

Python Summer Course

Course 2: Functions, Lists, Dictionaries & Classes

Théophile Gentilhomme

July 11, 2025



List

A **list** is an ordered, changeable collection of items, written with square brackets.

```
1 fruits = ["apple", "banana", "cherry"]  
2 empty = []  
3 mixed = [1, "yes", True]
```

Key Features:

- Ordered: items have positions (indexes)
- Mutable: you can change, add, or remove items
- Can contain any type, even mixed types



Accessing Elements & Slicing

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 fruits = ["apple", "banana", "cherry", "orange", "melon"]
2 print(fruits[0])
3 print(fruits[-1])
```

Python Code

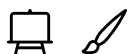
[↺ Start Over](#)[▶ Run Code](#)

```
1 print(fruits[1:3])    # From index 1 to 2 → ['banana', 'cherry']
2 print(fruits[:2])     # From start to index 1 → ['apple', 'banana']
3 print(fruits[2:])     # From index 2 to end → ['cherry', 'orange']
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 print(fruits[::2])    # Every 2nd item → ['apple', 'cherry']
2 print(fruits[::-1])   # Reversed list → ['orange', 'cherry', 'banana', 'apple']
```



List Manipulation

Add & Remove

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 fruits = ["apple", "banana", "cherry"]
2
3 print(len(fruits))
4
5 fruits.append("orange")      # Add at the end
6 fruits.insert(1, "kiwi")    # Insert at position
7 fruits.remove("banana")     # Remove by value
8
9 print(fruits)
```



Looping Through Lists

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1  for fruit in fruits:  
2      print(fruit)
```

Useful Functions

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 print(len(fruits))      # Number of items
2 print(sorted(fruits))   # New sorted list
3 fruits.sort()           # Sort in place
4 print(fruits)
5 fruits.reverse()        # Reverse order
6 print(fruits)
```



Indexing Reminder

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 fruits[2] = "grape"      # Modify item at index 2
2 print(fruits)
```



List Comprehension

List comprehensions are a concise way to **create new lists** by transforming or filtering items. it is also more efficient than doing a for loop.

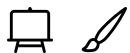
```
1 new_list = [expression for item in iterable]
```


Example: Squares of numbers

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 squares = [x**2 for x in range(5)]  
2 print(squares) # [0, 1, 4, 9, 16]
```

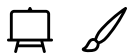


With Condition: Even numbers

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 evens = [x for x in range(10) if x % 2 == 0]
2 print(evens) # [0, 2, 4, 6, 8]
```

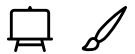


With Transformation

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 fruits = ["apple", "banana", "cherry"]
2 uppercased = [fruit.upper() for fruit in fruits]
3 print(uppercased) # ['APPLE', 'BANANA', 'CHERRY']
```



Tuple

A **tuple** is an ordered, immutable collection of values, like a list, but you **can't change it**.

```
1 my_tuple = (1, 2, 3)
2 empty = ()
3 single = (5,) # Comma is required for single-item tuples
```

Key Features:

- Ordered: elements have a position
- Immutable: you can't add, remove, or change items
- Can contain mixed types: `("Alice", 30, True)`
- Supports indexing and slicing like lists

Example

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 person = ("Alice", 30)
2
3 print(person[0])
4 print(len(person))
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 person = ("Alice", 30)
2 # Immutable
3 person[0] = "Bob"
```



Set

A **set** is an unordered collection of **unique** items. It is great for removing duplicates and testing membership.

Python Code

↺ Start Over

▶ Run Code

```
1 my_set = {1, 2, 3, 3, 2}
2 print(my_set) # {1, 2, 3}
3
4 # Empty set
5
6 my_empty_set = set() # not = {} !!
```

⚠ Properties:

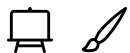
- Sets are **unordered**: no indexing
- Only **immutable** items allowed (no lists/dicts inside sets)

Set Operations

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 a = {1, 2, 3}
2 b = {3, 4, 5}
3
4 print(a | b)    # Union
5 print(a & b)    # Intersection
6 print(a - b)    # Difference
```



Methods

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 a.add(6)
2 a.remove(1)
3 print(a)
```



What I can't put in a set

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 a.add(["a", "b", "c"])
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 # A tuple is ok!
2 a.add(("a", "b", "c"))
3 print(a)
4 a.add(tuple(["a", "b", "c"]))
5 print(a)
```



Dictionaries

A **dictionary** is a collection of key-value pairs, like a real-life lookup table.

Python Code

↺ Start Over

▶ Run Code

```
1 ✓ person = {  
2     "name": "Alice",  
3     "age": 30,  
4     "is_student": False  
5 }  
6  
7 print(person["name"])  
8  
9 # Empty dictionary  
10 my_dict = {} # or dict()  
11  
12 # Add an element  
13 my_dict["Counts"] = 0  
14 print(my_dict)
```



! Important:

- Keys must be **unique** and **immutable** (e.g. strings, numbers)
- Values can be any type
- Dictionaries are **unordered** before Python 3.7

Python Code

↺ Start Over

▶ Run Code

```
1 # this is ok
2 my_dict[("a", 5)] = [1, 2, 3]
```

Python Code

↺ Start Over

▶ Run Code

```
1 # this is NOT ok
2 my_dict[[1, 2, 3]] = 8
```

Dictionary Comprehension

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 squares = {x: x**2 for x in range(5)}  
2 print(squares) # {0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

You can also add a condition:

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 evens = {x: x for x in range(10) if x % 2 == 0}  
2 print(evens)
```

Common Operations

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 person = {"name": "Alice", "age": 30}
2
3 print(person.keys())
4 print(person.values())
5 print(person.get("email"))
6
7 person["email"] = "alice@example.com"
8 del person["age"]
9 print(person)
```

Important:

- dictionary logic is the base of JSON format (see later)
- dictionary are used a lot to provide data samples (e.g. ML/DL)

Functions

Functions are reusable blocks of code that perform a specific task.

```
1 def function_name(parameters):  
2     """  
3     Optional docstring describing what the function does.  
4     """  
5     # code block  
6     # many complicated things using parameters  
7     return result  
8     # or does not return anything
```

Example

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 ✓ def greet (name) :  
2     return f"Hello, {name}!" #  
3  
4 print(greet ("Alice"))
```



Function Parameters & Return Values

Functions can take inputs (zero, one or more) and return outputs.

Important:

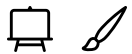
- **Parameters** are local names inside functions
- **Return** ends the function and gives back a value
- **Docstring** helps explain the function's purpose, but is optional

Example:

Python Code

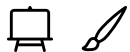
[↺ Start Over](#)[▶ Run Code](#)

```
1 v def add(a, b):  
2     """Return the sum of a and b."""  
3     return a + b  
4  
5 result = add(3, 5)  
6 print(result)
```



Mutable vs Immutable Parameters

When passing values to functions, behavior depends on **whether the object is mutable or immutable**.



Immutable (e.g. `int`, `str`, `tuple`)

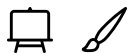
- A **copy of the value** is passed
- Changes inside the function **don't affect** the original

Python Code

↺ Start Over

▶ Run Code

```
1 def update_number(x):  
2     x = x + 1  
3     print("Inside:", x)  
4  
5 n = 5  
6 update_number(n)  
7 print("Outside:", n)  # Still 5
```



Mutable (e.g. `list`, `dict`, `set`)

- A **reference to the object** is passed
- Changes inside the function **do affect** the original

Python Code

↺ Start Over

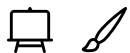
▶ Run Code

```
1 ✓ def add_item(my_list):  
2     my_list.append("new")  
3  
4     items = ["apple", "banana"]  
5     add_item(items)  
6     print(items)
```



Functions Call Functions

Functions can be combined, one function can call another to build **modular and reusable** logic.



Example: Grading system

Python Code

↺ Start Over

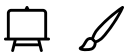
▶ Run Code

```

1  def calculate_average(scores):
2      return sum(scores) / len(scores)
3
4  def determine_grade(average):
5      if average >= 90:
6          return "A"
7      elif average >= 75:
8          return "B"
9      elif average >= 60:
10         return "C"
11     else:
12         return "F"
13
14 def grade_student(scores):
15     avg = calculate_average(scores)
16     grade = determine_grade(avg)
17     return f"Average: {avg:.1f}, Grade: {grade}"
18
19 # Example usage
20 print(grade_student([88, 92, 79]))

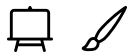
```

Functions, Lists, Dictionaries & Classes



Key Concepts

- Each function has a **clear responsibility**
- Complex logic is broken into **smaller, reusable pieces**
- You can use `if`, `for`, and `return` together



Other features (introduced later or in provided references):

- Default values
- Function as argument
- Lambda functions

Classes and Objects

A **class** defines a blueprint for objects: it groups **data** and **behavior** together.

We will not go into much details here, but just give an overview for you to understand objects and how to use them.



Create a Simple Class

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 class Dog:
2     def bark(self):
3         print("Woof!")
```



Create and Use an Object (Instance)

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 my_dog = Dog()    # Create an object
2 my_dog.bark()     # Call a method
```

The object `my_dog` is an **instance** of the class `Dog`.



Class Initialization with `__init__`

The `__init__` method runs **when the object is created** and sets initial values of the attributes.

Example with Constructor

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 class Dog:
2     def __init__(self, name, age):
3         self.name = name
4         self.age = age
5
6     def speak(self):
7         print(f"{self.name} says: Woof!")
8
9 my_dog = Dog("Rex", 4)
10 my_dog.speak()      # "Rex says: Woof!"
11 print(my_dog.age)   # 4
```

⚠ Important: `self` refers to the **current object**: you must include it in all methods!

Adding Behavior with Methods

You can define your own methods to give objects useful **behaviors**.

If a class represents a **coffee machine**, the methods represent different programmes to make different coffee.

But all the programmes use the same internal attributes (e.g. coffee, water), or even internal functions (e.g. grind coffee, heat water)

Example with State Change

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 class Counter:
2     def __init__(self):
3         self.value = 0
4
5     # We use default value if not supplied
6     def increment(self, inc = 1):
7         self.value += 1
8
9     def reset(self):
10        self.value = 0
11
12 counter = Counter()
13 counter.increment()
14 counter.increment()
15 print(counter.value)    # 2
16 counter.reset()
17 print(counter.value)    # 0
```

Objects **remember their state**, and methods can **modify** it.

Functions, Lists, Dictionaries & Classes



Your turn!

Define student data: Create a list of students. Each student is a dictionary containing:

- "name" (string),
- "age" (int),
- "grades" (a dictionary of course:grade pairs)

Solution

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 v students = [  
2 v     {  
3         "name": "Alice",  
4         "age": 20,  
5         "grades": {"Math": 85, "Bio": 92}  
6     },  
7 v     {  
8         "name": "Bob",  
9         "age": 22,  
10        "grades": {"Math": 73, "CS": 88}  
11    }  
12 ]
```



Write functions, taking your list of students, to:

- Display all student names
- Calculate average grade for a given student (using building `sum()` function)

Solution

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 ✓ def get_all_names(students):  
2     return [student["name"] for student in students]  
3  
4 ✓ def calculate_average(grades):  
5     return sum(grades.values()) / len(grades)  
6  
7  
8 print(get_all_names(students=students))  
9  
10 print(calculate_average(students[0]["grades"]))
```



Create a Student class

Define a class with attributes: name, age, grades, and methods to:

- Add a grade for a given course
- Compute the average for the student
- Display infos (whatever you want to print)

Solution

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 class Student:
2     def __init__(self, name, age, grades=None):
3         self.name = name
4         self.age = age
5         self.grades = grades or {}
6
7     def add_grade(self, course, grade):
8         self.grades[course] = grade
9
10    def average(self):
11        return sum(self.grades.values()) / len(self.grades)
12
13    def infos(self):
14        return f"{self.name} ({self.age}): {self.average()}"
15
16 student = Student("Theophile", 39)
17 student.add_grade("math", 60)
18 student.add_grade("sport", 85)
19
20 print(student.infos())
```

Functions, Lists, Dictionaries & Classes

