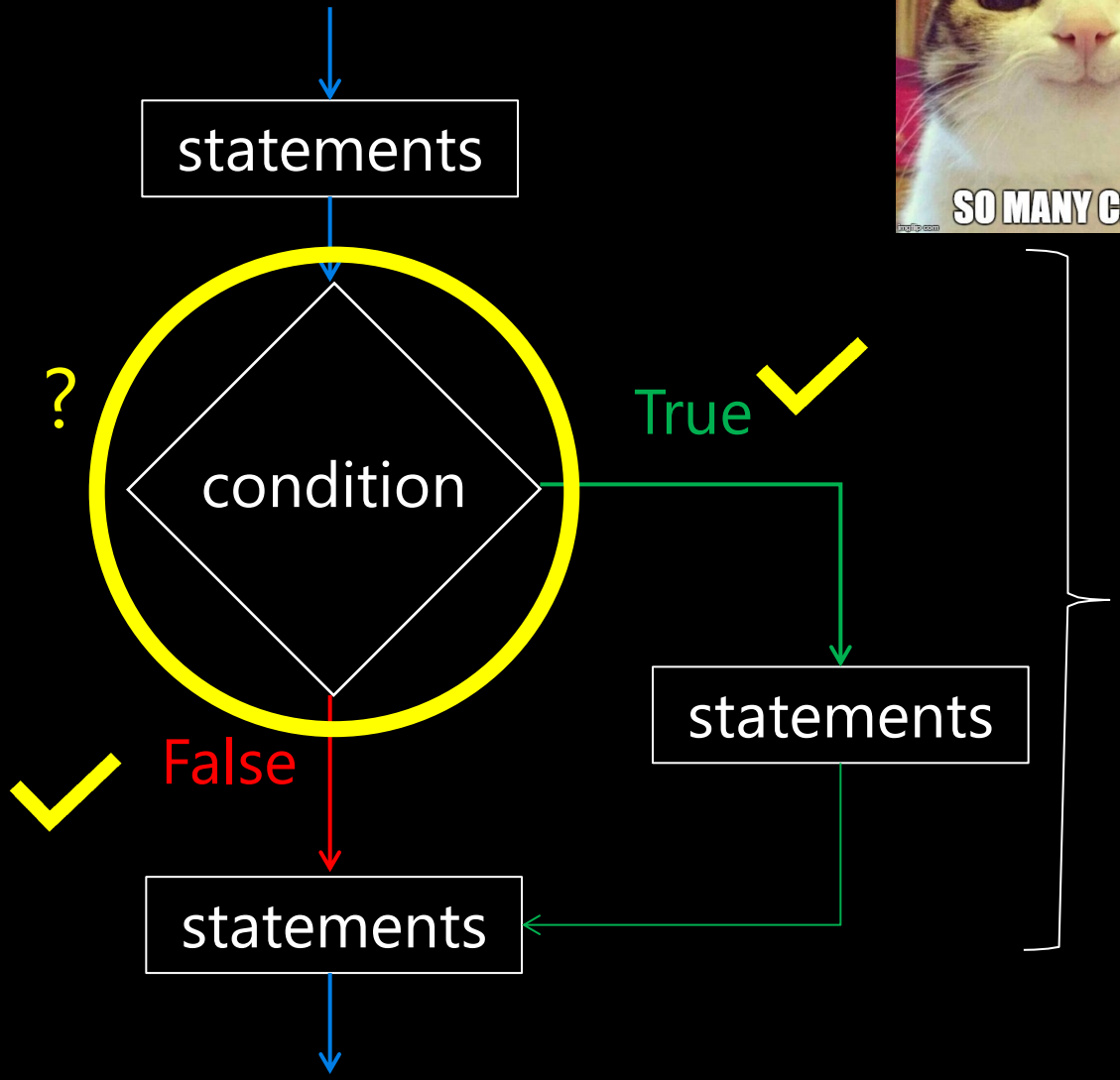
- Let's go experiment with some of what we just saw
  - Short-circuit (lazy) evaluation

**Open your notebook**

**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!")
```

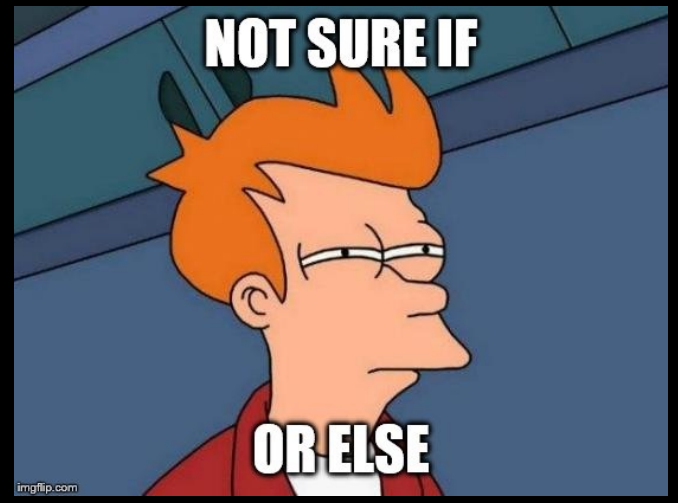
```
Hooray you passed!
```

There must be an easier way to account for all the other cases…

# 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**

# APS106

UNIVERSITY OF TORONTO

# Booleans, Logic, & Conditional “if” Statements.

**Week 3** | Lecture 1 (3.1)

if nothing else, write #cleancode