Lists

Outline

- Lists
  - Creating a list
  - Indexing and slicing
  - Methods and operations
    - **List methods**: append, insert, remove, extend, sort, count, pop,
    - **Operators**: del, in, +, *
    - **Build-in function**: len, max, min, sum
  - Lists and strings
    - split, join

Lists

- Like a string, a list is a sequence of values.
  - In a string, the values are characters; in a list, they can be any type.
- The values in list are called elements or items.

string

h	e	l	l	o		w	o	r	l	d	→ character
0	1	2	3	4	5	6	7	8	9	10	→ Index

list

'Leo'	'Nora'	'Emma'	'James'	'Lucy'	→ item
0	1	2	3	4	→ Index

- The simplest way to create a list is to enclose the elements in square brackets.

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
```

Types of elements

- In a list, the elements can be any type.

An empty list

```
empty_list = []
```

A list of numbers

```
price_list = [100, 200, 550, 300, 450, 150, 200]
```

A list of lists

```
birthday_ddmm = [[1,10],[16,4],[19,2],[11,12],[9,7]]
```

- The elements of a list don't have to be the same type.

A list contains a string, a float, an integer, and another list

```
info = ['spam', 2.0, 5, [10, 20]]
```

Indexing and slicing

- Because lists are sequences, indexing and slicing work the same way for lists as they do for strings.

'Leo'	'Nora'	'Emma'	'James'	'Lucy'	→ item
0	1	2	3	4	→ Index

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
```

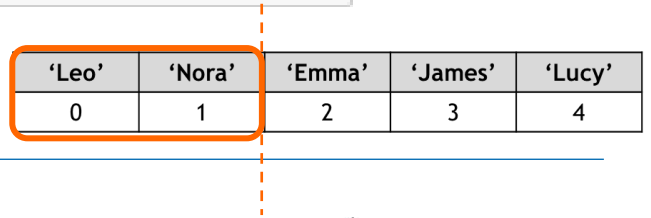
```
print(name_list[1])
```

```
Nora
```

```
print(name_list[0:2])
```

```
['Leo', 'Nora']
```

From position 0 to position 2, but NOT including 2.



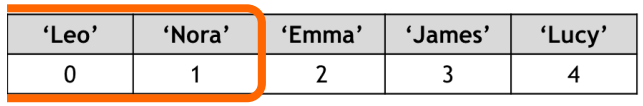
Indexing and slicing

The format for list slicing: **[start_index : stop_index]**

```
print(name_list[:2])
```

If start_index is not specified, the slice starts at the beginning.

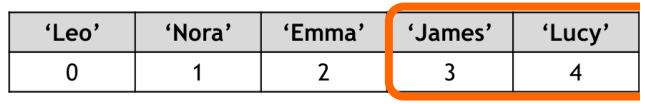
```
['Leo', 'Nora']
```




```
print(name_list[3:])
```

If end_index is not specified, the slice goes to the end.

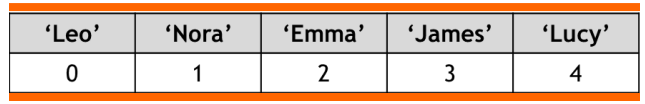
```
['James', 'Lucy']
```




```
print(name_list[:])
```

If neither start_index nor stop_index is specified, the slice is a copy of the whole list.

```
['Leo', 'Nora', 'Emma', 'James', 'Lucy']
```



Indexing and slicing – negative index

- Use negative indexes to start the slice from the end of the list.

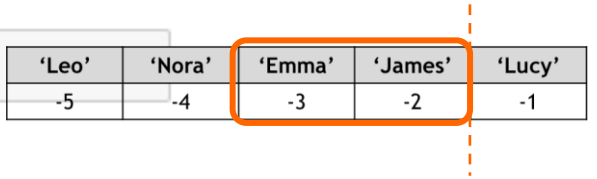
'Leo'	'Nora'	'Emma'	'James'	'Lucy'	
0	1	2	3	4	→ Index
-5	-4	-3	-2	-1	→ Negative Index

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
print(name_list[-1])
```

```
Lucy
```

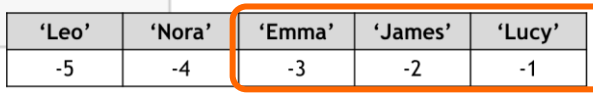
```
print(name_list[-3:-1])
```

```
['Emma', 'James']
```




```
print(name_list[-3:])
```

```
['Emma', 'James', 'Lucy']
```



Indexing and slicing – nested list

- A list of lists

```
#[day,month]
birthday_ddmm = [[12,'Oct'],[16,'Apr'],[19,'Feb'],[11,'Dec'],[9,'Jul']]
```

12	Oct	16	Apr	19	Feb	11	Dec	9	Jul	→ item
0		1		2		3		4		→ Index

```
birthday_ddmm[0]    #get the birthday of the first person
```

```
[12, 'Oct']
```

```
birthday_ddmm[0][1] #get birthday month of the first person
```

```
'Oct'
```

12	Oct	→ item
0	1	→ Index

Indexing and slicing - assignments

- Unlike strings, lists are mutable. When using a list, you can change its contents by assigning to either a particular item or an entire section (slice).
  - Index assignment

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
```

```
name_list[1] = "Clara"
name_list
```

```
['Leo', 'Clara', 'Emma', 'James', 'Lucy']
```

  - Slice assignment

```
name_list[2:4] = ["Ella","Jasper"]
name_list
```

```
['Leo', 'Clara', 'Ella', 'Jasper', 'Lucy']
```

Exercise

(A.1) Define a list named `str_list`, which contains the following elements: `A, B, C, D, E`. Print out the list.

(A.2) Print the first element in `str_list`.

(A.3) Use slice notation to print out `['B', 'C', 'D']`.

(A.4) Print the last element in `str_list`.

(A.5) Replace the last element `'E'` with `'F'` and print the updated list.

List methods – append, insert, remove

- Like strings, Python list objects also support type-specific method calls.

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
```

```
name_list.append("Henry") # add a new item to the end of a list
name_list
```

```
['Leo', 'Nora', 'Emma', 'James', 'Lucy', 'Henry']
```

```
name_list.insert(2,'Mia') # insert an item at given position
name_list
```

```
['Leo', 'Nora', 'Mia', 'Emma', 'James', 'Lucy', 'Henry']
```

```
name_list.remove("Emma")  # remove an item
name_list
```

```
['Leo', 'Nora', 'Mia', 'James', 'Lucy', 'Henry']
```

List methods – extend

- To append multiple items at the end of a list, you can use `extend`.

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
```

```
added_name = ['Henry','Mia']
name_list.extend(added_name)
print(name_list)
```

```
['Leo', 'Nora', 'Emma', 'James', 'Lucy', 'Henry', 'Mia']
```

List methods – sort

- The `sort()` method sorts the elements of a given list in a specific ascending or descending order.

```
number_list = [4, 3, 5, 0, 2, 1]
number_list.sort()
print(number_list)
```

```
[0, 1, 2, 3, 4, 5]
```

- When sorting a list of strings, the strings are rearranged in lexicographic order.

```
name_list = ["Leo", "Nora", "Emma", "James", "Lucy"]
name_list.sort()
print(name_list)
```

```
['Emma', 'James', 'Leo', 'Lucy', 'Nora']
```

Exercise

(B.1) Considering the following lists. Add a new item `'F'` to the end of a list.

```
str_list = ['A','B','C','D','E']
```

```

```

(B.2) Insert an item `'Z'` between `'B'` and `'C'`.

```

```

(B.3) Remove `'A'` from the list.

```

```

(B.4) Sort the items in lexicographic order.

```

```

In-place methods

- In-place methods can alter the contents of the list.

```
# In-place methods can alter the contents of the list
list_1 = [1,2,3]
list_1.append(4)
print(list_1)
```

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

```
# Most in-place methods return 'None'
list_1 = [1,2,3]
list_2 = list_1.append(4)
print(list_2)
```

```
None
```

- Most list methods modify the list and return None.
- Some methods will return values, e.g., count, pop.

List methods – count

- The `count()` method returns the number of times the specified element appears in the list.

```
item_list = ["apple", "milk", "egg", "apple", "fish", "beef"]
```

```
apple_count = item_list.count("apple")
print(apple_count)
print(item_list)
```

```
2
['apple', 'milk', 'egg', 'apple', 'fish', 'beef']
```

Deleting items – pop

- There are several ways to delete elements from a list.
  - If you know the **value** of the element, you can use `remove`.
  - If you know the **index** of the element, you can use `pop` or `del`.

Case1: Delete the element at the specified position and store the deleted element in a new variable.

```
mylist = ['a', 'b', 'c', 'd', 'e']
deleted_item = mylist.pop(1)
print(mylist)
print(deleted_item)
```

```
['a', 'c', 'd', 'e']
b
```

Case2: Delete the last element

```
mylist = ['a', 'b', 'c', 'd', 'e']
deleted_item = mylist.pop()
print(mylist)
print(deleted_item)
```

```
['a', 'b', 'c', 'd']
e
```

Deleting items – del

- If you don’t need the deleted item, you can use the `del` operator.
  - Delete the element at the specified position

```
mylist = ['a', 'b', 'c', 'd', 'e']
del mylist[1]
print(mylist)
```

```
['a', 'c', 'd', 'e']
```

  - Delete adjacent elements using list slicing

```
mylist = ['a', 'b', 'c', 'd', 'e']
del mylist[1:3]
print(mylist)
```

```
['a', 'd', 'e']
```

Use `in` operator

- We can use `in` operator to check if an item exists in the list.

```
item_list = ["apple", "milk", "egg", "apple", "fish", "beef"]
"apple" in item_list
```

```
True
```

```
item_list = ["apple", "milk", "egg", "apple", "fish", "beef"]
"Apple" in item_list
```

```
False
```

Math operators

- Lists support many of the same operations as strings.
  - + operator means concatenation

```
a = [1, 2, 3]
b = [4, 5, 6]
c = a + b
print(c)
```

```
[1, 2, 3, 4, 5, 6]
```

  - * operator means repetition

```
a*3
```

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

Built-in functions

- There are some built-in functions that can be used on lists that allow you to quickly look through a list.

```
number_list = [3, 41, 12, 9, 74, 15]
```

```
len(number_list)  # Number of elements
```

```
6
```

```
max(number_list) # Maximum value in the list
```

```
74
```

```
min(number_list)  # Minimum value in the list
```

```
3
```

```
sum(number_list) # The sum of all elements
```

```
154
```

Exercise

(C.1) Considering the following list. Use `pop()` method to remove `'Sun'`. Print the updated list and the deleted element.

Expected result:

```
['Mon','Tue','Wed','Thu','Fri','Sat']
'Sun'
```

```
day_list = ['Mon','Tue','Wed','Thu','Fri','Sat','Sun']
```

```

```

(C.2) Use `del` operator to remove the first two elements in `day_list`.

```

```

(C.3) Considering the following list. Check if `'z'` in the list.

```
mylist = ['x','w','y','x','y','z','y','x','x','w','y','z']
```

```

```

(C.4) Use `mylist` defined in (C.3). Get the number of elements in `mylist`.

```

```

(C.5) Use `mylist` defined in (C.3). Count the number of times the value `'x'` appears in the the list.

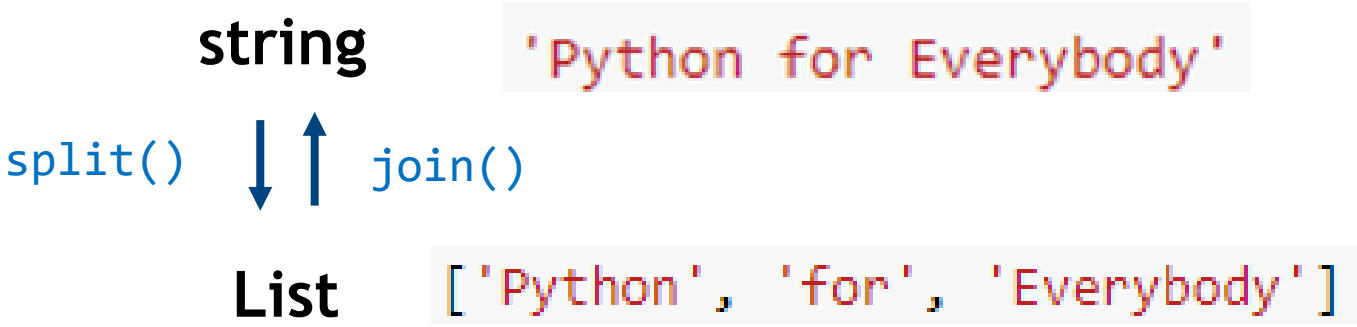
```

```

Lists and strings

- A string is a sequence of characters.
- A list is a sequence of values.

- To convert a variable from a string to a list, you can use `split()`.
- To convert a variable from a list to a string, you can use `join()`.



Lists and strings - split

- Use the `split` method to break a string into words.

```
mystr = 'Python for Everybody'
mylist = mystr.split()
print(mylist)
```

```
['Python', 'for', 'Everybody']
```

- Use an optional argument called a `separator` to specify the word boundaries.

```
mystr = 'Python-for-Everybody'
mylist = mystr.split('-')     # mystr.split(sep = '-')
print(mylist)
```

```
['Python', 'for', 'Everybody']
```

Lists and strings - join

- Concatenates the elements by `join` method
  - `join` is the inverse of split
  - `join` is a string method

```
mylist = ['Python', 'for', 'Everybody']
delimiter1 = ' '
delimiter1.join(mylist)
```

```
'Python for Everybody'
```

```
delimiter2 = '-'
delimiter2.join(mylist)
```

```
'Python-for-Everybody'
```

Lists and strings - mutable and immutable

```
# Lists are mutable
list_1 = [1,2,3]
list_1.append(4)
print(list_1)
```

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

```
# strings are immutable
str_1 = "ABC"
str_1.replace("A","Z")
```

```
'ZBC'
```

```
str_1
```

```
'ABC'
```

```
str_2 = str_1.replace("A","Z")
str_2
```

```
'ZBC'
```

Exercise

Exercise.D

(D.1) Concatenate the following strings into a string named `mystr`.

Hint: Use math operator.

Expected output:

```
#WWDC21#iphon13#apple#iOS15#MacBook#swift#ios15#swiftui#xcode#apple#MobileAppDevelopment#wwdc21#iosdev"#Apple#AppleEvent#Develope
```

```
tweet1 = "#WWDC21#iphon13#apple#iOS15#MacBook"
tweet2 = "#swift#ios15#swiftui#xcode#apple#MobileAppDevelopment#wwdc21#iosdev"
tweet3 = "#Apple#AppleEvent#Developer#WWDC"
```

```

```

(D.2) Convert `mystr` to all uppercase and store the value in a new variable named `mystr_upper`.

```

```

(D.3) Convert `mystr_upper` to a list of words.

Hint: Use "#" as seperator

```

```

(D.4) Count the number of times the value 'WWDC21' appears in the list.

```

```

Class and object

- Python is an object-oriented programming (OOP) language. Object-oriented programming is a programming paradigm based on the concept of objects.
- Class: A class is a blueprint to create objects.
- Object: An object is an instance of a class.

- https://www.geeksforgeeks.org/python-classes-and-objects/?ref=lbp

Class and object

- Example

```
mystr = "hello world"
print(type(mystr))
```

Create a new object of class “str“.

```
<class 'str'>
```

```
mystr.upper()
```

Functions bound to objects are called methods.

```
'HELLO WORLD'
```

```
mylist = [3, 2, 1]
print(type(mylist))
```

Create a new object of class “list“.

```
<class 'list'>
```

```
mylist.sort()
mylist
```

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

Python variables and memory allocation

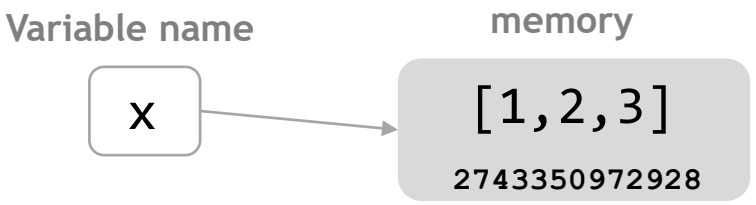
- A python variable is a symbolic name, which is a reference to an object. After creating an object, you can refer to it by variable name.
- Use id() to see the memory address (object's identity).

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

```
id(x)
```

```
2743350972928
```

memory address



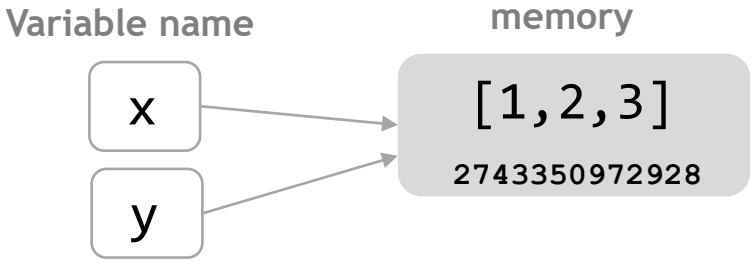
Create an object in memory and let x be a reference to this object.

- If one variable is assigned to another variable, both variables point to the same memory address.

```
y = x
```

```
id(y)
```

```
2743350972928
```

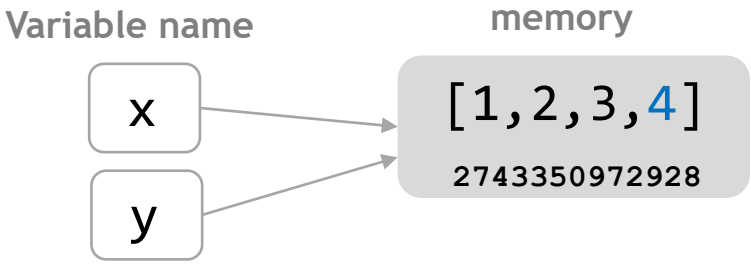


Python variables and memory allocation

- If two variables point to the same address, changing the value of one variable will change the value of the other variable.

```
y.append(4)
print(x)
print(y)
```

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



- Use the function `copy()` to create a copied variable, and then you can change the copied variable without changing the original variable.

```
z = x.copy()
id(z)
```

```
2743351359168
```

```
z.append(5)
print(x, y, z)
```

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