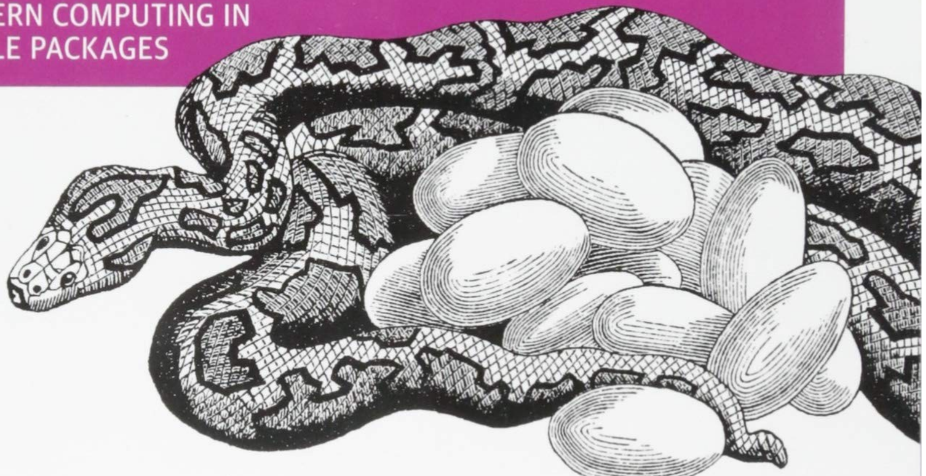
O'REILLY®

Introducing Python

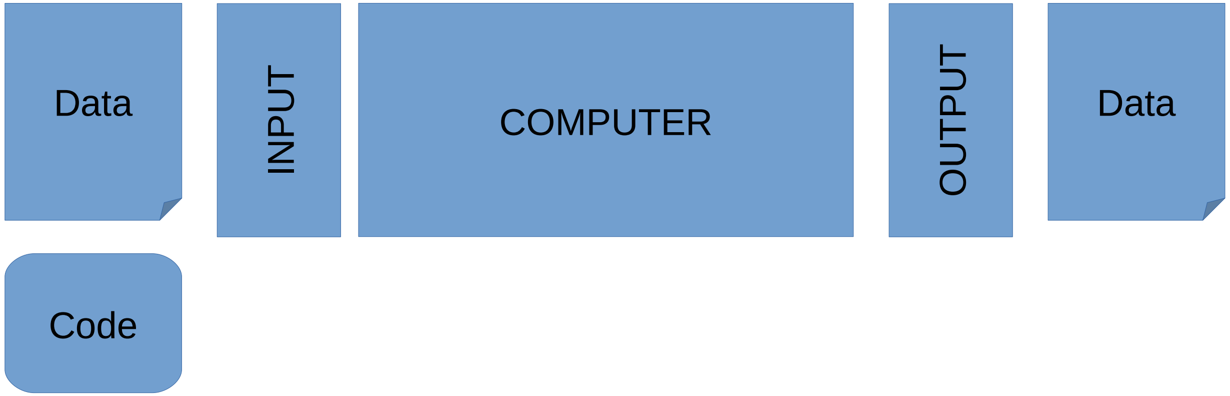
MODERN COMPUTING IN SIMPLE PACKAGES



Bill Lubanovic

Computer science basics

- Computers are machines capable of accepting data through and input device, process those data automatically under the control of a previously stored program, and provide the result information through an output device



Algorithms

- An algorithm is a set of well-defined instructions for accomplishing a task
- When we write computer program, we are generally implementing a method (an algorithm) devised previously to solve some problem.
- A computer program is a sequence of instructions that are executed by a CPU
- Computer programs can be written in high-level (e.g., Python, Perl, C, C++, Java), or primitive programming languages
- Algorithm design techniques:
  - Structured (Modular) Programming
  - Object Oriented programming

Pseudocode

- Pseudocode is an informal coding practice to help programmers plan algorithms and train programmatic thinking.
- Pseudocode is not tied to any specific programming language such as Python, JavaScript, or C#. Instead, it uses human languages.
- By using pseudocode, you can plan every step of your program without worrying about syntax.
- Its greatest benefit is to allow you to discover the vulnerabilities and opportunities of your programmatic logic in order to improve it before implementation.

Example

Write a program that asks the user for a temperature in Fahrenheit and prints out the same temperature in Celsius.

Example Pseudo-code:

- x = Get user input
- y = Convert x to Celsius
- Output message displaying Celsius temperature

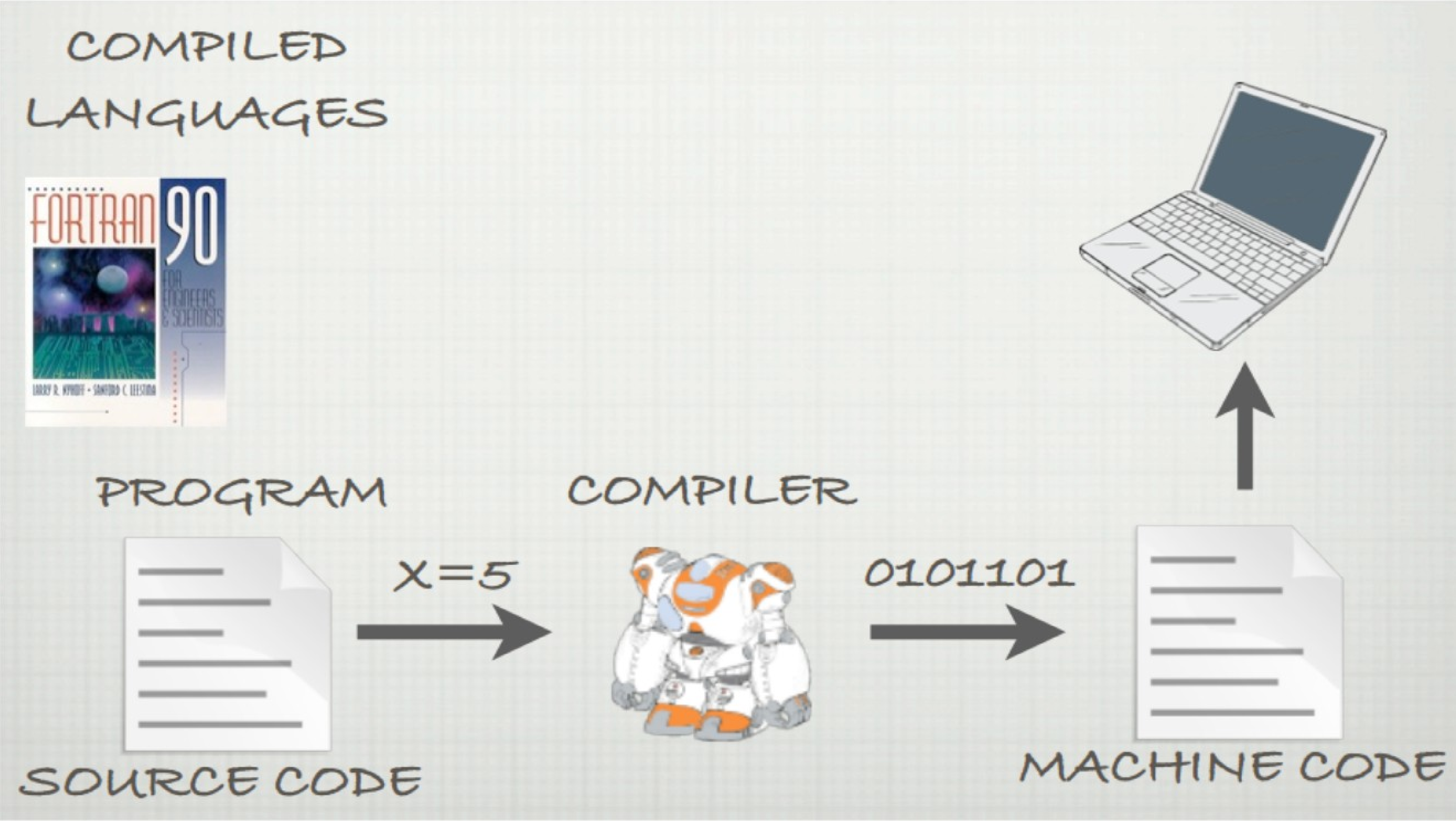
flowchart

- A flowchart is a type of diagram that represents the workflow or process of an algorithm. The flowchart shows the steps as symbols of various kinds, and their order/sequence by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem.

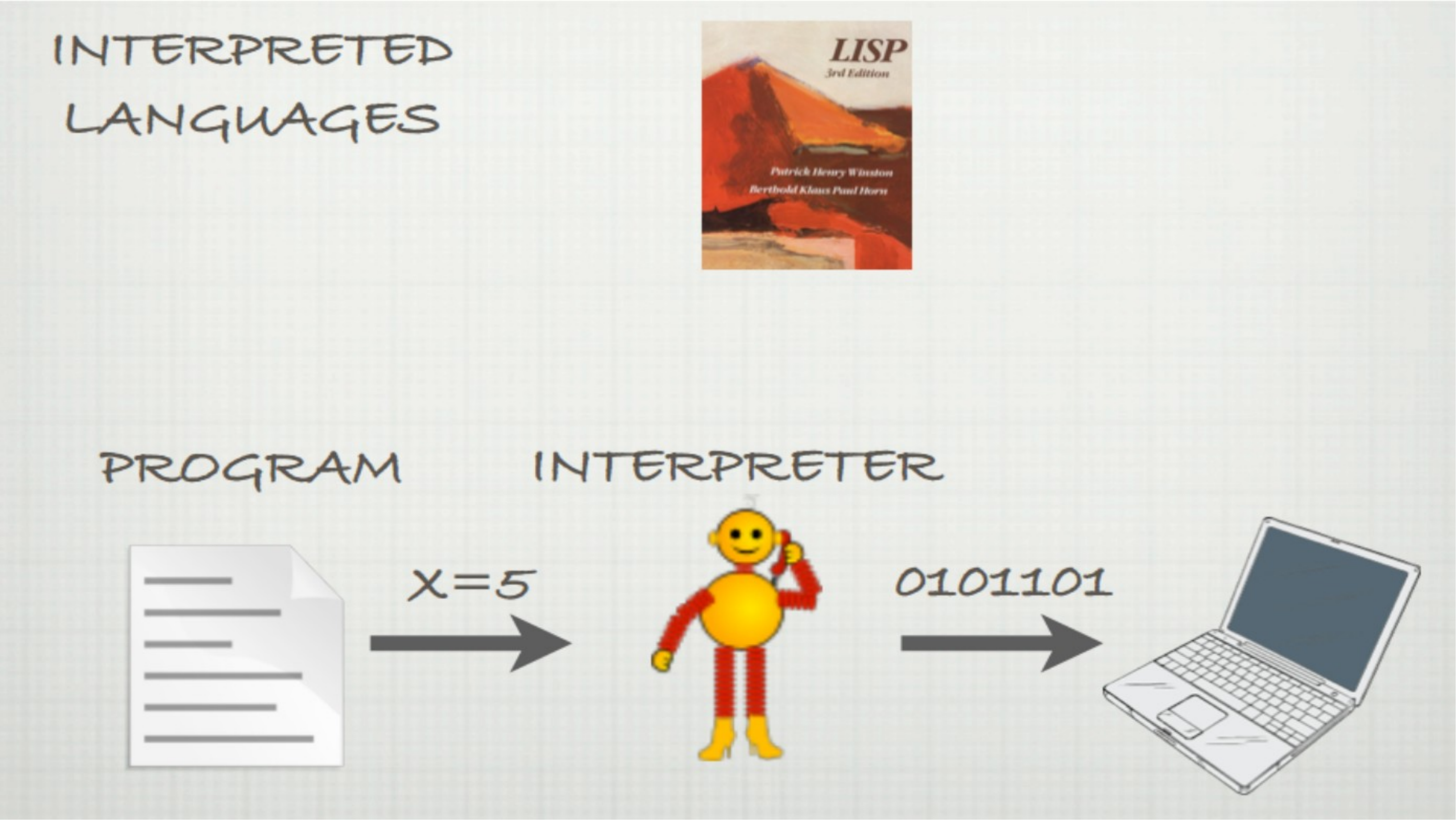
Interpreters and compilers

- An interpreter performs the instructions of a program in a high-level programming language
- A compiler translates a program in a high-level programming language to machine code

Interpreters and compilers

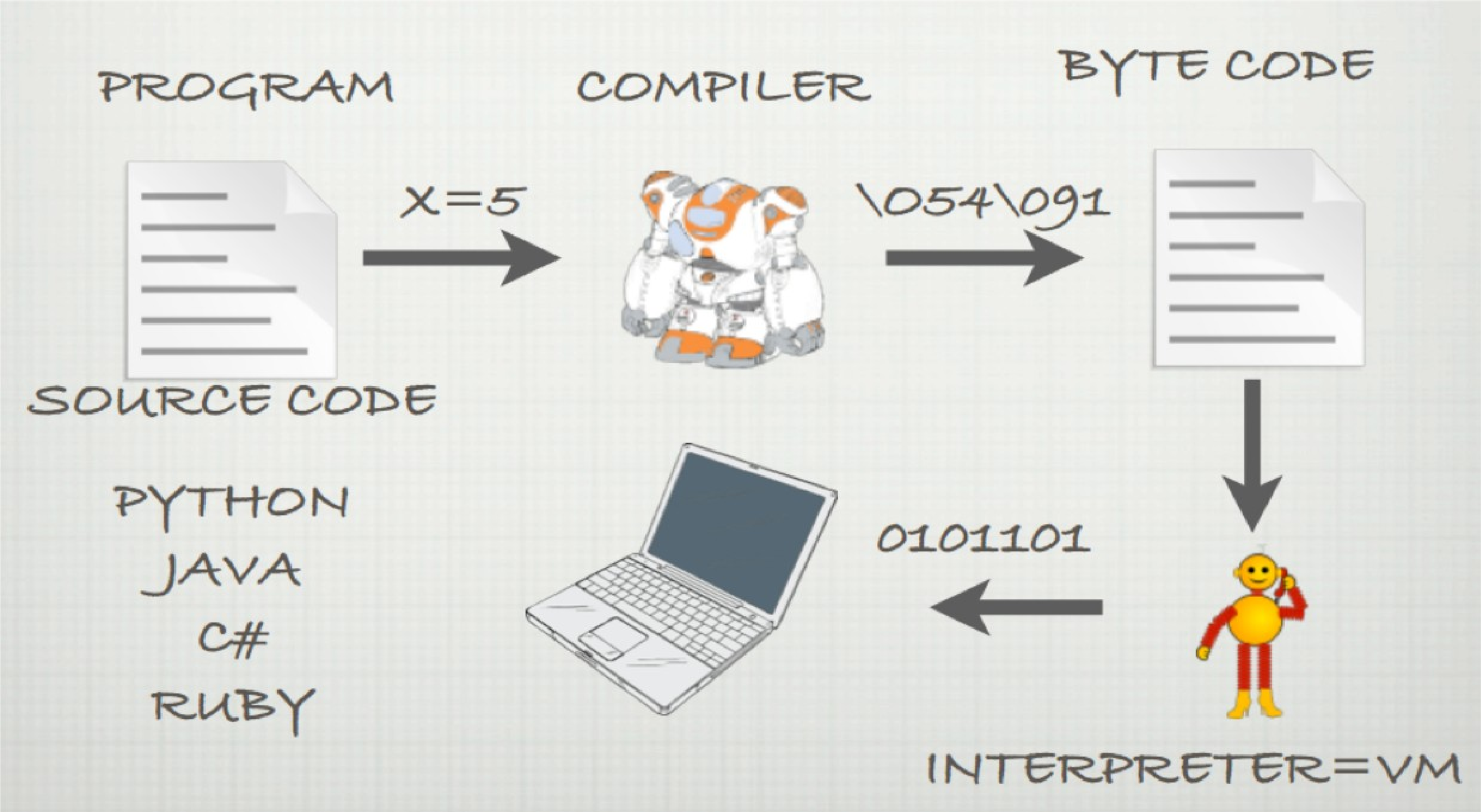


Interpreters and compilers

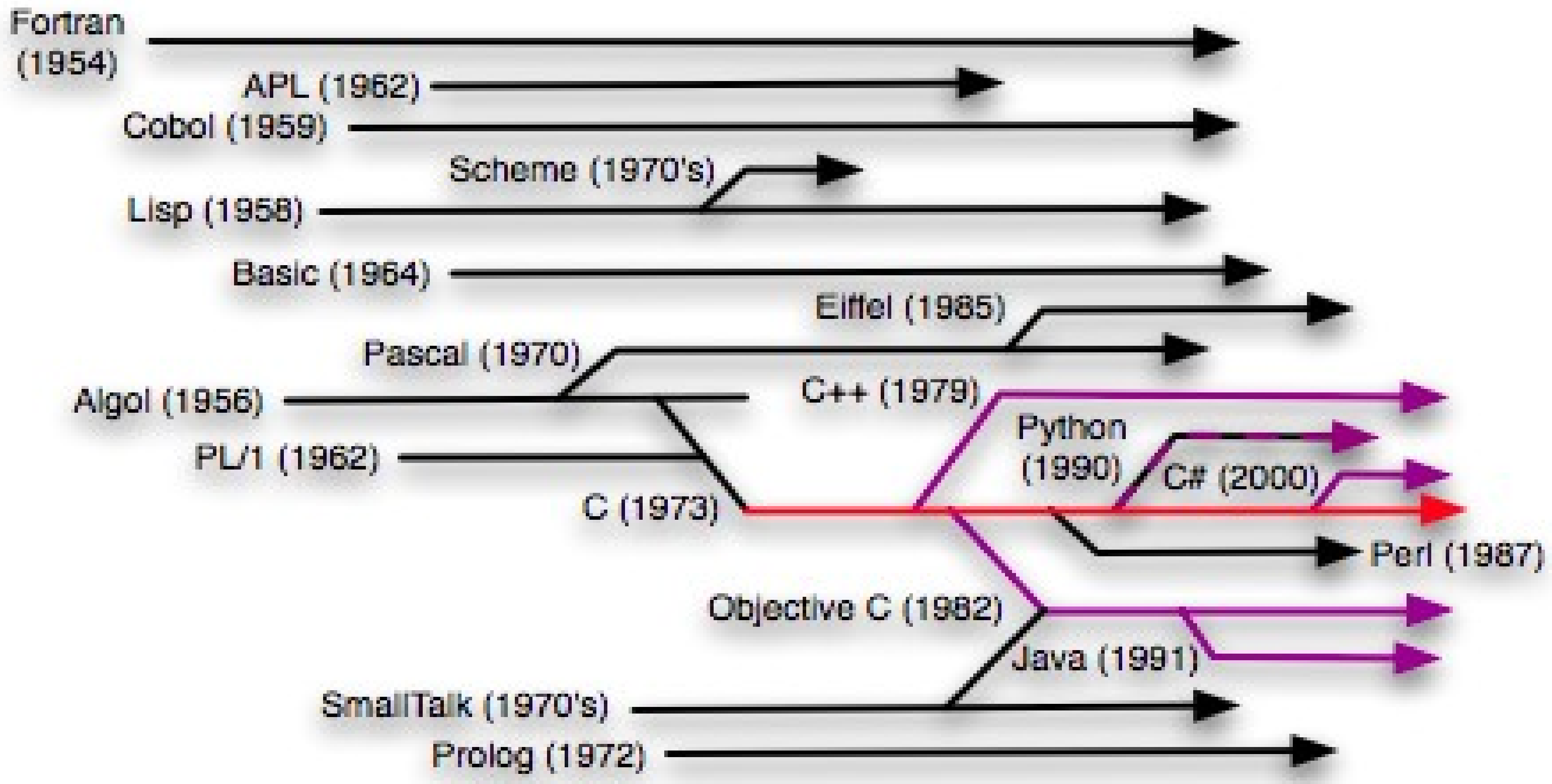


INTERPRETED LANGUAGES

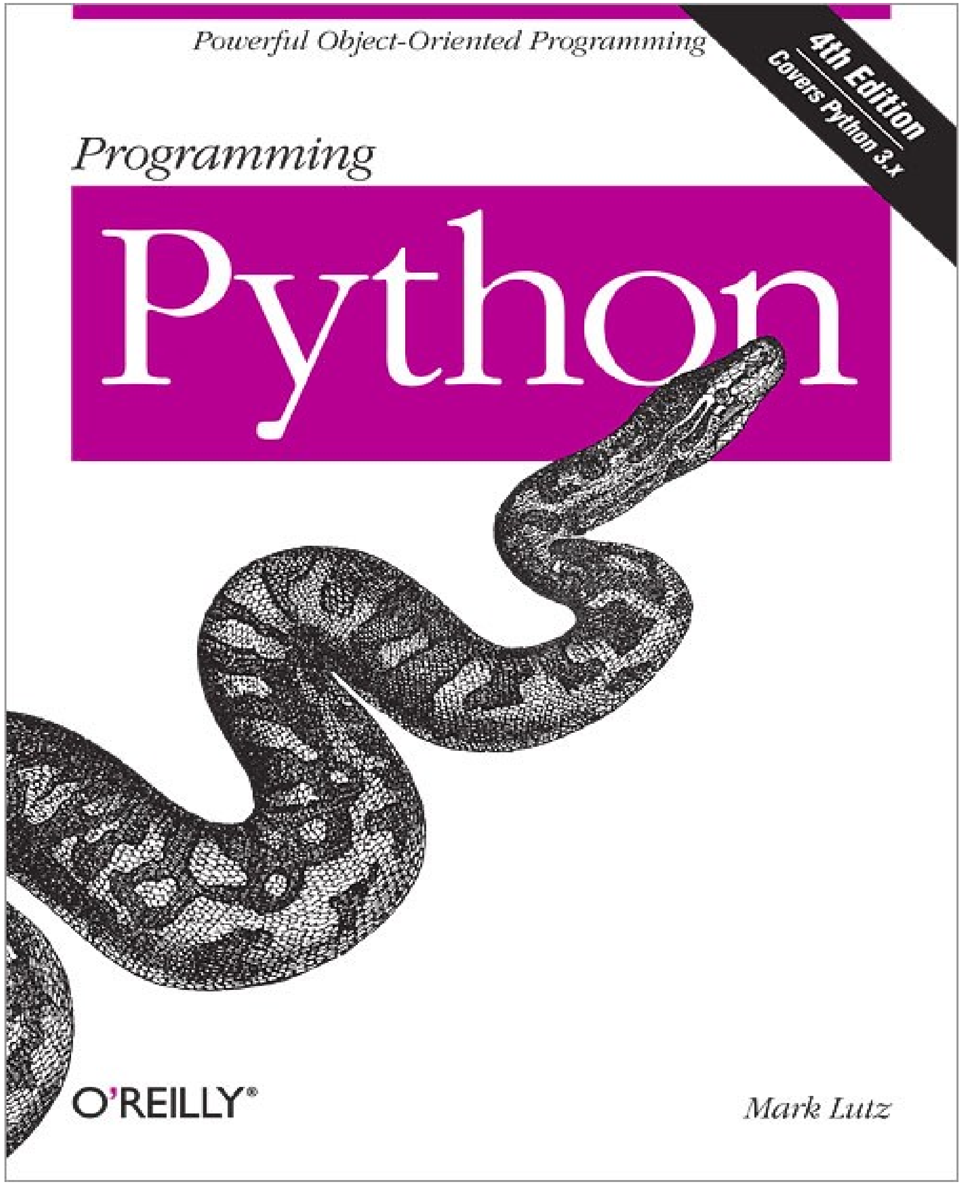
Interpreters and compilers



Programming languages



Python



https://www.python.org/

https://docs.python.org/3/

https://docs.python.org/3/tutorial/

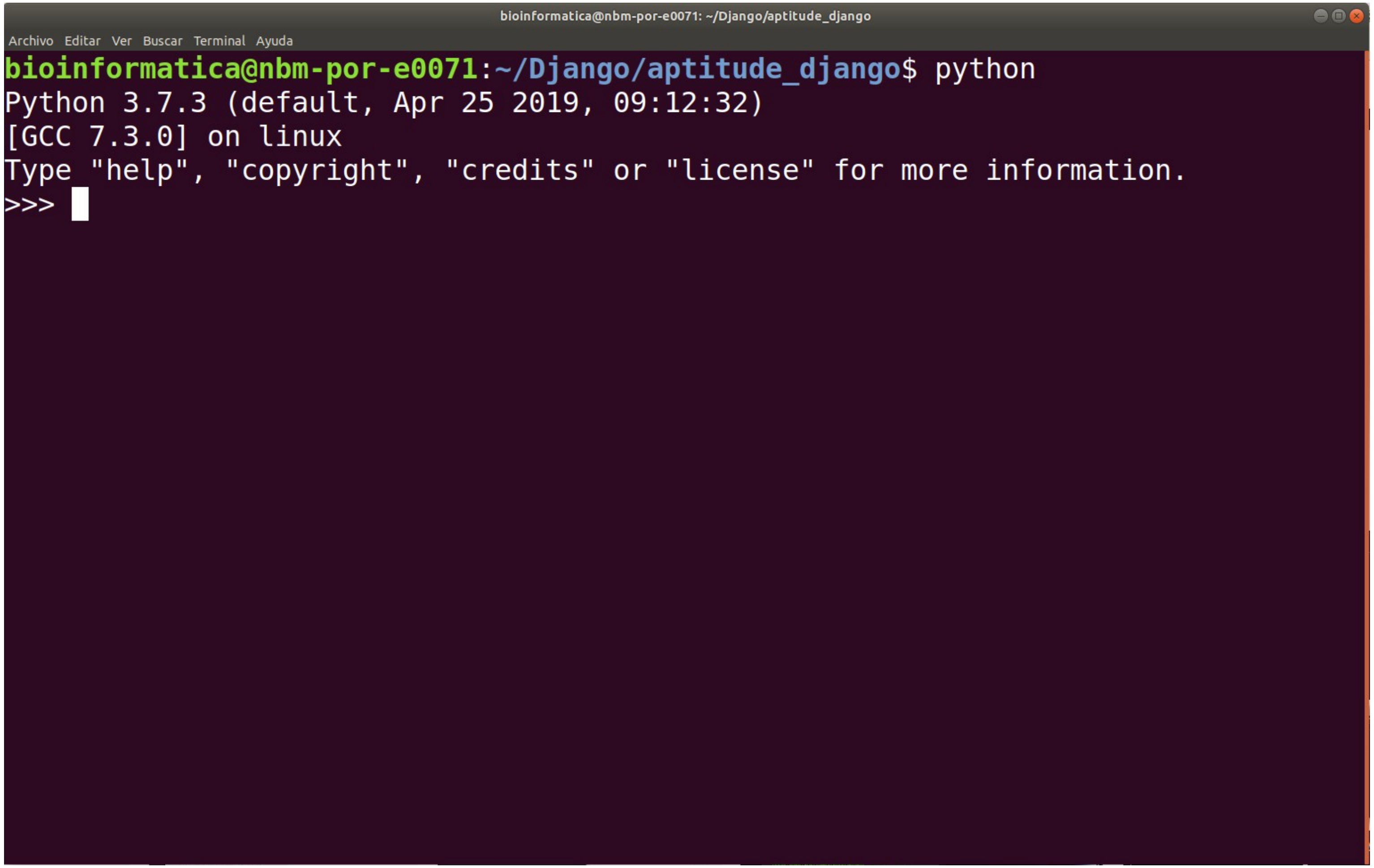
https://www.python.org/dev/peps/pep-0008/

http://www.diveintopython3.net/

http://www.learnpython.org/

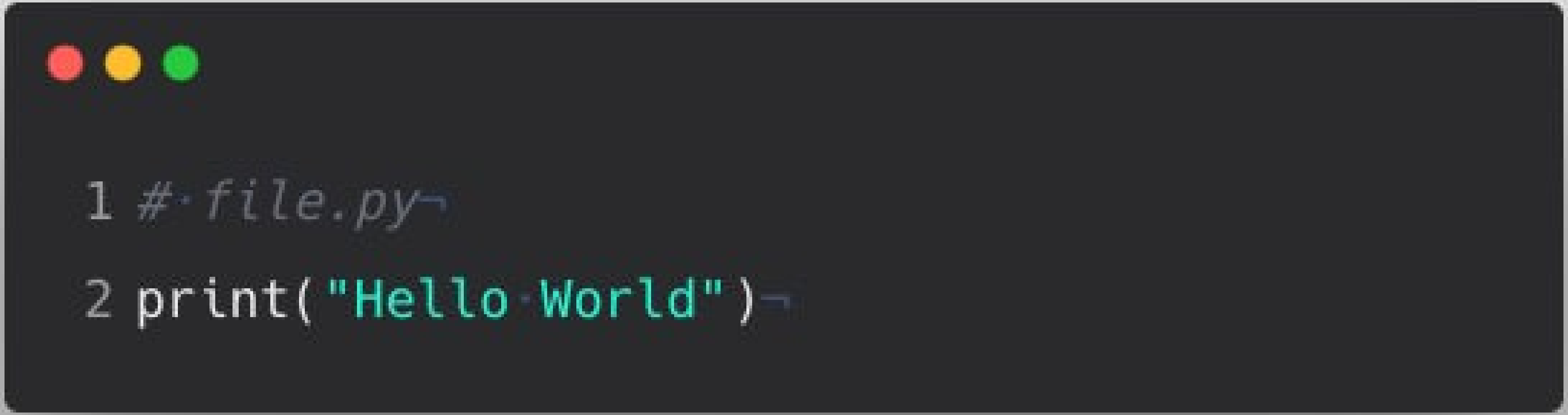
https://realpython.com/

Python



bioinformatica@nbm-por-e0071: ~/Django/aptitude_django
Archivo Editar Ver Buscar Terminal Ayuda

```
bioinformatica@nbm-por-e0071:~/Django/aptitude_django$ python
Python 3.7.3 (default, Apr 25 2019, 09:12:32)
[GCC 7.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> 
```



```python
# file.py
print("Hello World")
```

Python

- **Everything in Python is an object, and almost everything has attributes and methods.**
  - **Object:** A single software unit that combines attributes and methods
  - **Attribute:** A "characteristic" of an object; like a variable associated with a kind of object
  - **Method:** A "behavior" of an object; like a function associated with a kind of object
  - **Class:** *Code that defines the attributes and methods of a kind of object (A class is a collection of variables and functions working with these variables)*

Python

- Python has a way to put definitions in a file. Such a file is called a module
- Definitions from a module can be imported into our code by using the import statement

```
>>> import math
```

- The built-in function dir() is used to find out which names a module defines. It returns a sorted list of strings:

```
>>> dir(math)
```

- You can get help() on any function name to see how to use it.

```
>>> help(math.cos)
```

Python

- Python scripts have extension .py
- You can run them rfom the command line invoking the python interpreter

```
python my_script.py
```

Python

```
#!/usr/bin/python

#
# Let's calculate diameter, circumference and area for a circle of given radius
#

import math

r = input("What is the radius of your circle (in cm)? ")

print("The diameter of your circle is {} cm".format(2*r))
print("The circumference of your circle is {} cm".format(2*math.pi*r))
print("The area of your circle is {} cm2".format(math.pi*pow(r,2)))
```

Control statements

- Make choices based on conditions – to selectively execute certain portions of the code
  - Use `if` to execute code based on a condition
  - Use `if-else` to make a choice based on a condition
  - Use `if-elif-else` structures to make a choice based on a series of conditions

Control statements

Conditional Loops

while *logical_expression***:**

statements…

```
>>> i = 0
>>> while i < 5:
...     print(i)
...     i += 1
...
0
1
2
3
4
```

Iterative Loops

for *individual_item* in *iterator*:

statements…

```
>>> names = ["chris", "iftach", "jay"]
>>> for name in names:
...     print(name)
...
chris
iftach
Jay
```

Generating Random Numbers

- Great for simulations and games
- Random numbers generated by computer are not truly random but pseudorandom, generated by formula; complex but predictable pattern
- Need to use a module (random)

```
import random

random.randrange(n) # generates random number
                    # from 0 to n - 1
```

Guess My Number Game

```
from random import randrange
print("Welcome to 'Guess My Number'!")

print("I'm thinking of a number between and 100")
print("Try to guess it in as few attemps as possible")

c=0
n=randrange(1,101)
while True:
    a = input("Take a guess: ")
    c+=1
    if (a>n):
        print("Lower...")
    elif(a<n):
        print("Higher...")
    else:
        print("You guessed it!")
        print("and it only took you {} attempt(s)".format(c))
        break
```

String functions

```
>>> len("GATTACA")
7
```

← Length

```
>>> print "GAT" + "TACA"
GATTACA
```

← Concatenation

```
>>> print "A" * 10
AAAAAAAAAA
```

← Repeat

```
>>> "GAT" in "GATTACA"
True
```

← Substring tests

```
>>> word = "GATTACA"
>>> word[1:4]
ATT
```

← Assign a string slice to a variable name

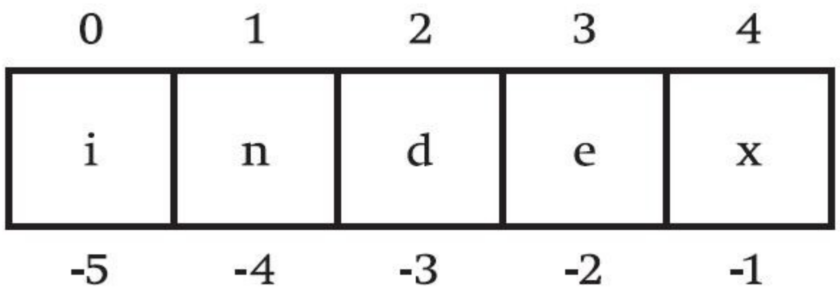
String Methods

```
quote = "I think there is a world market for maybe five computers."
>>>quote.upper()
I THINK THERE IS A WORLD MARKET FOR MAYBE FIVE COMPUTERS
>>>quote.lower()
i think there is a world market for maybe five computers.
>>quote.title()
I Think There Is A World Market For Maybe Five Computers.
>>quote.replace("five", "millions of")
I think there is a world market for millions of computers.
```

String Methods

```
word = "engineering"
>>> word.startswith("e")
True
>>> word.endswith("e")
False
>>> word.count('e')
3
>>> word.find(“ne”)
4
>>> "ne" in word
True
```

Indexing and slicing



0	1	2	3	4
i	n	d	e	x
-5	-4	-3	-2	-1

- Use brackets and position number to index index[3]
- Positive position numbers: starts at 0; ends with the length of a sequence - 1
- Negative position numbers: starts at the end of sequence with position number: –1
- Attempt to access beyond last position results in error

Indexing

```
>>> word = "engineering"

>>> len(word)

11

>>> word[0]

'e'

>>> word[1:5]

'ngin'

>>> word[5:]

'eering'

>>> word[-3:]

'ing'

>>> word[:3]

'eng'
```

Immutable vs Mutable

```
>>> word = "game"
>>> word[0] = "l"
TypeError: object does not support item assignment
```

- **Mutable:** Changeable
- **Immutable:** Unchangeable
- String immutability -- Strings are immutable sequences; can’t be changed
  - Tuples are immutable too; Lists are mutable!
- But can **create new strings from existing ones** (like through concatenation)

for loops

- Repeats loop body for each element in a sequence
- Ends when it reaches end of the sequence
- **Sequence:** An ordered list of elements
- **Element:** A single item in a sequence
- **Iterate:** To move through a sequence, in order

```
for letter in “hello world”:
	print(letter)
```

Lists

- List: A mutable sequence of any type
- Creating List

```
team = []
team = ["Alberto", "Juan", "Nuria",”Esther”]
```

- len function

```
len(team)
```

- in operator

```
if "Alberto" in team:
    print("Hi, Alberto, you are part of the team”)
```

- Indexing and slicing

```
team[1], team[:3]
```

- Concatenating lists

```
team + ['Oscar', 'Arantxa’]
```

Understanding List Mutability

- **Mutable =>** Can be modified
- Lists are mutable
  - Elements (or slices) can be added
  - Elements (or slices) can be modified
  - Elements (or slices) can be removed

Assigning New Element Or Slice

```
>>> team.append('Oscar')
['Alberto', 'Juan', 'Nuria', 'Esther', 'Oscar']

>>> team[0] = "Arantxa"
>>> print(team)
['Arantxa', 'Juan', 'Nuria', 'Esther', 'Oscar']

>>> team[3:4] = ["Jon"]
>>> print(inventory)
['Arantxa', 'Juan', 'Nuria', ’Jon’]
```

Deleting an Element or a Slice

```
>>> team = ['Arantxa', 'Juan', 'Nuria', ’Jon’, 'Alberto', 'Esther', 'Oscar']

>>> del(team[2])
>>> print(team)
 ['Arantxa', 'Juan', ’Jon’, 'Alberto', 'Esther', 'Oscar']

>>> del(team[:2])
>>> print(team)
['Jon', 'Alberto', 'Esther', 'Oscar']
```

Strings and lists

```
>>> quote = ‘ I think there is a world market for maybe
five computers’
>>> quote.split()
['I', 'think', 'there', 'is', 'a', 'world', 'market', 'for', 'maybe',
'five', 'computers.']

>>> word = ‘engineering’
>>> list(word)
['e', 'n', 'g', 'i', 'n', 'e', 'e', 'r', 'i', 'n', 'g']
```

The range() function

```
>>> range(5)
[0, 1, 2, 3, 4]

>>> range(0, 50, 5)
[0, 5, 10, 15, 20, 25, 30, 35, 40, 45]

>>> range(10,1,-1)
[10, 9, 8, 7, 6, 5, 4, 3, 2]
```

Returns **a sequence** of integers in range

- range(*i*) returns sequence 0 through *i* - 1
- range(*i*, *j*) returns sequence *i* through *j* - 1
- range(*i*, *j*, *k*) returns sequence *i* to *j - 1*, step *k*

The range() function

```
# counting forward
for i in range(10):
    print(i)

# counting by fives
for i in range(0, 50, 5):
   print(i)

# counting backwards
for i in range(10, 0, -1):
   print(i)
```

List comprehension

- word = ‘engineering’
- letters = list(word)
- [s for s in word]

  ['e', 'n', 'g', 'i', 'n', 'e', 'e', 'r', 'i', 'n', 'g']
- >>> [x ** 2 for x in range(20)]

  [0, 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225, 256, 289, 324, 361]

List comprehension

- [x for x in range(20) if x % 2 == 0]

- lst_lst = [[1,2,3,4,5], [6,7,8], [9,10]]
- lst = [y for x in lst_lst if len(x) < 4 for y in x if y % 2 == 0]

Lists

- list.append(x) - Add an item to the end of the list;
- list.extend(L) - Extend the list by appending all the items in the given list;
- list.insert(i, x) - Insert an item at a given position. The first argument is the index of the element before which to insert, so a.insert(0, x) - inserts at the front of the list, and a.insert(len(a), x) is equivalent to a.append(x).
- list.remove(x) - Remove the first item from the list whose value is x. It is an error if there is no such item.
- list.pop([i]) -Remove the item at the given position in the list, and return it. If no index is specified, a.pop() removes and returns the last item in the list.
- list.index(x) -Return the index in the list of the first item whose value is x
- list.count(x) -Return the number of times x appears in the list.
- list.sort(cmp=None, key=None, reverse=False) - Sort the items of the list in place
- list.reverse() -Reverse the elements of the list, in place.

Tuples

- **Tuple:** Immutable sequence of values of any type
- Could have tuple of integers for a high score list, for example
- Tuples elements don't need to all be of same type

```
a = ("Monday", 3, 4.5)
```

Tuple Basics

- Creating an Empty Tuple

```
team = ()
```

- Treating a Tuple as a Condition

```
if not team:
   print("You are empty-handed.")
```

- Creating a Tuple with Elements

```
team = ('Jon', 'Alberto', 'Esther', 'Oscar')
```

- Looping through a tuple’s elements

```
for person in team:
   print(person)
```

Tuple Immutability

```
>>> team = ('Jon', 'Alberto', 'Esther', 'Oscar')

>>> team[0] = "Arantxa"

TypeError: object doesn't support item assignment
```

- Tuples are immutable
- But can create new tuples from existing ones

Unpacking a sequence

```
>>> name, age = ("Alberto", 42)
>>> print(name)
Alberto
>>> print(age)
42
```

Sequence unpacking: Automatically accessing each element of a sequence as a result of assignment statement

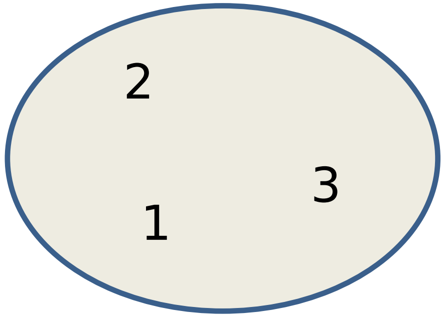
Processing sequence

```
for name in team:
    print(name)


for i in range(len(team))
    print(“{}.- {}”.format(i, team[i]))


for i, name in enumerate(team):
```

Sets

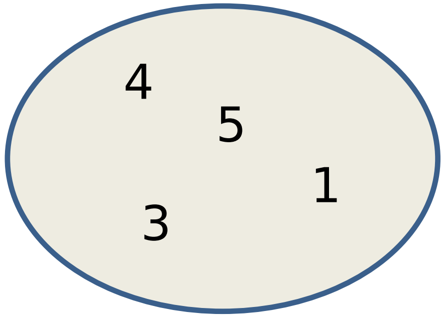
- Mathematical set: a collection of values, without duplicates or order
- Order does not matter

  { 1, 2, 3 } == { 3, 2, 1 }



- No duplicates

  { 3, 1, 4, 1, 5 } == { 5, 4, 3, 1 }



- For every data structure, ask:
  - How to create
  - How to query (look up) and perform other operations
    - (Can result in a new set, or in some other datatype)
  - How to modify

Create a set

1. Direct mathematical syntax

```
odd = { 1, 3, 5 }
prime = { 2, 3, 5 }
```

   Cannot express empty set: “**{}**” is a dictionary

2. Construct from a list

```
odd = set([1, 3, 5])
prime = set([2, 3, 5])
empty = set([])
```

   Python always prints using this syntax

Modifying a set

- Add one element to a set:

```
myset.add(new_ele)
myset = myset | { new_ele }
```

- Remove one element from a set:

```
myset.remove(elt)   # elt must be in myset
myset.discard(elt)  # never errs
myset = myset - { elt }
```

- Choose and remove some element from a set:

```
myset.pop()
```

Set operations

```
odd = { 1, 3, 5, 7 }
prime = { 2, 3, 5, 7 }
even = {2,4,6,8}
```

- membership ▦ Python: **4 in prime** ▲ False
- union ■ Python: **odd | prime** ▲ { 1, 2, 3, 5 }
- intersection 💾 Python: **odd & prime** ▲ { 3, 5 }
- difference \ or -Python: **odd – prime** ▲ { 1 }
- Iteration over sets:

```
# iterates over items in arbitrary order
for item in myset:
    print(item)
```

Dictionaries or mappings

- A dictionary maps each key to a value
- Order does not matter
- Given a key, can look up a value
  - Given a value, cannot look up its key
- No duplicate keys
  - Two or more keys may map to the same value
- Keys and values are Python values
  - Keys must be immutable (not a list, set, or dict)
- Can add key → value mappings to a dictionary
  - Can also remove (less common)

Dictionary syntax in Python

```
d = { }
d = dict()
alberto = {
  ‘name’: "Alberto",
  ‘age’: 25,
  ‘city’: "Pamplona" }
juan = {
  ‘name’: "Ana",
  ‘age’: 28,
  ‘city’: "Madrid" }
```

Iterating through a dictionary

```
atomic_number = {"H":1, “O”:8, “C”:6 ,"Fe":26, "Au":79}

# Print out all the keys:
for element_name in atomic_number.keys():
    print element_name

# Another way to print out all the keys:
for element_name in atomic_number:
    print element_name

# Print out all the values:
for element_number in atomic_number.values():
    print element_number

# Print out the keys and the values
for (ele_name, ele_number) in atomic_number.items():
    print("The atomic number of {} is {} ".format(ele_name, ele_number)
```

Modifying a dictionary

```
alberto["City"] = “Barcelona”  # change mapping
alberto["Country"] = “Spain”  # change mapping

del(alberto["City"])  # remove mapping
```

Data types. Sequences

- Mutables:
  - list: ordered collection of values of any type which can be added and deleted
    - [’hello’,4, (1,2),{3,4}]
  - set: unordered, not repeated collection of values of any type which can be added and deleted
    - {’infinite’,1,0,5,(’a’,1)}
  - dict: unordered collection of key:value pairs. Key can be ayn inmutable type, value can be of any type
    - {’tomato’:(1,’Kg’), ’cuccumber’:2,’salt’:’1 spoon’, ’aceite’:.1}

Data types. Sequences

- Inmutables:
  - str: An ordered sequence of characters
    - “Hello world!”
  - frozenset : A set object is an unordered collection of immutable values
    - frozenset({3,5,6.1})
  - tuple: sequence of 0, 1 or n elements (can be of different type)

    (1,’a’,3,3)