

# CFDS® – Chartered Financial Data Scientist

# Introduction to Python

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4 December 2025

## Table of Contents

- 1 Data types and structures
  - 1.1 First examples
  - 1.2 Variables
  - 1.3 Basic Data Types
  - 1.4 Basic Data Structures
  - 1.5 Control flow
  - 1.6 Functions

## Data types and structures

### First examples

#### First examples

- Printing to the standard output:

```
In [ ]: print("Hello World")
```

## First examples

- A calculator:

```
In [ ]: 2+4
```

```
In [ ]: 2-4
```

```
In [ ]: 2**12
```

- A double asterisk ( `**` ) is the operator for taking powers.
- The code in a cell is executed by clicking on "Run" or via the shortcut `Shift + Enter`.

## Variables

### Variables

- The kernel stores data in variables. The assignment operator `=` assigns a variable name (left-hand side) a value (right-hand side).

```
In [ ]: a = 5  
b = 2  
a*b
```

```
In [ ]: savings = 50
```

```
In [ ]: savings
```

### Variables

- Calculate the savings value in seven years, given an interest rate of 7%.

```
In [ ]: r = 0.07  
future_value = savings*(1+r)**7  
future_value
```

## Built-in functions

- A number of built-in functions are available ([link](#)):

Built-in functions

## Built-in functions

```
In [ ]: round(future_value, 4)
```

Use `help()` to learn more about functions:

```
In [ ]: help(round)
```

## Basic Data Types

### Basic Data Types

Object type	Meaning	Used for
int	Integer value	Natural numbers
float	Floating-point number	Real numbers
bool	Boolean value	Something true or false
str	String object	Character, word, text

### Integers

- Zero, natural numbers and their negative counterparts, i.e.,  
 $\mathbb{Z} = \{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$

```
In [ ]: a = 4  
        type(a)
```

### Floating point numbers ("floats")

- Computer representation of real numbers, i.e.,  $\mathbb{R}$

```
In [ ]: 1.6 / 4
```

```
In [ ]: type(1.6/4)
```

### Integers and floats

```
In [ ]: int(5)
```

```
In [ ]: float(5)
```

```
In [ ]: type(5)
```

```
In [ ]: type(5.)
```

### Boolean: True or False

- Data type associated with logical expressions
- A Boolean is either `True` or `False`

```
In [ ]: type(5>4)
```

```
In [ ]: 5 == 3
```

```
In [ ]: 5 != 3
```

## Booleans

```
In [ ]: 5 < 3
```

```
In [ ]: 5 > 3
```

```
In [ ]: 5 >= 3
```

```
In [ ]: 5 <= 3
```

## Integer representation of Booleans

```
In [ ]: int(True)
```

```
In [ ]: int(False)
```

## Logical operators: `and`, `or`

```
In [ ]: True and True
```

```
In [ ]: True and False
```

```
In [ ]: False and False
```

```
In [ ]: True or False
```

## Strings

- Strings represent text, i.e., a string is a sequence of characters.
- The basic object to represent strings is `str`.
- A string object is defined by wrapping its contents in in single or double quotation marks.

```
In [ ]: t = 'this is a string object'
```

```
In [ ]: t
```

```
In [ ]: t = "this is a string object"  
t
```

- Simple operations can be achieved with built-in string functions:

```
In [ ]: t.capitalize()
```

```
In [ ]: t.split()
```

- `\n` is used to force a new line.
- Note: Writing `t.` and hitting the `TAB` key shows the available built-in functions.

## Useful string methods

Useful string methods

Source: Python for Finance, 2nd ed.

## Printing

- Use `print()` to print strings and other objects.

```
In [ ]: print('Python for Finance')
```

```
In [ ]: print(t)
```

## Printing

```
In [ ]: i = 0
while i < 4:
    print(i)
    i += 1
```

```
In [ ]: i = 0
while i < 4:
    print(i, end='|')
    i += 1
```

## Formatted printing

- The syntax with curly braces ( `{}` ) was introduced in Python 3.7.

```
In [ ]: 'this is an integer %d' % 15
```

```
In [ ]: 'this is an integer {:d}'.format(15)
```

```
In [ ]: 'this is an integer {:4d}'.format(15)
```

## Formatted printing

```
In [ ]: 'this is a float %f' % 15.3456
```

```
In [ ]: 'this is a float %.2f' % 15.3456
```

```
In [ ]: 'this is a float {:.f}'.format(15.3456)
```

```
In [ ]: 'this is a float {:.2f}'.format(15.3456)
```

Another useful way to print is to concatenate strings with a + sign:

```
In [ ]: 'this is a float ' + str(15.3456)
```

## Basic Data Structures

### Basic Data Structures

| Object type | Meaning | Used for | -|---|- | tuple | Immutable container | Fixed set of objects, record | list | Mutable container | Changing set of objects | dict | Mutable container | Key-value store | set | Mutable container | Collection of unique objects

- We shall skip dictionaries and sets here as they will be rarely used (if at all) once we have introduced `pandas`.
- Similarly, we shall just skim over lists as they are often used as an auxiliary data structure, e.g. in loops.

### Tuples

- The elements of a tuple are written between parentheses, or just separated by commas.
- Tuples are immutable.

```
In [ ]: t = 1, 2, 3, 'Tom'
t
```

```
In [ ]: t = (1, 2, 3, 'Tom')
t
```

```
In [ ]: t[3]
```

NOTE: Indices start at 0, not at 1.

## Lists

- A list is created by listing its elements within square brackets, separated by commas.

```
In [ ]: l = [1.2, "john", "timmy", "helena"]  
  
l
```

```
In [ ]: l[2]
```

```
In [ ]: type(l)
```

NOTE: Indices start at 0, not at 1.

## Lists

- Negative indices: Count from the end

```
In [ ]: l
```

```
In [ ]: l[-1]
```

```
In [ ]: l[-2]
```

## Lists

- Extract elements using `[from:to]` :

```
In [ ]: l
```

```
In [ ]: l[1:3]
```

NOTE: `names[from:to]` contains the elements from "from" to ("to"-1).

## Lists

- Extract sublists, e.g. from index 2 or until index 2:

```
In [ ]: l[2:]
```

```
In [ ]: l[:2]
```

## Lists

- Extract sublists by using `[from:to:step]` , e.g. every second element or all elements from index 2:

```
In [ ]: l
```

```
In [ ]: l[::2]
```

```
In [ ]: l[2::]
```

## Lists

- Use `[from:to:step]` to reverse a list:

```
In [ ]: l[::-1]
```

## Lists

- Use `*` and `+` to repeat and join lists:

```
In [ ]: l*2
```

```
In [ ]: l + l[::-1]
```

## Lists

- Lists are mutable

```
In [ ]: l
```

```
In [ ]: l[0] = "thomas"
```

```
In [ ]: l
```

```
In [ ]: l[2:4] = ["hannah", "laura"]
```

```
In [ ]: l.append([4,3])
```

```
In [ ]: l
```

## List methods

- To view the methods available to a list, type the list name with a full-stop (e.g. `l.` )and press the `Tab` button.

```
List methods
```

# Control flow

## Control flow

- Control flow refers to control structures such as `if`-statements and `for`-loops that control the order in which code is executed.

## Control flow: `if`-statements

- The `if/elif/else` statement executes code based on whether a condition is true or false:

```
In [ ]: if 2+2 == 4:
        print("I am a math genius!")
```

- The condition `2+2==4` resolves to true, so the indented code following the condition is executed.
- Code blocks are delimited by indentation.

## Control flow: `if`-statements

- In the code below the conditions are checked and the first block matching a `TRUE` condition is executed:

```
In [ ]: x = 100
        if x == 1:
            print(x)
        elif x == 2:
            print(x)
        elif x == 3:
            print(x)
        elif x == 4:
            print(x)
        else:
            print("{} > 4".format(x))
```

## Control flow: `for`-loops

A `for` loop iterates over a sequence of values and executes the respective code block:

```
In [ ]: names = ["John", "Alina", "Timmy", "Helena"]
        for participant in (names):
            print('{} is taking this lecture.'.format(participant))
```

- If the sequence is a counter, i.e., a sequence of numbers, then the function `range()` is useful:

```
In [ ]: for (i) in range(4):
        print(i)
```

**List comprehension** allows to generate lists in a one-line `for` statement:

```
In [ ]: l=[i for i in range(4)]
        l
```

## Control flow: `while`-statement

- The `while` loop repeatedly executes a block of statements provided the condition remains `TRUE` :

```
In [ ]: a = 4
        i = 0
        while i < a:
            print("{} is smaller than {}".format(i, a))
            i = i+1
```

- The `break` keyword interrupts control flow:

```
In [ ]: for i in range(5):
        print("{} is smaller than {}".format(i, 3))
        if i == 2:
            break
```

## Functions

### Functions

- It is useful to group code that is repeatedly used in **functions**.
- A `function`-block consists of the function header and the function body.
- As with other code blocks, the function body must be indented.

```
In [ ]: def circle_circumference(radius):
        return 2 * 3.14159 * radius * 2
```

```
In [ ]: circle_circumference(5)
```

### Function syntax

- The syntax for writing a function is:
  - keyword `def` followed by
  - function's name followed by
  - the arguments of the function, separated by commas, in parentheses followed by a colon ( `:` )
  - function body (indented)
  - optional: within the function body the `return` keyword can be used to return an object or value

## Function syntax

- Function arguments are passed "by reference" meaning that changes to an object can be made within a function:

```
In [ ]: def try_to_modify(x, y, z):
        x = 23
        y.append(42)
        z = [99] # new reference
        print(x)
        print(y)
        print(z)

a = 77 # immutable variable
b = [99] # mutable variable
c = [28]

try_to_modify(a, b, c)
print(a)
print(b)
print(c)
```

## Function syntax

- Function arguments can be given default values:

```
In [ ]: def plus10(x = 50):
        return x + 10
```

```
In [ ]: plus10()
```

```
In [ ]: plus10(20)
```