

Python provides a type called a list that can store a collection of data of any size. You can store multiple items in a single list variable. Lists allow duplicate items.

1. Creating Lists

Python lists are written with square brackets []. List items can be of any data type (string, int, boolean, etc.):

```
list1 = ["apple", "banana", "cherry"]
list2 = [1, 5, 7, 9, 3]
list3 = [True, False, False]
```

A list can contain different data types:

```
list4 = ["abc", 34, True, 40.5, "male"]
```

Example 01: Create a list.

```
mylist = ["apple", "banana", "cherry"]

print(mylist)
```

Output:

```
['apple', 'banana', 'cherry']
```

Example 02: You can use brackets ([]) and multiplication operator to create a list that contains a number of items, and initialize these item with the same values.

```
list1 = ["Hello"] * 5

print(list1)
```

Output:

```
['Hello', 'Hello', 'Hello', 'Hello', 'Hello']
```

Example 03: Using split method to make a list.

```
string = "apple, banana, cherry"

mylist = string.split(", ")

print(mylist)
```

Output:

```
['apple', 'banana', 'cherry']
```

Note: `split()` method returns a list of item(s).

Example 04: Get multiple strings from the user input and store them in a list.

```
string = input("Enter strings: ")  
  
mylist = string.split(", ")  
  
print(mylist)
```

Output:

```
Enter strings: apple, banana, cherry  
['apple', 'banana', 'cherry']
```

2. Converting List into String

The `join()` function is one of the simplest methods to convert a list to a string in python. The main point to keep in mind while using this function is that the `join()` function can convert only those lists into string that contains only string as its items.

Example 05: Convert a list into a string

```
list1 = ["Programming", "is", "fun"]  
  
str1 = " ".join(list1)  
  
print(str1)
```

Output:

```
Programming is fun
```

3. `in` Operator

Example 06: the `in` operator lets you loop through all the members of a list and check if there's a member in the list that is equal to the given item.

```
num = 1  
x = [0, 1, 2]  
  
if num in x:  
    print(num, "is in the list.")  
else:  
    print(num, "is not in the list.")
```

Output:

```
1 is in the list.
```

Example 07: the `in` operator lets you loop through all the members of a list and check if there's a member in the list that is equal to the given item.

```
num = 1
x = [0, 1, 2]

if num not in x:
    print(num, "is not in the list.")
else:
    print(num, "is in the list.")
```

Output:

```
1 is in the list.
```

4. Displaying Lists Items

Example 08: Display list items.

```
mylist = [1, 2, 3]

print(mylist)
print(*mylist)
print(*mylist, sep = "\t")
```

Output:

```
[1, 2, 3]
1 2 3
1    2    3
```

5. Accessing List Items

Same as strings, you can access list items by referring to the index number. The first item has index `0`. Negative indexing means beginning from the end, `-1` refers to the last item, `-2` refers to the second last item etc.

Example 09: Access list items by referring to the index number.

```
mylist = ["apple", "banana", "cherry"]

print(mylist[0])
print(mylist[1])
print(mylist[-1])
print(mylist[-2])
```

Output:

```
apple
banana
cherry
banana
```

6. Updating List Items

Example 10: Update list items.

```
mylist = ["apple", "banana", "cherry"]

mylist[1] = "watermelon"
mylist[-1] = "orange"

print(mylist)
```

Output:

```
['apple', 'watermelon', 'orange']
```

7. Slicing a List

Slicing a list means extracting a part of a list.

Example 11: Slice a list where its data in positions 1, 2 and 3.

```
mylist = ["apple", "banana", "cherry", "watermelon", "orange"]

newlist = mylist[1:4]

print(newlist)
```

Output

```
['banana', 'cherry', 'watermelon']
```

8. Reversing a List

Same as strings, use can reverse a list using `[::-1]`.

Example 12: Reverse a list

```
mylist = ["apple", "banana", "cherry", "watermelon", "orange"]

newlist = mylist[::-1]

print(newlist)
```

Output

```
['orange', 'watermelon', 'cherry', 'banana', 'apple']
```

9. Iterate Through a List

As strings are sequences, you can loop through them directly.

Example 13: Iterate through a list

```
mylist = ["apple", "banana", "cherry"]

for item in mylist:
    print(item, end = "\t")
```

Output

```
apple    banana    cherry
```

Example 14: Iterate through a list by index.

```
mylist = ["apple", "banana", "cherry"]

for i in range(3):
    print(mylist[i], end = "\t")
```

Output

```
apple    banana    cherry
```

10. List Methods

Python has a set of built-in methods that you can use on lists such as:

<i>Method</i>	<i>Description</i>
<code>sort()</code>	Sorts the list
<code>count()</code>	Returns the number of items with the specified value
<code>append()</code>	Adds an item at the end of the list
<code>pop()</code>	Removes the item at the specified position
<code>insert()</code>	Adds an item at the specified position
<code>remove()</code>	Removes the item with the specified value
<code>reverse()</code>	Reverses the order of the list
<code>index()</code>	Returns the index of the first item with the specified value. If the item is not found, a ValueError exception is raised.

To sort an items in a list, you can use a method called `sort()`.

Syntax:

```
list.sort(reverse = True|False)
```

The `sort()` method sorts the list ascending by default. Use `list.sort(reverse = True)` will sort the list descending. This does not work if the list is storing data of different types in the same list.

Example 15: Use `sort()` method to sort the list in ascending order.

```
car_list = ["Ford", "Camry", "Prius"]

car_list.sort()
print(car_list)
```

Output:

```
['Camry', 'Ford', 'Prius']
```

Example 16: Use `sort()` method to sort the list in descending order.

```
car_list = ["Ford", "Camry", "Prius"]

car_list.sort(reverse = True)
print(car_list)
```

Output:

```
['Prius', 'Ford', 'Camry']
```

Example 17: Use `count()` method to count the number of items with the specified value

```
list1 = [2, 3, 4, 3, 10, 3, 5, 6, 3]

item_count = list1.count(3)

print("There are", item_count, "of number 3 in the list.")
```

Output:

```
There are 4 of number 3 in the list.
```

Example 18: Use `append()` method to add an item to the end of the list.

```
list1 = []

list1.append(1)
list1.append(2)

print(list1)
```

Output:

```
[1, 2]
```

Example 19: `insert()` to insert a value at a specific index in the list:

```
list1 = ["apple", "banana", "cherry"]

list1.insert(1, "orange")

print(list1)
```

Output:

```
['apple', 'orange', 'banana', 'cherry']
```

Example 20: use `pop()` method to remove the last item from a list.

```
list1 = ["apple", "banana", "cherry"]

list1.pop()

print(list1)
```

Output:

```
["apple", "banana"]
```

If you specify the index, the `pop()` method removes the item at the index.

Example 21: In this example, we will use `pop()` method to remove the second item:

```
list1 = ["apple", "banana", "cherry"]

list1.pop(1)

print(list1)
```

Output

```
["apple", "cherry"]
```

Example 22: `pop()` also returns the value it pops:

```
list1 = ["apple", "banana", "cherry"]

x = list1.pop(1)

print(x)
```

Output

```
Banana
```

Example 23: Use the `remove()` method to remove the first matching item (which is passed as an argument) from the list.

```
animals = ["cat", "dog", "rabbit", "pig", "rabbit"]

animals.remove("rabbit")

print("Updated animals list: ", animals)
```

Output

```
Updated animals list: ['cat', 'dog', 'pig', 'rabbit']
```

Example 24: Use the `reverse()` method to reverse a list.

```
list1 = [1, 20, 3, 40, 5]

list1.reverse()

print(list1)
```

Output

```
[5, 40, 3, 20, 1]
```

Example 25: Use the `index()` method to find the position of an item in a list.

```
list1 = [1, 20, 3, 20, 5]

i = list1.index(20)

print(i)
```

Output:

```
1
```

11. Functions for Lists

Several functions that can be used with lists:

Function	Description
<code>len()</code>	returns the number of items in the list.
<code>max()</code>	returns the item with the greatest values in the list.
<code>min()</code>	returns the item with the lowest values in the list.
<code>sum()</code>	returns the sum of all item in the list.
<code>shuffle()</code>	A function in the <code>random</code> module used to shuffle the item randomly in the list.

Example 26: Use functions on a list.

```
list1 = [1, 2, 3, 4, 1, 5]

print(len(list1))
print(max(list1))
print(min(list1))
print(sum(list1))
```

Output:

```
6
5
1
16
```

Example 27: Use `shuffle()` in the `random` module to shuffles the list.

```
import random

list1 = [0, 1, 2, 3, 4]

random.shuffle(list1)

print(list1)
```

Output:

```
[4, 1, 3, 0, 2]
```

12. `list()` Constructor

The `list()` constructor returns a list. Let's see some examples of how `list()` constructor can be used.

Example 28: Get multiple integers from the user input and store them in a list

```
mylist = list(eval(input("Enter integers separated by commas: ")))

print(mylist)
```

Output:

```
Enter integers separated by commas: 1, 3, 5, 7, 9
[1, 3, 5, 7, 9]
```

Here is how the line 1 in the program above works:

- `input("Enter integers separated by commas: ")` prompts the user to input a string of integers, separated by commas (e.g., 1, 3, 5, 7, 9).
- `eval()` converts a input string "1, 3, 5, 7, 9" to a tuple: (1, 3, 5, 7, 9).
- `list()` converts the evaluated tuple (1, 3, 5, 7, 9) into a list: [1, 3, 5, 7, 9].
- The resulting list [1, 3, 5, 7, 9] is assigned to the variable `mylist`.

Example 29: Get multiple integers from the user input and store them in a list

```
mylist = list(eval(input("Enter numbers separated by spaces: ").replace(" ", ",")))  
  
print(mylist)
```

Output:

```
Enter numbers separated by spaces: 1 3 5 7 9  
[1, 3, 5, 7, 9]
```

Here is how the line 1 in the program above works:

- `input("Enter integers separated by space: ")` prompts the user to input a string of integers, separated by commas (e.g., 1, 3, 5, 7, 9).
- `replace(" ", ",")` replaces all spaces in the input string with commas. "1 3 5 7 9" → "1,3,5,7,9". Now the input is formatted as a comma-separated string, which `eval()` function can interpret.
- `eval()` converts a input string "1,3,5,7,9" to a tuple: (1, 3, 5, 7, 9).
- `list()` converts the evaluated tuple (1, 3, 5, 7, 9) into a list: [1, 3, 5, 7, 9].
- The resulting list [1, 3, 5, 7, 9] is assigned to the variable `mylist`.

Example 30: Using the `list()` constructor and a build-in function called `range()` to create sequential numerical list items.

```
list1 = list(range(5))          # list1 = [0, 1, 2, 3, 4]  
list2 = list(range(10, 15))    # list2 = [10, 11, 12, 13, 14]  
list3 = list(range(1, 10, 3))  # list3 = [1, 4, 7]  
  
print(list1)  
print(list2)  
print(list3)
```

Output:

```
[0, 1, 2, 3, 4]  
[10, 11, 12, 13, 14]  
[1, 4, 7]
```

Example 31: To get a duplicate copy of list1 into list2, you can use: `list2 = [] + list1`

```
list1 = [1, 2, 3, 4]  
list2 = [] + list1  
  
print(list2)
```

Output:

```
[0, 1, 2, 3, 4]
```

Example 32: Combine multiple lists together

```
list1 = [1, 2, 3, 4]
list2 = [10, 11, 12, 13, 14]

list3 = list1 + list2

print(list3)
```

Output:

```
[0, 1, 2, 3, 4, 10, 11, 12, 13, 14]
```

13. List Comprehension

In Python, you can turn for loops into one-liners by using comprehensions.

The list comprehension goes with the syntax:

```
output_list = [expression for var in input_list if condition]
```

where the if condition part is optional.

For example, let's create a new list of numbers from a list of numbers by leaving out all the negative numbers.

Example 33: Copy items which are positive from a list to another list.

```
old_list = [-2, 4, -6, 8, -10, 12]
new_list = []

for num in old_list:
    if num > 0:
        new_list.append(num)

print(new_list)
```

Output:

```
[4, 8, 12]
```

Now, we will make this for loop shorter by using a list comprehension:

Example 34: Copy items which are positive from a list to another list using list comprehension.

```
old_list = [-2, 4, -6, 8, -10, 12]

new_list = [num for num in old_list if num > 0]

print(new_list)
```

Output:

```
[4, 8, 12]
```

14. Multi-dimensional Lists

A multi-dimensional list is a list that contains other lists as its items. It is considered as nested list. Data in a table or a matrix can be stored in a two-dimensional list (2D list).

For example, the following table, which provides the distances between cities, can be stored in a list named `distances`.

Distance Table (in miles)							
	Chicago	Boston	New York	Atlanta	Miami	Dallas	Houston
Chicago	0	983	787	714	1,375	967	1,087
Boston	983	0	214	1,102	1,505	1,723	1,842
New York	787	214	0	888	1,549	1,548	1,627
Atlanta	714	1,102	888	0	661	781	810
Miami	1,375	1,505	1,549	661	0	1,426	1,187
Dallas	967	1,723	1,548	781	1,426	0	239
Houston	1,087	1,842	1,627	810	1,187	239	0

The data in the table above can be stored in a array named `distances` as below:

```
distances = [[0, 983, 787, 714, 1375, 967, 1087],  
             [983, 0, 214, 1102, 1505, 1723, 1842],  
             [787, 214, 0, 888, 1549, 1548, 1627],  
             [714, 1102, 888, 0, 661, 781, 810],  
             [1375, 1505, 1549, 661, 0, 1426, 1187],  
             [967, 1723, 1548, 781, 1426, 0, 239],  
             [1087, 1842, 1627, 810, 1187, 239, 0]]
```

14.1 Accessing Items in 2D Lists

You can think of a two-dimensional list as a table that consists of rows and columns. The values in a two-dimensional list can be accessed through row and column indexes.

Example 35: Create A two-dimensional list named `matrix` and access its items.

```
matrix = [[1, 2, 3, 4, 5],  
          [6, 7, 0, 0, 0],  
          [0, 1, 0, 0, 0],  
          [1, 0, 0, 0, 8],  
          [0, 0, 9, 0, 3]]  
  
print(matrix[0][0])  
print(matrix[4][4])  
print(matrix[0])  
print(matrix[4])  
print(matrix)
```

	[0]	[1]	[2]	[3]	[4]	Column index
[0]	1	2	3	4	5	
[1]	6	7	0	0	0	
[2]	0	1	0	0	0	
[3]	1	0	0	0	8	
[4]	0	0	9	0	3	

Row index

Output:

```
1
3
[1, 2, 3, 4, 5]
[0, 0, 9, 0, 3]
[[1, 2, 3, 4, 5], [6, 7, 0, 0, 0], [0, 1, 0, 0, 0], [1, 0, 0, 0, 8], [0, 0, 9, 0, 3]]
```

14.2 Initializing 2D Lists

Example 36: Initialize a 2D list with input values

```
matrix = [] # Create an empty list

num_rows = eval(input("Enter the number of rows: "))

for row in range(num_rows):
    row_items = list(eval(input("Enter items separated by a comma: ")))
    matrix.append(row_items) # Add a new row

print(matrix)
```

Output:

```
Enter the number of rows: 3
Enter items separated by a comma: 1, 2, 3
Enter items separated by a comma: 4, 5, 6
Enter items separated by a comma: 7, 8, 9
[[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

13.3 Iterating 2D Lists

In order to iterate through these nested lists, we must use a nested loop. The outer loop iterates through the row number, the inner loop runs through the items inside of a row.

Example 37: Display each item in a 2D list by using a loop.

```
matrix = [[1, 2, 3],
          [4, 5, 6],
          [7, 8, 9]]

for row in matrix:
    for value in row:
        print(value, end = " ")
    print()
```

Output:

```
1 2 3
4 5 6
7 8 9
```

Example 38: Display each item in a 2D list by using a loop by index.

```
matrix = [[1, 2, 3],  
          [4, 5, 6],  
          [7, 8, 9]]  
  
for row in range(len(matrix)):  
    for column in range(len(matrix[row])):  
        print(matrix[row][column], end = " ")  
    print()
```

Output:

```
1 2 3  
4 5 6  
7 8 9
```

Example 39: Display each item in a 2D list. In this example, the inner list is unpacked into three variables (a, b, c).

```
matrix = [[1, 2, 3],  
          [4, 5, 6],  
          [7, 8, 9]]  
  
for a, b, c in matrix:  
    print(a, b, c)
```

Output:

```
1 2 3  
4 5 6  
7 8 9
```

You can apply the `sort()` method to sort a two-dimensional list. It sorts the rows on their first items. For the rows with the same first item, they are sorted on the second item. If the first and second items in the rows are the same, their third items are sorted, and so on.

Example 40: Sort a 2D list.

```
points = [[4, 2], [1, 7], [4, 5], [1, 2], [1, 1], [4, 1]]  
  
points.sort()  
  
print(points)
```

Output:

```
[[1, 1], [1, 2], [1, 7], [4, 1], [4, 2], [4, 5]]
```

14. Three-dimensional Lists

A two-dimensional list consists of a list of one-dimensional lists and a three-dimensional list consists of a list of two-dimensional lists, and so on. You can create n-dimensional lists for any integer n.

Example 41: In this example, we use a three-dimensional list to store exam scores for a class of three students with four exams, and each exam has two parts (multiple-choice and essay).

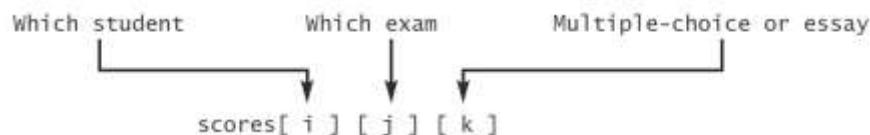
```
scores = [[[11.5, 20.5], [11.0, 22.5], [15, 33.5], [13, 21.5]],  
          [[4.5, 21.5], [11.0, 22.5], [15, 34.5], [12, 20.5]],  
          [[6.5, 30.5], [11.4, 11.5], [11, 33.5], [11, 23.5]]]  
  
print(scores[0])  
print(scores[0][1])  
print(scores[0][1][0])  
print(scores[0][1][1])  
print(len(scores))  
print(len(scores[0]))  
print(len(scores[0][0]))
```

Output:

```
[[11.5, 20.5], [11.0, 22.5], [15, 33.5], [13, 21.5]]  
[11.0, 22.5]  
11.0  
22.5  
3  
4  
2
```

`scores[0][1][0]` refers to the multiple-choice score for the first student's second exam, which is `11.0`. `scores[0][1][1]` refers to the essay score for the first student's second exam, which is `22.5`.

The following figure depicts the meaning of the values in the list.



Exercises

1. Write a program that first will read integers from the user into a list until the user enters 0. Then, display the list that contains no duplicate. You are allowed have only one list for this program. Hint: store only the new entered integer; if the entered integer already existed in the list, do not store it.
2. Ask the user to enter the names of three people they want to invite to a party and store them in a list. After they have entered all three names, ask them if they want to add another. If they do, allow them to add more names until they answer “no”. When they answer “no”, display how many people they have invited to the party. Here is a sample run:

```
Enter the names of three people: Sok Rasy, Chim Narith, Lim Nary Enter
Would you like to invite another person? yes Enter
Enter the person's name: Ly Narin Enter
Would you like to invite another person? yes Enter
Enter the person's name: Bun Sophat Enter
Would you like to invite another person? no Enter

You have invited 5 people to the party. They are:
Sok Rasy
Chim Narith
Lim Nary
Ly Narin
Bun Sophat
```

3. (Assign grades) Write a program that asks the user to enter a list of scores separated by a space in one line, and then assigns grades based on the following scheme:

The grade is A if score is ≥ 85 .
The grade is B if $85 > \text{score} \geq 75$.
The grade is C if $75 > \text{score} \geq 60$.
The grade is F otherwise.

Here is the sample run:

```
Enter scores: 70 65 92 45 Enter
Score is 70 and Grade is B
Score is 65 and Grade is C
Score is 92 and Grade is A
Score is 45 and Grade is F
```

4. Write a program that reads some integers between 1 and 100 separated by a space in one line, and counts the occurrences of each. Here is the sample run:

```
Enter integers between 1 and 100: 2 5 6 5 4 3 23 43 2 Enter
2 occurs 2 times
3 occurs 1 time
4 occurs 1 time
5 occurs 2 times
6 occurs 1 time
23 occurs 1 time
43 occurs 1 time
```

Note that if a number occurs more than one time, the plural word “times” is used in the output.

5. Write a program that reads in numbers separated by a space in one line, and displays distinct numbers (i.e., if a number appears multiple times, it is displayed only once). (Hint: Read all the numbers and store them in list1. Create a new list list2. Add a number in list1 to list2. If the number is already in the list, ignore it.) Here is the sample run:

```
Enter ten numbers: 1 2 3 2 1 6 3 4 5 2 ↴Enter  
The distinct numbers are: 1 2 3 6 4 5
```

6. (Guess the capitals) Write a program that repeatedly asks the user to enter a capital city for a country. Upon receiving the user input, the program reports whether the answer is correct. Assume that 10 countries and their capital cities are stored in a 2D list. The program asks the user to answer all the countries' capital cities and displays the total correct count. The user's answer is not case sensitive. The questions are **randomly displayed**. Implement the program using a list to represent the data in the following table:

Cambodia	Phnom Penh
Thailand	Bangkok
China	Beijing
Japan	Tokyo
India	Delhi
Malaysia	Kuala Lumpur
...	...

Here is a sample run:

```
What is the capital of Alabama? Montogomery ↴Enter  
The correct answer should be Montgomery  
What is the capital of Alaska? Juneau ↴Enter  
Your answer is correct  
What is the capital of Arizona? ...  
...  
The correct count is 35
```