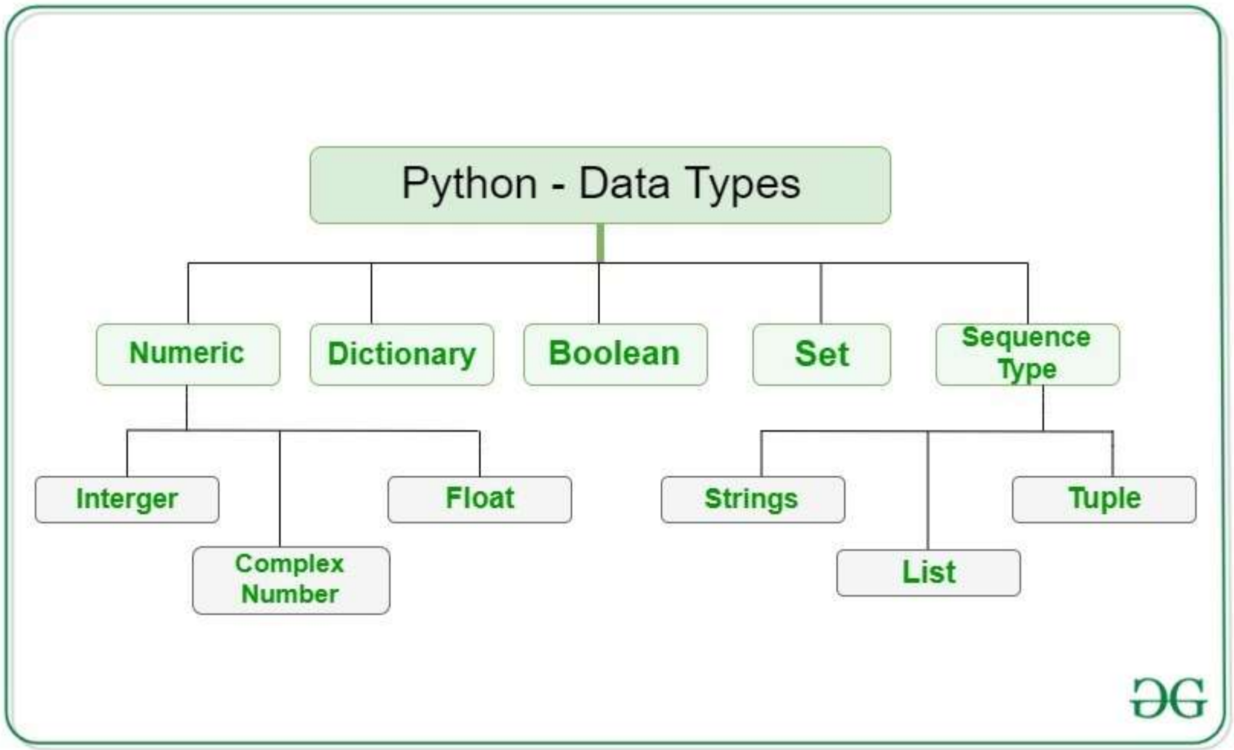
# Introduction Python Programming

## Python Data Types

Data types are the classification or categorization of data items. It represents the kind of value that tells what operations can be performed on a particular data. Since everything is an object in Python programming, data types are actually classes and variables are instance (object) of these classes. Following are the standard or built-in data type of Python

- **Numeric**
- **Sequence type**
- **Boolean**
- **Set**
- **Dictionary**



In Python, numeric data type represents the data which has numeric value. Numeric value can be integer, floating number or even complex numbers. These values are defined as int, float and complex class in Python.

- **Integers** – This value is represented by int class. It contains positive or negative whole numbers (without fraction or decimal). In Python there is no limit to how long an integer value can be.
- **Float** – This value is represented by float class. It is a real number with floating point representation. It is specified by a decimal point. Optionally, the character e or E followed by a positive or negative integer may be appended to specify scientific notation.
- **Complex Numbers** – Complex number is represented by complex class. It is specified as *(real part) + (imaginary part)j*. For example – 2+3j

**Note** – type() function is used to determine the type of data type.

```
# Python program to
# demonstrate numeric value
a = 5
print("Type of a: ", type(a))
b = 5.0
print("\nType of b: ", type(b))
c = 2 + 4j
print("\nType of c: ", type(c))
```

**Output:**

```
Type of a:  <class 'int'>
Type of b:  <class 'float'>
Type of c:  <class 'complex'>
```

**Sequence Type**

In Python, sequence is the ordered collection of similar or different data types. Sequences allows to store multiple values in an organized and efficient fashion. There are several sequence types in Python

- **String**
- **List**
- **Tuple**

**String**

In Python, Strings are arrays of bytes representing Unicode characters. A string is a collection of one or more characters put in a single quote, double-quote or triple quote. In python there is no character data type, a character is a string of length one. It is represented by str class.

```
String1 = 'Welcome to the Bioinformatics and Genomic Data Analysis'

print(String1)
```

**Output**

```
Welcome to the Bioinformatics and Genomic Data Analysis
```

## List

Lists are just like the arrays, declared in other languages which is an ordered collection of data. It is very flexible as the items in a list do not need to be of the same type.

***Creating List***

Lists in Python can be created by just placing the sequence inside the square brackets [].

**Output**

```
[5, 7, 9.4, “nimr”, “workshop”]
Print(List1)
```

**Tuple**

Just like list, tuple is also an ordered collection of Python objects. The only difference between type and list is that tuples are immutable i.e. tuples cannot be modified after it is created. It is represented by tuple class

```
Tuple1 = (29, 3, .4, “data”, “genomics”)
print(Tuple1)
```

**Output**

```
(29, 3, .4, “data”, “genomics”)
```

**Boolean**

Data type with one of the two built-in values, True or False. Boolean objects that are equal to True are truthy (true), and those equal to False are falsy (false). But non-Boolean objects can be evaluated in Boolean context as well and determined to be true or false. It is denoted by the class bool. **Note** – True and False with capital ‘T’ and ‘F’ are valid booleans otherwise python will throw an error.

```
Nimr = 34==34
Bio = 9==6
print(Nimr)
print(Bio)
print(type(Nimr))
```

**Output**

```
True
False
Class ‘bool’
```

**Set**

In Python, Set is an unordered collection of data type that is iterable, mutable and has no duplicate elements. The order of elements in a set is undefined though it may consist of various elements.

**Creating Sets**

Sets can be created by using the built-in set() function with an iterable object or a sequence by placing the sequence inside curly braces, separated by ‘comma’. Type of elements in a set need not be the same, various mixed-up data type values can also be passed to the set.

```
Set1 = set(“Bioinformatic and Genomic Data Analysis Workshop”)
print(Set1)
```

**Output**

```
{' ', 'l', 'o', 'h', 'a', 'r', 'm', 'k', 'p', 'W', 'B', 'G', 'y', 'n',
't', 's', 'c', 'd', 'e', 'A', 'i', 'f', 'D'}
```

## 2 Using Python as a Calculator

In the following examples, input and output are distinguished by the presence or absence of prompts (`>>>` and `...`): to repeat the example, you must type everything after the prompt, when the prompt appears; lines that do not begin with a prompt are output from the interpreter. Note that a secondary prompt on a line by itself in an example means you must type a blank line; this is used to end a multi-line command

Let's try some simple Python commands. Start the interpreter and wait for the primary prompt, >>>. (It shouldn't take long.)

### 2.1 Numbers

**The interpreter** acts as a simple calculator: you can type an expression at it and it will write the value. Expression syntax is straight forward: the operators `+`, `-`, `*` and `/` work just like in most other languages (for example, Pascal or C); parentheses (`()`) can be used for grouping. For example:

```
>>> 4 + 4
8
>>> 50 - 5*6
20
>>> (50 - 5*6) / 4
5.0
>>> 8 / 5 # division always returns a floating point number
1.6
```

The integer numbers (e.g. `2`, `4`, `20`) have type `int`, the ones with a fractional part (e.g. `5.0`, `1.6`) have type `float`. We will see more about numeric types later in the tutorial.

**Division (`/`)** always returns a float. To do *floor division* and get an integer result (discarding any fractional result) you can use the `//` operator; to calculate the remainder you can use `%`:

```
>>> 17 / 3 # classic division returns a float
5.666666666666667
>>>
>>> 17 // 3 # floor division discards the fractional part 5
>>> 17 % 3 # the % operator returns the remainder of the division
2
>>> 5 * 3 + 2 # result * divisor + remainder
17
```

With Python, it is possible to use the `**` operator to calculate powers[1]:

```
>>> 5 ** 2 # 5 squared
```

[1] Since `**` has higher precedence than `-`, `-3**2` will be interpreted as `-(3**2)` and thus result in `-9`. To avoid this and get `9`, you can use `(-3)**2`.

```
25
>>> 2  ** 7  # 2 to the power of 7
128
```

The equal sign (=) is used to assign a value to a variable. Afterwards, no result is displayed before the next interactive prompt:

```
>>> width = 20
>>> height = 5 * 9
>>> width * height
900
```

If a variable is not "defined" (assigned a value), trying to use it will give you an error:

```
>>> n # try to access an undefined variable Traceback (most recent call last):
File "<stdin>", line 1, in <module>
NameError: name 'n' is not defined
```

There is full support for floating point; operators with mixed type operands convert the integer operand to floating point:

```
>>> 4 * 3.75 - 1
14.0
```

In interactive mode, the last printed expression is assigned to the variable _. This means that when you are using Python as a desk calculator, it is somewhat easier to continue calculations, for example:

```
>>> tax = 12.5 / 100
>>> price = 100.50
>>> price * tax
12.5625
>>> price + _
113.0625
>>> round(_, 2)
113.06
```

This variable should be treated as read-only by the user. Don't explicitly assign a value to it — you would create an independent local variable with the same name masking the built-in variable with its magic behavior.

In addition to `int` and `float`, Python supports other types of numbers, such as `Decimal` and `Fraction`. Python also has built-in support for complex numbers, and uses the `j` or `J` suffix to indicate the imaginary part (e.g. `3+5j`).

### 2.1.2 Strings

Besides numbers, Python can also manipulate strings, which can be expressed in several ways. They can be enclosed in single quotes (`'...'`) or double quotes (`"..."`) with the same result[2].

```
>>> 'spam eggs' # single quotes
'spam eggs'
>>> "doesn't" # ...or use double quotes instead
"doesn't"
>>> '"Yes," they said.'
'"Yes," they said.'
```

String literals can span multiple lines. One way is using triple-quotes: `"""..."""` or `'''...'''`. End of lines are automatically included in the string, but it's possible to prevent this by adding a `\` at the end of the line. The following example:

**3.1.**

```
print("\
Usage: This bioinformatics workshop is an experience I can never forget in a
     hurry")
```

produces the following output (note that the initial newline is not included):

```
Usage: This bioinformatics workshop is an experience I can never forget in a hurry
```

Strings can be concatenated (glued together) with the `+` operator, and repeated with `*`:

```
>>> # 3 times 'un', followed by 'ium'
>>> 3 * 'un' + 'ium' 'unununium'
```

Two or more *string literals* (i.e. the ones enclosed between quotes) next to each other are automatically concatenated.

```
>>> 'Py' 'thon'
'Python'
```

This feature is particularly useful when you want to break long strings:

```
>>> text = ('Put several strings within parentheses '
...         'to have them joined together.')
>>> text
'Put several strings within parentheses to have them joined
together.'
```

This only works with two literals though, not with variables or expressions:

```
>>> prefix = 'Py'
>>> prefix 'thon' # can't concatenate a variable and a string
  literal ...
SyntaxError: invalid syntax
>>> ('un' * 3) 'ium'
  ...
SyntaxError: invalid syntax
```

If you want to concatenate variables or a variable and a literal, use +:

```
>>> prefix + 'thon'
'Python'
```

Strings can be *indexed* (subscripted), with the first character having index 0. There is no separate character type; a character is simply a string of size one:

```
>>> word = 'Python'
>>> word[0]  # character in position 0
'P'
>>> word[5]  # character in position 5 'n'
```

Indices may also be negative numbers, to start counting from the right:

```
>>> word[-1]     # last character
'n'              # second-last character
>>> word[-2]
'o'
>>> word[-6]
'P'
```

Note that since -0 is the same as 0, negative indices start from -1.

In addition to indexing, *slicing* is also supported. While indexing is used to obtain individual characters, *slicing* allows you to obtain substring:

```
>>>         # characters from position 0 (included) to 2 (excluded)
word[0:2]
'Py'
>>>
word[2:5]   # characters from position 2 (included) to 5 (excluded)
'tho'
```

Note how the start is always included, and the end always excluded. This makes sure that `s[:i] + s[i:]` is always equal to `s`:

```
>>> word[:2] + word[2:]
'Python'
>>> word[:4] + word[4:]
'Python'
```

Slice indices have useful defaults; an omitted first index defaults to zero, an omitted second index defaults to the size of the string being sliced.

```
>>> word[:2]    # character from the beginning to position 2 (excluded)

'Py'
>>> word[4:]    # characters from position 4 (included) to the end

'on'
>>> word[-2:]   # characters from the second-last (included) to the end
'on'
```

One way to remember how slices work is to think of the indices as pointing *between* characters, with the left edge of the first character numbered 0. Then the right edge of the last character of a string of *n* characters has index *n*, for example:

```
+---+---+---+---+---+---+
| P | y | t | h | o | n |
+---+---+---+---+---+---+
  0   1   2   3   4   5
 -6  -5  -4  -3  -2  -1
```

The first row of numbers gives the position of the indices 0…5 in the string; the second row gives the corresponding negative indices. The slice from *i* to *j* consists of all characters between the edges labelled *i* and *j*, respectively.

For non-negative indices, the length of a slice is the difference of the indices, if both are within bounds. For example, the length of `word[1:3]` is 2.

Attempting to use an index that is too large will result in an error:

```
>>> word[42] # the word only has 6 characters
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: string index out of range
```

### 3.1.3 Lists

Python knows a number of *compound* data types, used to group together other values. The most versatile is the *list*, which can be written as a list of comma-separated values (items) between square brackets. Lists might contain items of different types, but usually the items all have the same type.

```
>>> squares = [1, 4, 9, 16, 25]
>>> squares
[1, 4, 9, 16, 25]
```

Like strings (and all other built-in *sequence* type), lists can be indexed and sliced:

```
>>> squares[0] # slicing returns a new list
1
>>> squares [-1]

 25
 >>> squares[-3:]
 [9, 16, 25]
```

All slice operations return a new list containing the requested elements. This means that the following slice returns a new (shallow) copy of the list:

```
>>> squares[:]
[1, 4, 9, 16, 25]
```

Lists also support operations like concatenation:

```
>>> squares + [36, 49, 64, 81, 100]
[1, 4, 9, 16, 25, 36, 49, 64, 81, 100]
```

Unlike strings, which are *immutable*, lists are a *mutable* type, i.e. it is possible to change their content:

```
>>> cubes = [1, 8, 27, 65, 125] # something's wrong here
>>> 4 ** 3 # the cube of 4 is 64, not 65!
64
>>> cubes[3] = 64 # replace the wrong value
>>> cubes
[1, 8, 27, 64, 125]
```

You can also add new items at the end of the list, by using the `append()` *method* (we will see more about methods later):

```
>>> cubes.append(216) # add the cube of 6
>>> cubes.append(7 ** 3) # and the cube of 7
>>> cubes
[1, 8, 27, 64, 125, 216, 343]
```

Assignment to slices is also possible, and this can even change the size of the list or clear it entirely:

```
>>> letters = ['a', 'b', 'c', 'd', 'e', 'f', 'g']
>>> letters
['a', 'b', 'c', 'd', 'e', 'f', 'g']
>>> # replace some values
>>> letters[2:5] = ['C', 'D', 'E']
>>> letters
['a', 'b', 'C', 'D', 'E', 'f', 'g']
>>> # now remove
them >>>
letters[2:5] = []
>>> letters
['a', 'b', 'f', 'g']
>>> # clear the list by replacing all the elements with an
empty list >>> letters[:] = []
>>> letters
[]
```

The built-in function `len()` also applies to lists:

```
>>> letters = ['a', 'b', 'c', 'd']
>>> len(letters)
4
```

It is possible to nest lists (create lists containing other lists), for example:

```
>>> a = ['a', 'b', 'c']
>>> n = [1, 2, 3]
>>> x = [a, n]
>>> x
[['a', 'b', 'c'], [1, 2, 3]]
>>> x[0]
['a', 'b', 'c']
```

## More on Lists

The list data type has some more methods. Here are all of the methods of list objects:

**`list.append(`*x*`)`**

Add an item to the end of the list. Equivalent to `a[len(a):] = [x]`.

**`list.extend(`*iterable*`)`**

Extend the list by appending all the items from the iterable. Equivalent to `a[len(a):] = iterable`.

**`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 equal to *x*. It raises a `ValueError` 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. (The square brackets around the *i* in the method signature denote that the parameter is optional, not that you should type square brackets at that position. You will see this notation frequently in the Python Library Reference.)

**`list.clear()`**

Remove all items from the list. Equivalent to `del a[:]`.

**`list.index`**(*x*[, *start*[, *end* ]])

Return zero-based index in the list of the first item whose value is equal to *x*. Raises a `ValueError` if there is no such item.

The optional arguments *start* and *end* are interpreted as in the slice notation and are used to limit the search to a particular subsequence of the list. The returned index is computed relative to the beginning of the full sequence rather than the *start* argument. `list.count`(*x*)

Return the number of times *x* appears in the list.

**`list.sort`**(*key=None*, *reverse=False*)

Sort the items of the list in place (the arguments can be used for sort customization, see `sorted()` for their explanation).

**`list.reverse()`**

Reverse the elements of the list in place.

**`list.copy()`**

Return a shallow copy of the list. Equivalent to `a[:]`.

An example that uses most of the list methods:

```
>>> fruits = ['orange', 'apple', 'pear', 'banana', 'kiwi', 'apple',
'banana'] >>> fruits.count('apple')
2
>>> fruits.count('tangerine')
0
>>> fruits.index('banana')
3
>>> fruits.index('banana', 4) # Find next banana starting a
position 4 6
>>> fruits.reverse()
>>> fruits
['banana', 'apple', 'kiwi', 'banana', 'pear', 'apple', 'orange']
>>> fruits.append('grape')
>>> fruits
['banana', 'apple', 'kiwi', 'banana', 'pear', 'apple', 'orange',
'grape']
>>> fruits.sort()
>>> fruits
['apple', 'apple', 'banana', 'banana', 'grape', 'kiwi', 'orange',
'pear']
>>> fruits.pop()
'pear'
```

You might have noticed that methods like `insert`, `remove` or `sort` that only modify the list have no return value printed – they return the default `None`.[1] This is a design principle for all mutable data structures in Python.

Bibliography

- **Guido van Rossum *et al.* (2018)**
- **https://www.geeksforgeeks.org/python-data-types/**