MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

Computer Science Department

COMP8060 – Scientific Programming with Python

Week 3 – Decision Structures

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September, 2025

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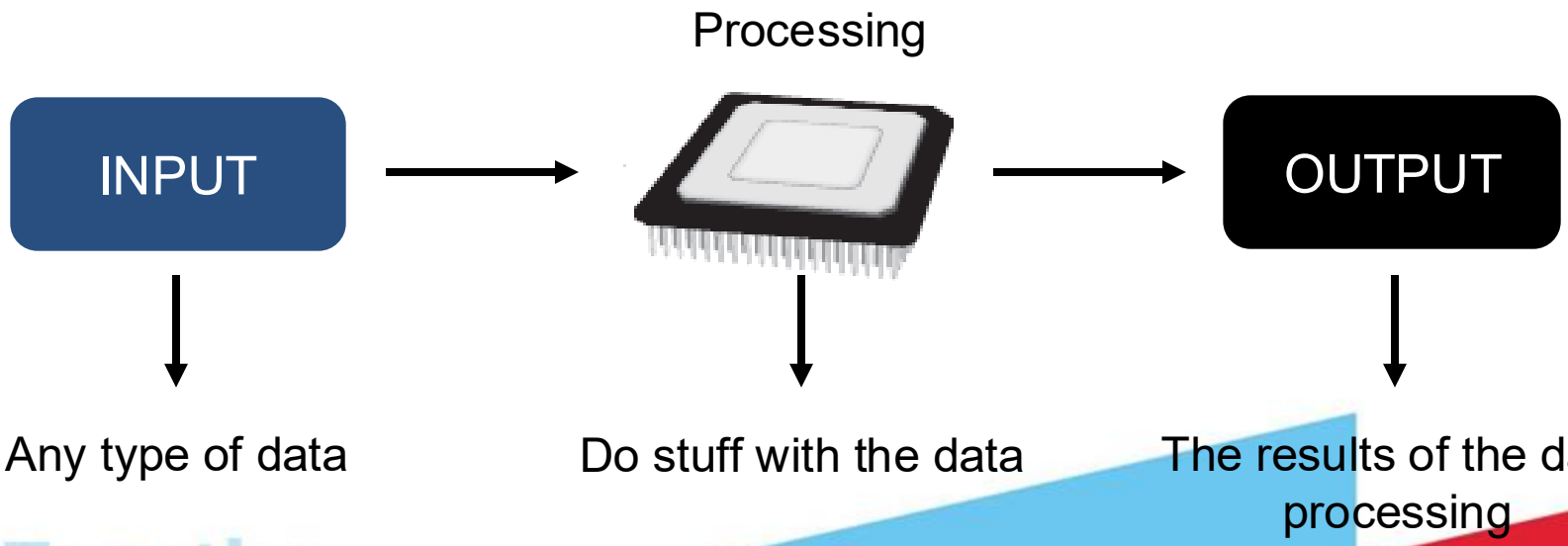
Last week

- Python and its runtime environment
- Input/Output and Processing in Python
- Data Types
- Operators
- Comments



Assignment (next week).

- The assignment will be delivered next week during the labs.
- It’s going to be a 20 questions long Multiple-choice test, and you will have 1 hour to finish it.
- Each group will do the assignment on its own lab, but don’t worry, all questions are random, so even if your colleague share his answers with you will have 0 effect (which I don’t expect to occur).

- ONLY LINUX!!!

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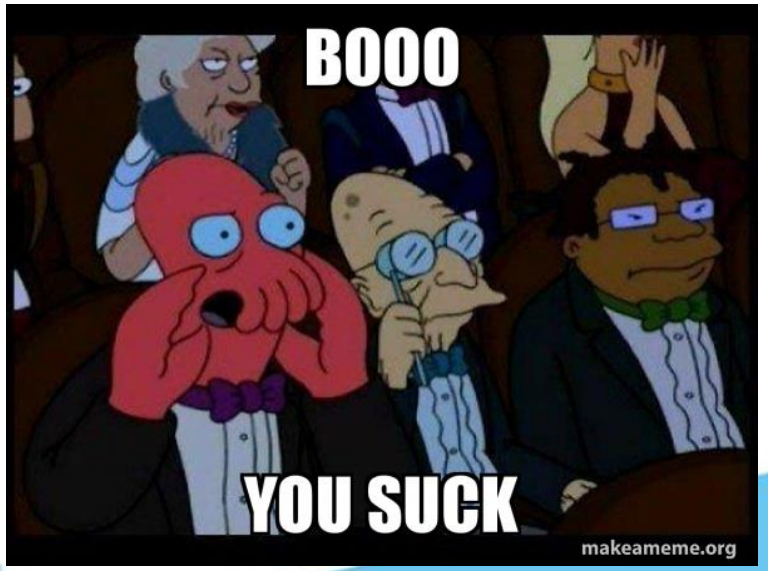
- **Summary:**
  - The if Statement
  - The if-else Statement
  - Nested Decisions Structures and the if-elif-else Statement
  - Logical Operators in Decision Structures
  - Boolean Variables
  - Python Modules
  - Q&A

The if statement

A Decision Structure – let's start with a bad programmer joke.

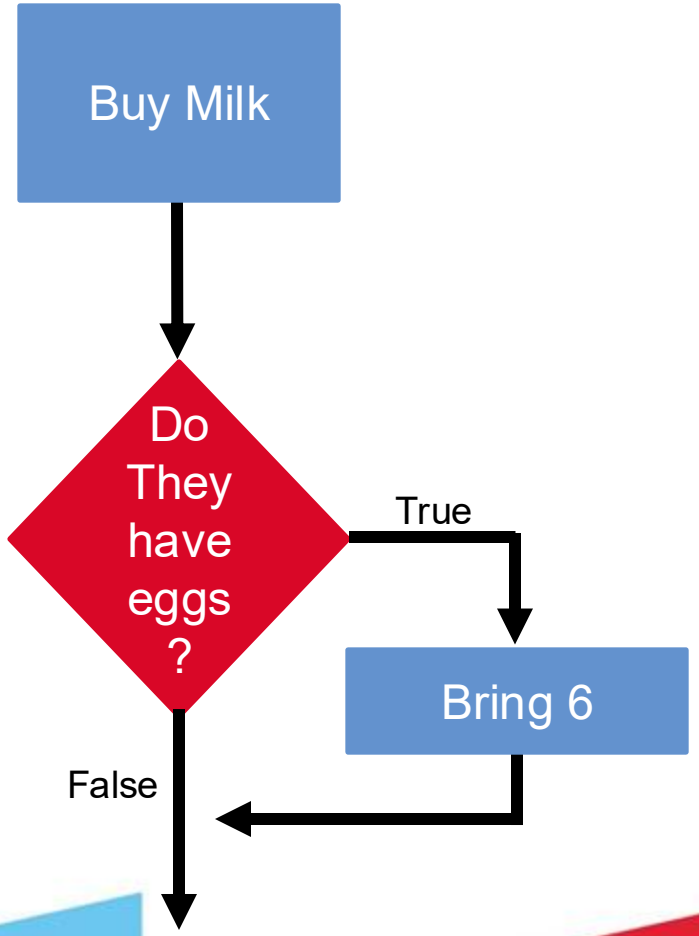
- "Husband, go to the market and buy a bottle of Milk. If they have eggs, bring six.
- The guy, who by the way was a programmer, bought six bottles of Milk.
- The wife baffled asked "Why the hell did you buy six bottles of milk?"
- The husband replied "because they had eggs…"



A Decision Structure

- Decision structure: This bad joke illustrates the basis of a decision structure. In which action(s) are performed only if a condition exists

  - Example:
    - If a user is 18 yr of age or less a ticket will cost them €10.
    - If the room temperature drops below 10 degree Celsius the heating should be activated

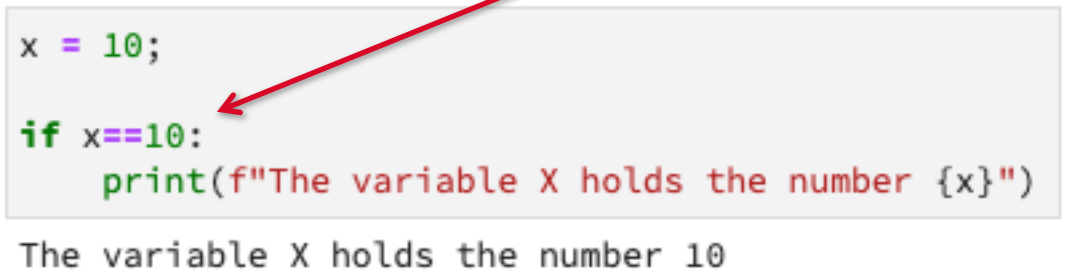


The `if` Statement

: after the condition

The indentation after the if condition is mandatory

- Python syntax:



```
x = 10;

if x==10:
    print(f"The variable X holds the number {x}")
```

```
The variable X holds the number 10
```

- First line is known as the if clause
  - Includes the keyword if followed by a condition
    - The condition can be **true** or **false**
    - When the if statement executes, the condition is tested, and if it is true the **indented block statements are executed**. otherwise, block statements are skipped

What is a Condition (Boolean Expression)

- A condition is a boolean expression that is tested by the *if* statement to determine if it is true or false
  - Example: a > b
    - This expression returns `True` if *a* is greater than *b*; `False` otherwise

Expression	Meaning
x > y	Is x greater than y?
x < y	Is x less than y?
x >= y	Is x greater than or equal to y?
x <=y	Is x less than or equal to y?
x == y	Is x equal to y?
x != y	I x not equal to y?

Boolean Expressions and Relational Operators (example)

- Employee is rewarded with a bonus of 500 if his/her sales exceed 5000

```
sales = input('Please enter number of sales')
sales = int(sales)
bonus = 0

if sales>5000:
    bonus = 500

print (f"Bonus Value is {bonus}")
```

Otherwise?

Boolean Expressions and Relational Operators (example)

- You can use multiple statements as part of an if statement. All indented lines after the if statement will be executed if the condition is evaluated to true.

```
sales = input('Please enter number of sales')
sales = int(sales)
bonus = 0

if sales>5000:
    print("Congratulations, you got a bonus!!")
    bonus = 500

print (f"Bonus Value is {bonus}")
```

```
Please enter number of sales 5001
Congratulations, you got a bonus!!
Bonus Value is 500
```

The if-else statement

The `if-else` Statement

- Dual alternative decision structure:

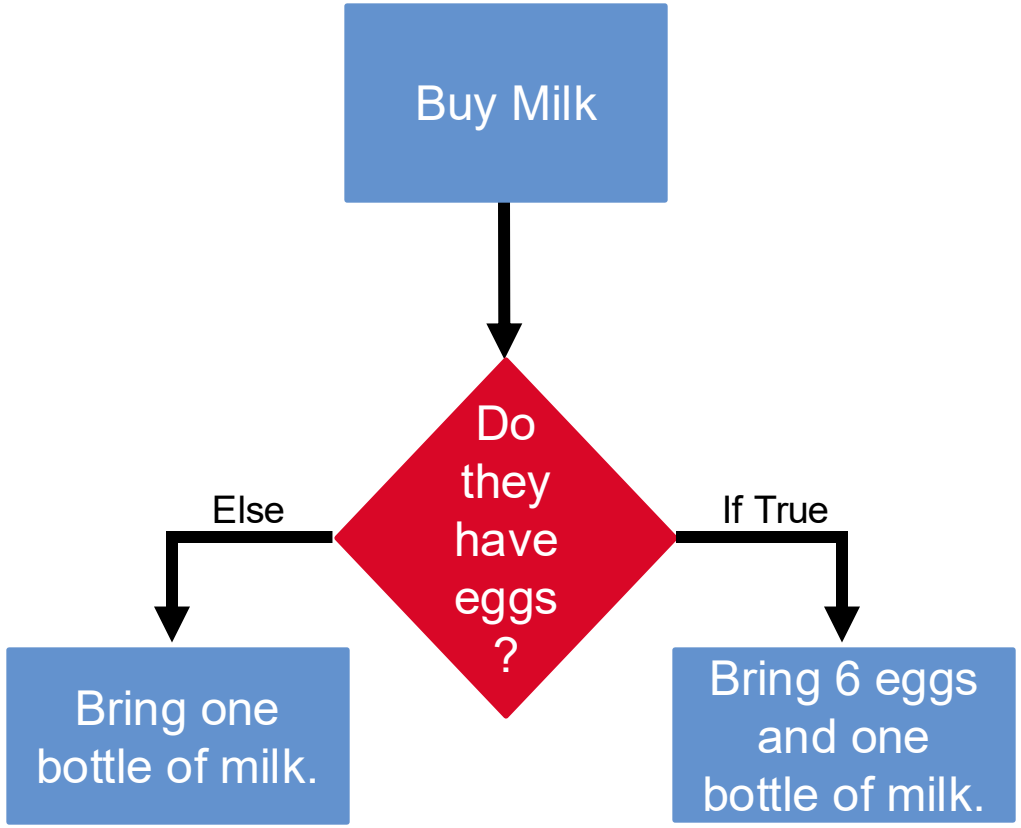
(two alternative paths of execution)

  - One is taken if the condition is true, and the other if the condition is false

  - Syntax:

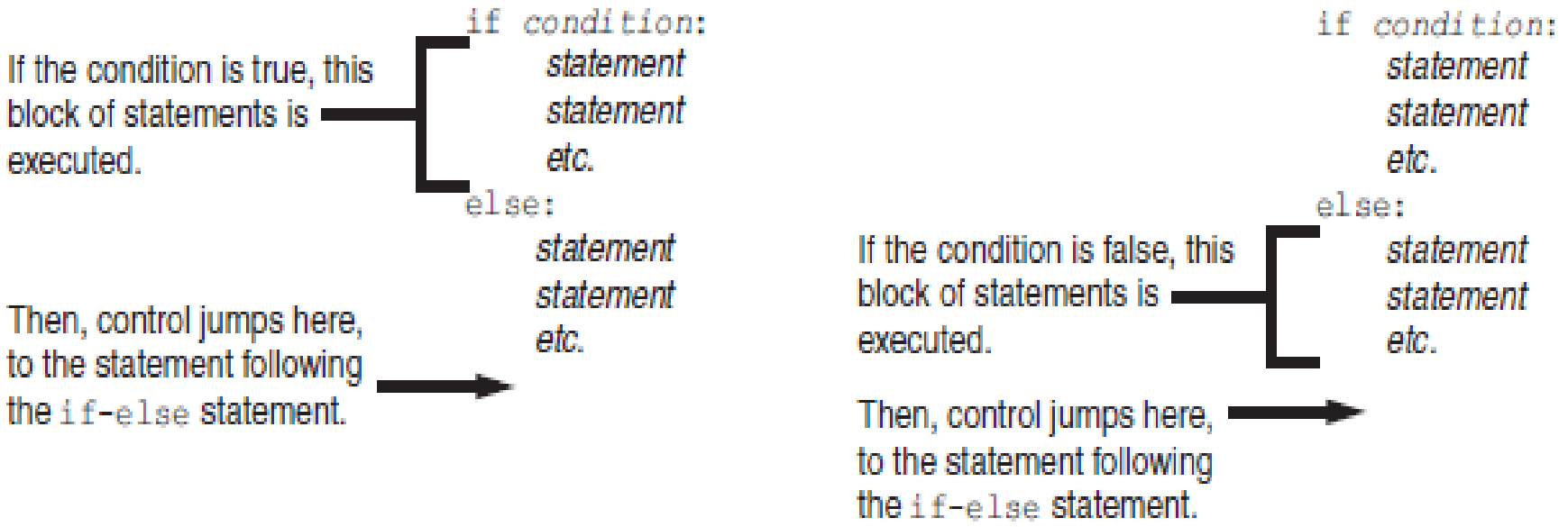
```
if condition:
        statement(s)
else:
        other statement(s)0
```

The `if-else` Statement



The `if-else` Statement (cont'd.)

Conditional execution in an `if-else` statement



The if-else Statement (example)

```
sales = input('Please enter number of sales')
sales = int(sales)
bonus = 0

if sales>5000:
    bonus = 500
else:
    bonus = 100
print ("Bonus Value is ", bonus)
```

Comparing Strings

- Strings can be compared using the == and != operators
  - Just like variables String comparisons are case sensitive

```
name1 = 'Mary'
name2 = 'mary'
if name1 == name2:
    print ("The names are the same")
else:
    print ("The names are NOT the same.")
```

```
The names are NOT the same.
```

Comparing Strings (Convert case)

- Make sure that both strings are comparable.
  - Use the methods .upper() and lower() to change the characters to upper and lowercases.
  - Use the method .title() to transform only the first letter to uppercase.

```
print(f"name1={name1.title()} and name2={name2.title()}")
print(f"name1={name1.upper()} and name2={name2.upper()}")
print(f"name1={name1.lower()} and name2={name2.lower()}")
```

```
name1=Mary and name2=Mary
name1=MARY and name2=MARY
name1=mary and name2=mary
```

```
name1 = 'Mary'
name2 = 'mary'
if name1.title() == name2.title():
    print ("The names are the same")
else:
    print ("The names are NOT the same.")
```

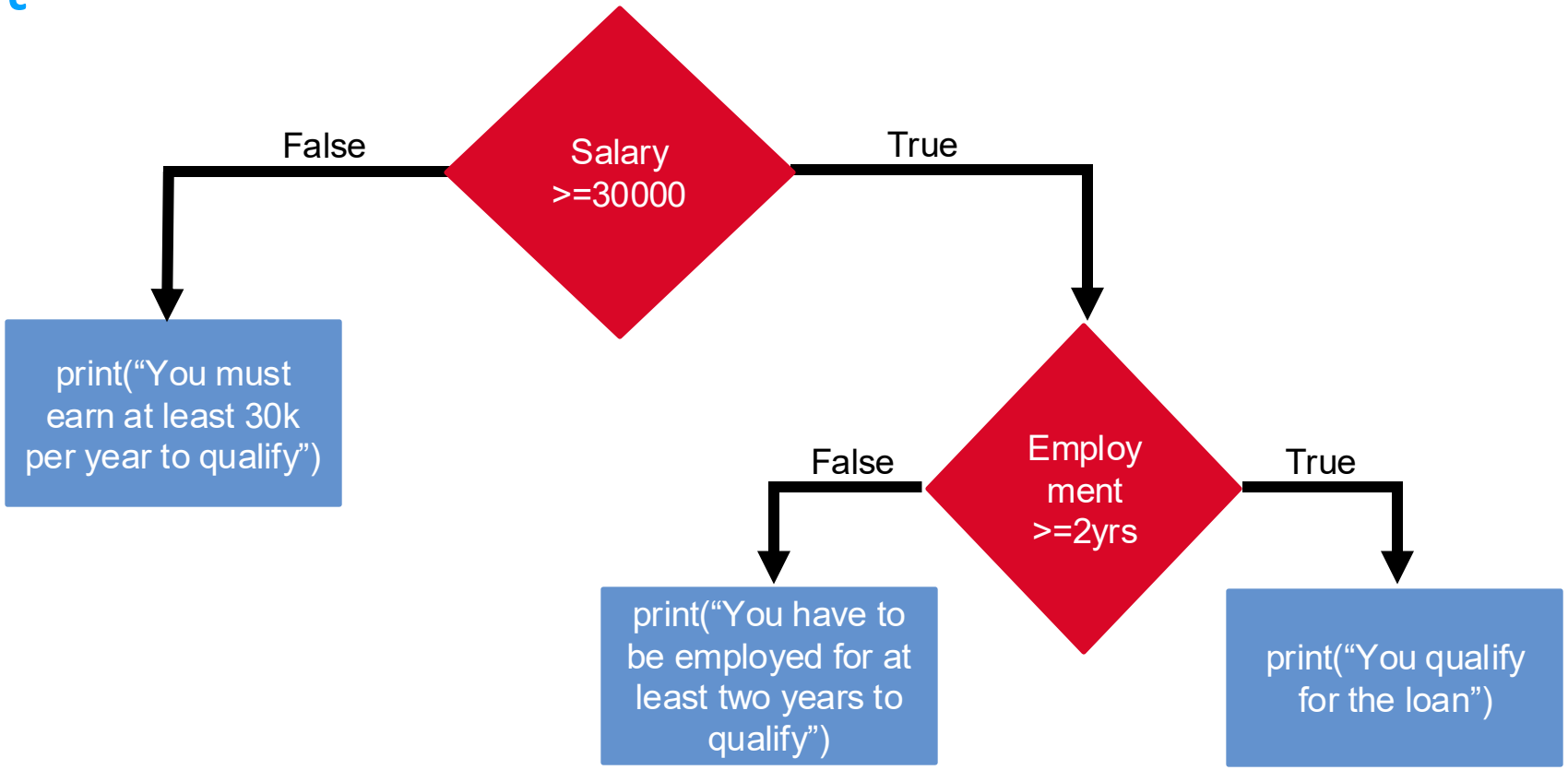
```
The names are the same
```

Nested Decision Structures and the `if-else` Statement

- If you need to evaluate multiple conditions then you can use a nested decision structure (an *if* statement inside another *if*)

  - Example:
    - Determine if someone qualifies for a loan, they must meet two conditions:
      - Must earn at least $30,000/year
      - Must have been employed for at least two years
    - Check first condition, and if it is true, check second condition

Nested Decision Structures and the `if-else` Statement

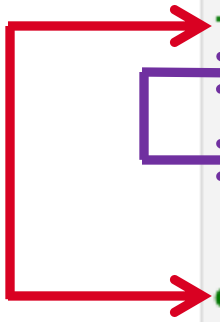


Nested Decision Structures and the `if-else` Statement

- Important to use **proper indentation** in a nested decision structure
  - Important for the Python interpreter
  - Makes the code more readable for the programmer

- Rules for writing nested if statements:
  - **else** clause should align with matching **if** clause
  - Statements in each block must be **consistently indented**

Nested Decision Structures and the `if-else` Statement



```
# Get the customer's annual salary.
salary = int(input("Enter your annual salary:"))
# Get the number of years on the current job.
yearsEmployed = int (input("Enter num years employed"))

if salary >= 30000.0:
    if yearsEmployed >= 2:
        print ("You qualify for the loan.")
    else :
        print ("You must have been on your current")
        print ("job for at least two years to qualify.")
else:
    print ("You must earn at least $30,000 per year")
```

The if-elif-else statement

The `if-elif-else` Statement

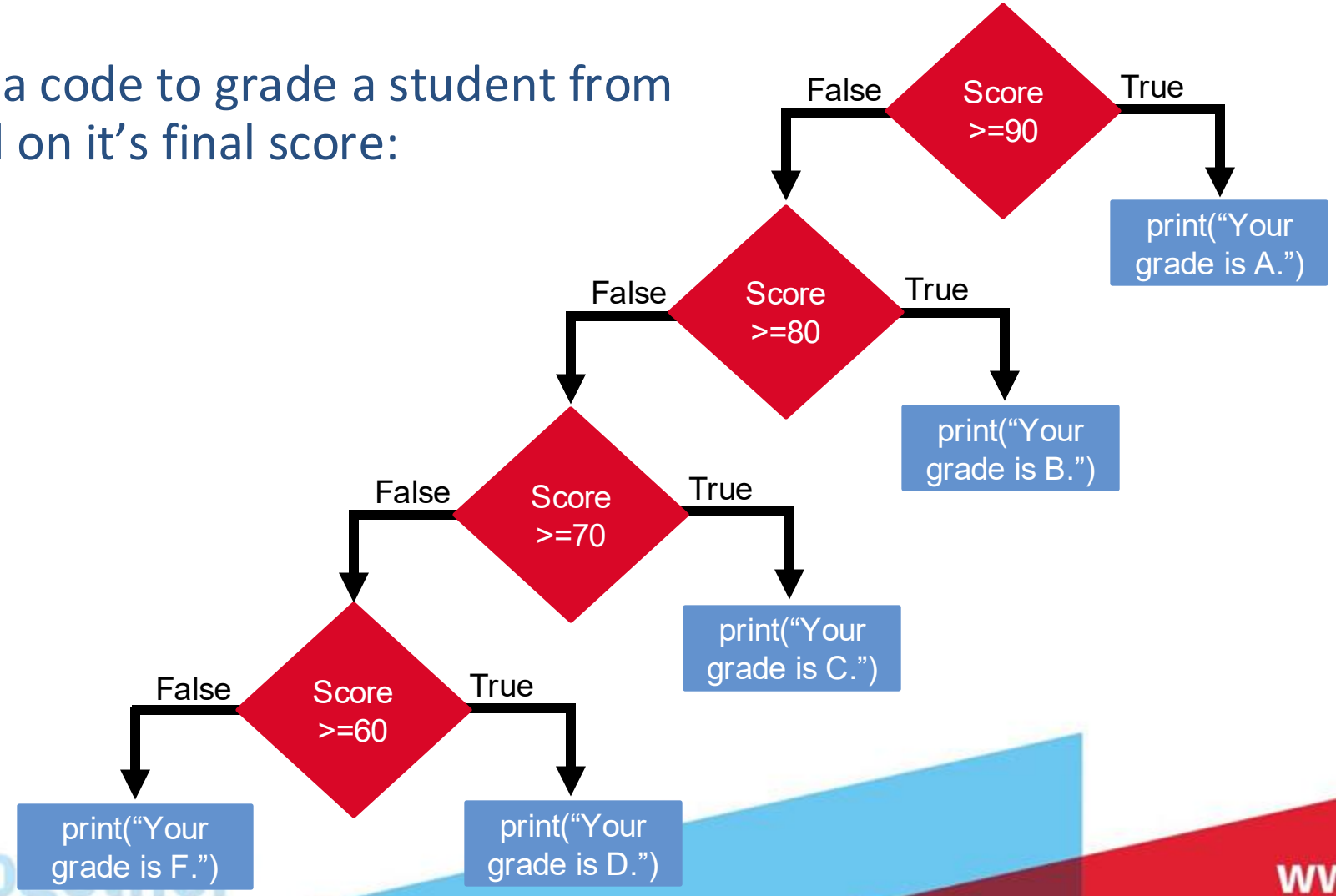
- if-elif-else statement: special version of a decision structure
  - Makes logic of nested decision structures simpler to write
    - Can include multiple elif statements

  - Syntax:

```
if condition1
        statements
elif condition2
        statements
.....
else
        statements
```

Nested Decision Structures and the `if-elif-else` Statement

- Let's create a code to grade a student from A to F based on it's final score:



Nested Decision Structures and the `if-elif-else` Statement

```
# Get the students overall grade.
score = int(input("Enter your exam score:"))
if score >= 90:
    print("Your grade is A.")
elif score >= 80:
    print ("Your grade is B.")
elif score >= 70:
    print ("Your grade is C.")
elif score >= 60:
    print ("Your grade is D.")
else :
    print ("Your grade is F.")
```

elif stands for “Else if”, and its way more memory efficient than nesting else-if statements.

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Logical Operators in decision structures

Logical

- Logical operators are used to combine conditional statements:

Symbol	Description	Example:
and	Returns True if both statements are true	x < 5 and x < 10
or	Returns True if one of the statements is true	x < 5 or x < 4
not	Reverse the result, returns False if the result is true	not(x < 5 and x < 10)

```
x = 5

print(x > 3 and x < 10)
```

```
True
```

```
x = 5

print(x > 3 or x < 4)
```

```
True
```

```
x = 5

print(not(x > 3 and x < 10))
```

```
False
```

Logical Operators in decision structures

- Logical operators: operators that can be used to create complex conditional statements
  - **`and`** operator and **`or`** operator: binary operators, connect two Boolean expressions into a single compound Boolean expression
  - **`not`** operator: unitary operator, reverses the truth of its Boolean operand

The `and` Operator

- Takes two Boolean expressions as operands
  - Creates a compound Boolean expression that is True only when **both sub expressions are true**
  - Can be used to simplify nested decision structures

- Truth table for the **`and`** operator

Expression	Value of the Expression
false and false	false
false and true	false
true and false	false
true and true	true

The and Operator

- The and operator allows us to include more conditions to an if statement.
- Thus, it expands what we can do with it.

```
# Get the students exam score and output the grade.
score = int(input("Enter your exam score:"))

if score >= 60  and score <70:
     print ("Your grade is a D.")
```

The **or** operator

- Takes two Boolean expressions as operands
  - Creates compound Boolean expression that is true when **either of the sub expressions is true**
  - Can be used to simplify nested decision structures

- Truth table for the **or** operator

Expression	Value of the Expression
false and false	false
false and true	true
true and false	true
true and true	true

The **or** operator

- If a user enters a value that is less than 0 or greater than 100 then they should be informed that it is invalid otherwise our code should say invalid.

- Notice that as long as one of the conditions below is true then the subsequent indented code is executed.

```
# Inform use if value received is invalid
grade = int(input(" Please enter exam grade: "))

if grade < 0  or grade > 100:
    print ("Invalid Grade ")
else:
    print ("Valid Grade ")
```

Short-Circuit Evaluation

- Short circuit evaluation: deciding the value of a compound Boolean expression after evaluating only one sub expression
  - Performed by the `or` and `and` operators
    - **For `and` operator**: If left operand is true, evaluate right operand. Otherwise, expression is false.
    - **For `or` operator:** If left operand is true, compound expression is true. Otherwise, evaluate right operand.

The **not** Operator

- Takes one Boolean expressions as operand and reverses its logical value
  - Sometimes it may be necessary to place parentheses around an expression to clarify to what you are applying the not operator
- Truth table for the *not* operator

Expression	Value of the Expression
true	false
false	true

The **not** Operator

- The following code checks the current temperature value and outputs a message it it has not exceeded 30 degrees.

```
temperature = int(input(" Please enter current temperature: "))
if not(temperature > 30):
    print ("This is below the maximum temperature")
```

Boolean Variables in Decision structures

- Boolean variable: references one of two values, `True` or `False`
  - Represented by `bool` data type

```
sales = int(input("Please input total sales"))

if sales >= 50000.0:
    salesQuotaMet = True
else:
    salesQuotaMet = False

if salesQuotaMet == True:
    print ("Congratulations. You will receive a bonus")
```

Boolean conditions are great to create a menu for the user.

match-case statement

A structural pattern matching

- It changes the execution control based on the value of an expression.
- It’s similar to the if-elif-else statement, but it can handle non-binary checks.

```
if action == "coffee”:
    product.append("coffee")
    value += 3
elif action == "tea”:
    product.append("tea")
    value += 2
elif action =="scone":
    product.append(”scone")
    value += 2
else:
    exit()
```

```
match action:
    case "coffee":
        product.append("coffee")
        value += 3
    case "tea”:
        product.append("tea")
        value += 2
    case "scone”:
        product.append(”scone")
        value += 2
    case _:
        exit()
```

Advantages

- Improves the readability of your code and provide a cleaner syntax:

```
if action == "coffee”:
    product.append("coffee")
    value += 3
elif action == "tea”:
    product.append("tea")
    value += 2
elif action =="scone":
    product.append(”scone")
    value += 2
else:
    exit()
```

```
match action:
    case "coffee":
    product.append("coffee")
        value += 3
    case "tea”:
        product.append("tea")
        value += 2
    case "scone”:
        product.append(”scone")
        value += 2
    case _:
        exit()
```

Advantages

- It can be used to match against patterns, not only values

```
match position:
    case (0, 0):
        print("Origin")
    case (0, y):
        print(f"Y={y}") # Matches any position where x is 0
    case (x, 0): # Matches any position where y is 0
        print(f"X={x}")
    case (x, y):
        print(f"X={x}, Y={y}")
    case _:
        print("Not a point")
```

Disadvantages

- It’s an overkill for simple, binary, checks, but it can be used without issues.
- The performance of both methods, case-match or if-elif-else is generally comparable

When to use it then?

When to use it then?

Feature	Use if-elif-else when...	Use match-case when...
Complexity	Conditions are complex (e.g., if x > 5 and y < 10:).	You are matching values or patterns against a single variable or expression.
Python Version	You need compatibility with Python < 3.10.	You can require Python 3.10+.
Use Case	You need simple, universal branching logic.	You are handling complex data structures (tuples, lists, class objects) and their shapes.
Readability	The logic is non-linear or doesn't fit a simple "match this pattern" model.	The logic is a clear list of cases, and the syntax makes it more readable.

How did programmers of the past lived without case-match?

Before Python 3.10

- They did not, they had a workaround:

```
def switch(action):
    if action == "coffee”:
        product.append("coffee")
        value += 3
    elif action == "tea”:
        product.append("tea")
        value += 2
    elif action =="scone":
        product.append(”scone")
        value += 2
    else:
        exit()

print(switch("coffee”))
```

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Python Modules, Packages and Libraries

Python Modules, the power of the community.

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Modules

- Related code saved into a .py file.
- Allow modularity of your program.

Packages

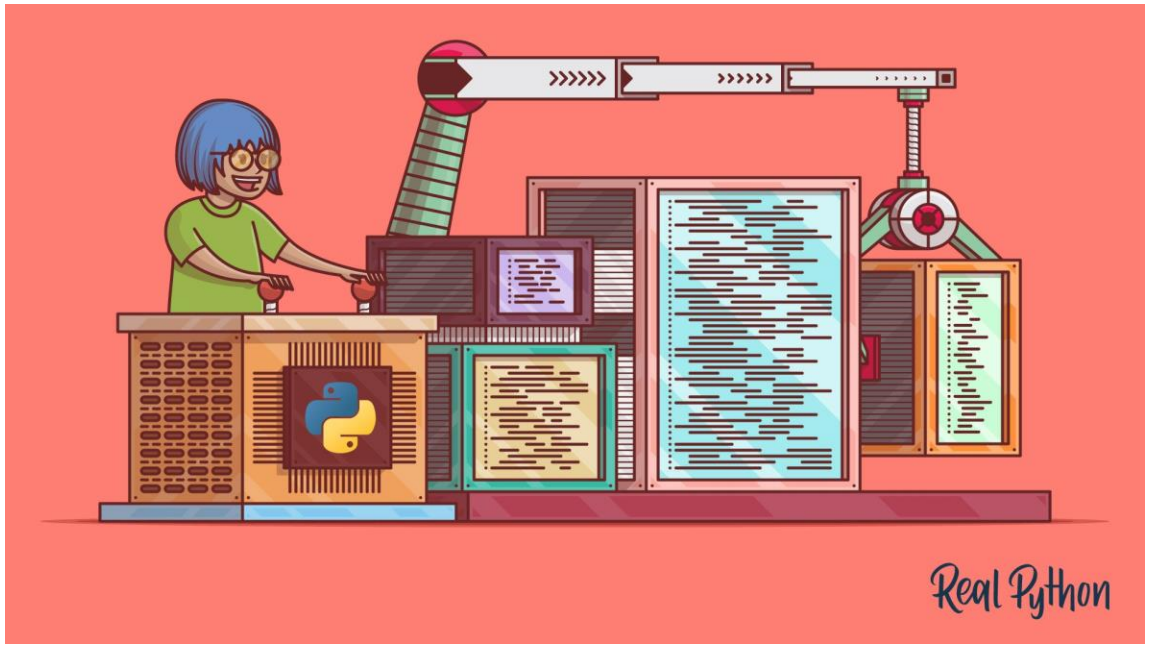
- Are directories of a collection of modules.
- Allow the organisation of related modules.

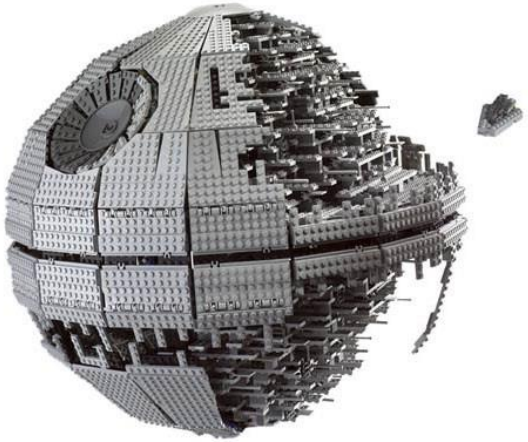
Libraries

- A collection of related Modules and Packages.

Python Modularity, the power of the community.

- Imagine Python as a set of LEGO bricks.
- You have your basic set, with in-built modules.
- But you can expand it with new collections to expand your code functionality!





Why bother coding if you can import code that can do the job?

Examples of Python modules

- Math module.
- Random module.
- Sys module.
- And many more…

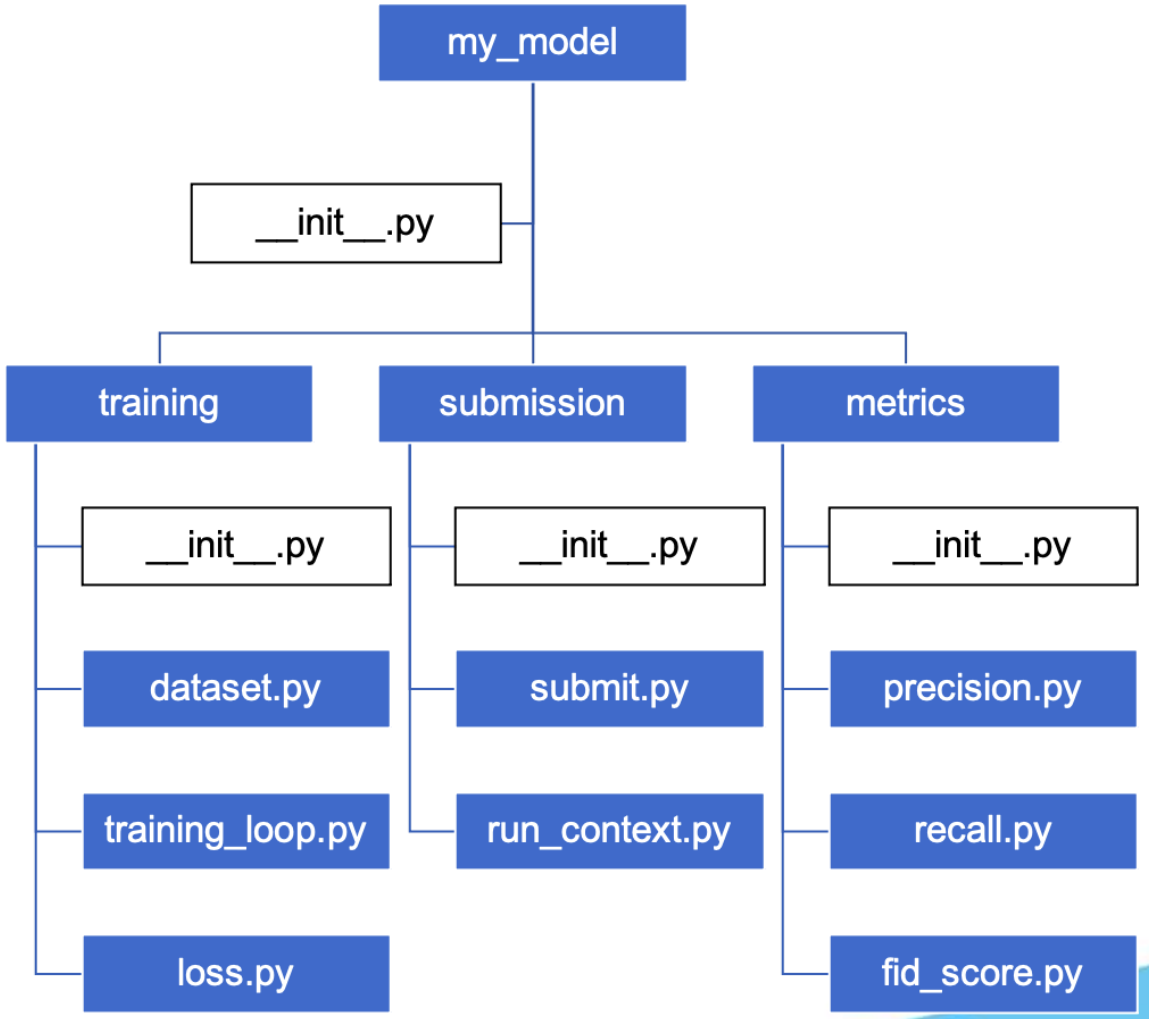
```
def classify_triangle(a: float, b: float, c: float) -> list:
    """
    Determine if a triangle is valid and classify its type.

    Args:
        a, b, c: Three side lengths of a potential triangle

    Returns:
        list: [validity_string, type_string]
    """
```

```
import triangle
```

```
triangle.classify_triangle(3,4,5)
```

```
['Valid', 'Scalene Right']
```

Examples of Packages

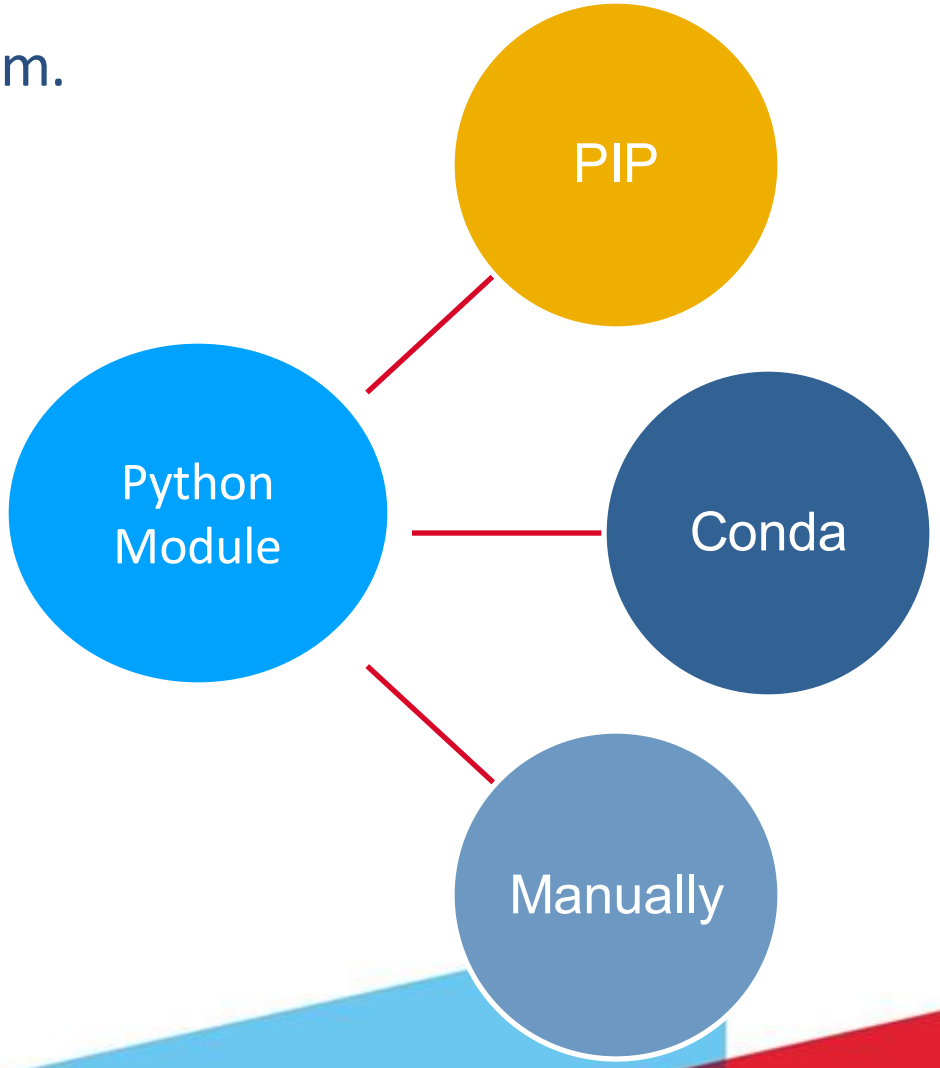


Examples of Packages

Examples of Libraries

Installation.

- There are many ways to install them.



- Let’s check how to do it using PIP.

Pip install.

- Pip is actually a protocol that should be used in an unix terminal, but you can use it on Jupyter or any on other interactive python by adding a ! before pip.

```
!pip install numpy
```

```
Requirement already satisfied: numpy in /User
s/bruno.andrade/miniconda3/lib/python3.8/site-
packages (1.20.3)
```

Import a module/package/library.

- Importing is easy,

```
import math
```

```
import matplotlib
```

```
import numpy
```

```
import numpy as np
```

- Built-in and installed modules will be loaded without any feedback
- You can also give a “nickname” to a module in order to save time, but it’s not the only reason!

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We give nicknames to libraries to avoid clashes between their and the basic python function names.

Import a module.

- If the module is not installed, an error flag will be raised…

```
import theano
```

```
---------------------------------------------
-----------------------------
ModuleNotFoundError                       Trac
eback (most recent call last)
/var/folders/9x/hx0451rj4n1fcxsm1m6ch5hx7p3m0
h/T/ipykernel_39859/3799233021.py in <module>
----> 1 import theano

ModuleNotFoundError: No module named 'theano'
```

Directly import functions from a library.

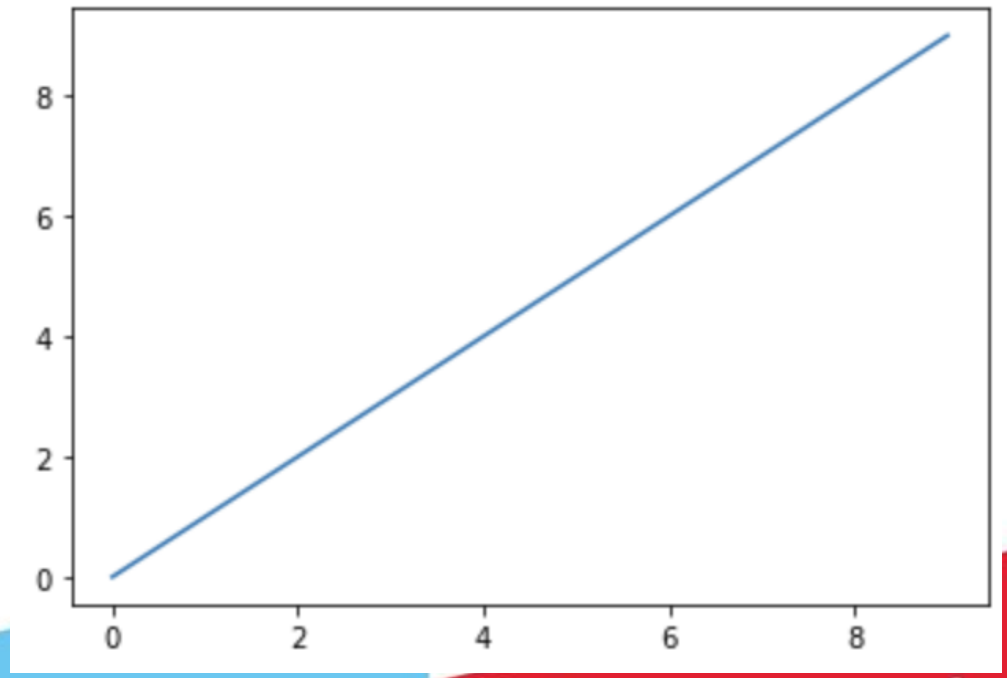
- You can also import modules from a package for the sake of brevity.

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
```

Now lets try to create a simple line plot:

```
data = np.arange(10)
plt.plot(data)
```

```
[<matplotlib.lines.Line2D at 0x7f9320c7ac40>]
```



Using methods from a module.

```
import random
```

```
positionX = random.randint(0,100)
print(positionX)
```

```
85
```

```
cakeChoice = random.choice(["Carrot Cake", "Cupcake",
                            "Banana cake","Cheesecake"])
cakeChoice
```

```
'Cupcake'
```

We are going to use the random module a lot.

We will talk more about modules and how to make your own in a couple of weeks.

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That’s all folks!