CSIT110

Fundamental Programming with Python

List and Tuple

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In this lecture

- List
- Splicing
- List methods
- Tuple
- Multi-dimensional list
- Problem solving with List

List

A list/array is used to hold a list of items:

```
animal_list = ["dog", "cat", "frog"]

fibo_numbers = [0, 1, 1, 2, 3, 5, 8, 13]

prime_numbers = [2, 3, 5, 7, 11, 13, 17]

subject_list = ["MATH101", "CS222", "PHY102", "ACCY203"]

correct_answer_list = [True, False, True, True, False]

random_list = ["Production Info", 342, False]

selected_products = [] # this is an empty list
```

List

This is how we define a list:

```
list_variable = [item1, item2, …, itemN]
```

List

List is zero-indexed
List items can be accessed via **index/indices**:

```
animal_list = ["dog", "cat", "frog"]

print(animal_list[0])   → "dog"
print(animal_list[1])   → "cat"
print(animal_list[2])   → "frog"

fibo_numbers = [0, 1, 1, 2, 3, 5, 8, 13]

print(fibo_numbers[0])  → 0
print(fibo_numbers[1])  → 1
print(fibo_numbers[2])  → 1
print(fibo_numbers[3])  → 2
print(fibo_numbers[4])  → 3
print(fibo_numbers[5])  → 5
print(fibo_numbers[6])  → 8
print(fibo_numbers[7])  → 13
```

List - Splicing

Sub-lists can be retrieved via **indices**:

```
a[start:stop] # elements from start to stop-1
a[start:]     # elements from start to the rest of the array
a[:stop]      # elements from the beginning to stop-1
a[:]          # a copy of the whole array
```

List - Splicing

Multiple list items can be accessed via **indices**:

```
animal_list = ["dog", "cat", "frog"]

print(animal_list[0:2])   → ["dog", "cat"]
print(animal_list[1:2])   → "cat"
print(animal_list[1:1])   → []
print(animal_list[1:])    → ["cat", "frog"]

fibo_numbers = [0, 1, 1, 2, 3, 5, 8, 13]

print(fibo_numbers[0])  → 0
print(fibo_numbers[1])  → 1
print(fibo_numbers[2])  → 1
print(fibo_numbers[3])  → 2
print(fibo_numbers[4])  → 3
print(fibo_numbers[5])  → 5
print(fibo_numbers[6])  → 8
print(fibo_numbers[7])  → 13
```

List – Length of list

using `len` to find out how many items in the list:

```
animal_list = ["dog", "cat", "frog"]

animal_count = len(animal_list) ⟶ 3
```

Note that `len(animal_list)` is 3, but the **last index** is 2 because the index start at 0.

```
print(animal_list[0])   → "dog"
print(animal_list[1])   → "cat"
print(animal_list[2])   → "frog"
```

List

```
animal_list = ["dog", "cat", "frog"]

print(animal_list[0])   → "dog"
print(animal_list[1])   → "cat"
print(animal_list[2])   → "frog"
```

We can go through the list using for loop via **index**:

```
for i in range(0, len(animal_list)):
  print(animal_list[i])
```

Or:

```
for i in range(0, len(animal_list)):
  animal = animal_list[i]
  print(animal)
```

List – An iterable Object

```
animal_list = ["dog", "cat", "frog"]

print(animal_list[0])   → "dog"
print(animal_list[1])   → "cat"
print(animal_list[2])   → "frog"
```

Alternative way: go through the list using for loop:

```
for animal in animal_list:
  print(animal)
```

List – An iterable Object

Example – increase each item by 10

```
random_numbers = [1, 4, 4, 10, -1]
```

Using for-loop, increase each item by 10:

```
for i in range(0, len(random_numbers)):
  random_numbers[i] = random_numbers[i] + 10
```

```
print(random_numbers)    ⟶ [11, 14, 14, 20, 9]
```

List – Update list element

```
animal_list = ["dog", "cat", "frog"]

animal_list[0] = "wombat"
animal_list[1] = "echidna"
animal_list[2] = "koala"

animal_list[3] = "kangaroo"   ERROR: index out of range


# we have to do this instead
animal_list.append("kangaroo")
animal_list.append("emu")

print(animal_list)
  → ['wombat', 'echidna', 'koala', 'kangaroo', 'emu']
```

List

items **appended** are added to the end of the list:

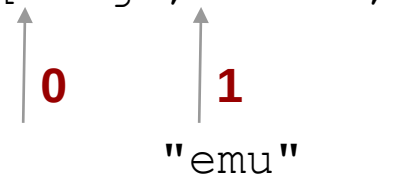
```
fibo_numbers = [0, 1, 1, 2, 3, 5, 8, 13]
fibo_numbers.append(21)
fibo_numbers.append(34)
fibo_numbers.append(55)
fibo_numbers.append(89)
print(fibo_numbers)
```

```
[0, 1, 1, 2, 3, 5, 8, 13 , 21 , 34 , 55 , 89]
```

List

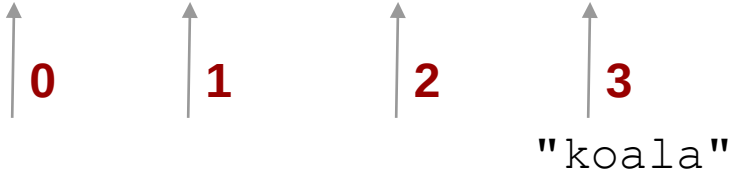
items can be **inserted** into the list:

```
animal_list = ["dog", "cat", "frog"]
```




```
animal_list.insert(1, "emu")
```

```
["dog", "emu", "cat", "frog"]
```




```
animal_list.insert(3, "koala")
```

```
["dog", "emu", "cat", "koala", "frog"]
```

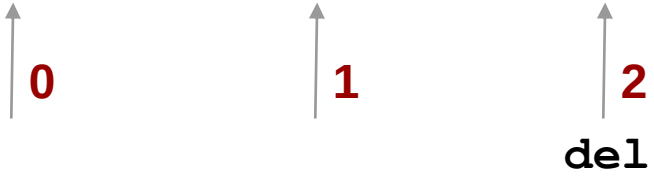
List – Remove by index

items can be **deleted** from the list via **index**:

```
subject_list = ["MATH101", "CS222", "PHY102", "ACCY203"]
```


```
# deleting the item at index 1
del subject_list[1]
```

```
["MATH101", "PHY102", "ACCY203"]
```




```
# deleting the item at index 2
del subject_list[2]
```

```
["MATH101", "PHY102"]
```

List – Remove by value

items can be **removed** from the list via **value**, only the **first appearance** get removed.

```
random_numbers = [3, 12, 4, 5, 4, 3, 2, 6, 12]

# remove the first appearance of 4
random_numbers.remove(4)
#  → [3, 12, 5, 4, 3, 2, 6, 12]

# remove the first appearance of 12
random_numbers.remove(12)
#  → [3, 5, 4, 3, 2, 6, 12]

# remove the first appearance of 7
random_numbers.remove(7)
  ValueError: list.remove(x): x not in list
```

List – Count elements

```
random_numbers = [1, 4, 4, 10, -1]
```

count how many an item appears in the list

```
four_count = random_numbers.count(4)    → 2

ten_count = random_numbers.count(10)    → 1

five_count = random_numbers.count(5)    → 0
```

List – Search element, getting index of the first

```
random_numbers = [1, 4, 4, 10, -1]
```

find the smallest **index** of an item in the list

```
four_index = random_numbers.index(4)          → 1

ten_index = random_numbers.index(10)          → 3

five_index = random_numbers.index(5)
        ValueError: 5 is not in the list
```

List – Find smallest and largest numeric element

```
random_numbers = [1, 4, 4, 10, -1]

# finding min item
number_min = min(random_numbers) → -1

# finding max item
number_max = max(random_numbers) → 10
```

List - Sorting

```
random_numbers = [1, 4, 4, 10, -1]
```

Sorting a list and return a new list, **original list is unchanged**

```
sorted_numbers = sorted(random_numbers)
```

sorted() is a built-in function that returns a new list

Now `sorted_numbers` is `[-1, 1, 4, 4, 10]`
but `random_numbers` is unchanged:
`random_numbers` is still `[1, 4, 4, 10, -1]`

List - Sorting

```
random_numbers = [1, 4, 4, 10, -1]
```

Sorting a list and **modify the original list**

```
random_numbers = [1, 4, 4, 10, -1]
random_numbers.sort()
```

list.sort() is a method of the list object which modifies said list

```
now random_numbers is changed,
random_numbers is now [-1, 1, 4, 4, 10]
```

List – reverse order and clear

```
random_numbers = [1, 4, 4, 10, -1]
```

items can be reversed

```
random_numbers.reverse()    # now [-1, 10, 4, 4, 1]
```

remove all items

```
random_numbers.clear()      # now []
```

List – adding and multiplying

```
list1 = [1, 4, 4, 10, -1]
list2 = [10, 7, 5]
```

adding two lists

```
list12 = list1 + list2  # now list12 = [1, 4, 4, 10, -1, 10, 7, 5]

list21 = list2 + list1  # now list21 = [10, 7, 5, 1, 4, 4, 10, -1]
```

multiply a list

```
list3 = [9, 8]

list4 = list3 * 3       # now list4 = [9, 8, 9, 8, 9, 8]
```

List – extending the list

```
list1 = [1, 4, 4, 10, -1]
list2 = [10, 7, 5]
```

Using .append()

```
list1.append(list2)
# list1 is now [1, 4, 4, 10, -1, [10, 7, 5]]
```

Using .extend() instead

```
list1.extend(list2)
# list1 is then [1, 4, 4, 10, -1, 10, 7, 5]
```

Example – Square sequence 0, 1, 4, 9, …

Create a list and put the first 10 squares into the list

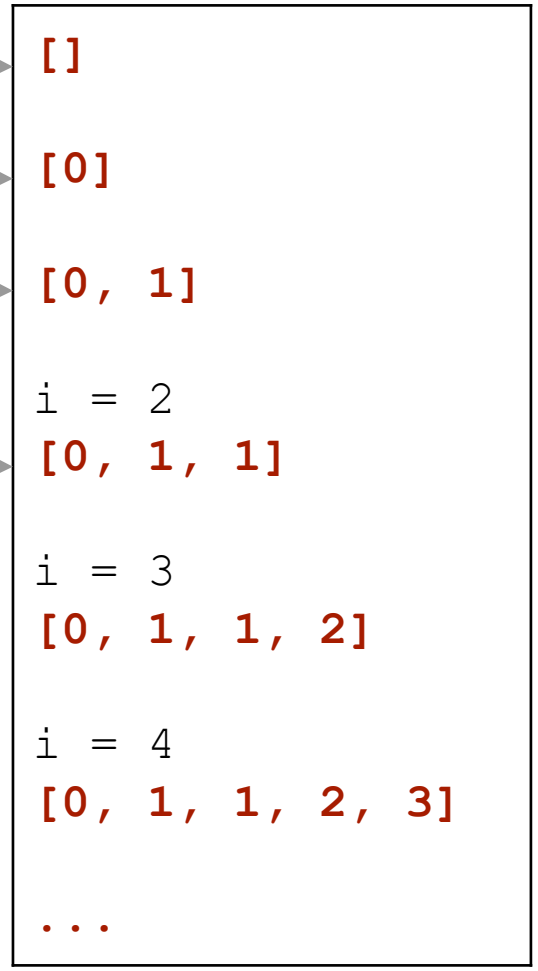
```
# initially, create an empty list
square_list = []
for i in range(0, 10):
  # adding square numbers to the list
  square_number = i * I
  square_list.append(square_number)
print("First 10 square numbers:")
print(square_list)
```

```
First 10 square numbers:
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
```

Example – Fibonacci 0, 1, 1, 2, 3, 5, 8, …

Create a list and put the first 10 fibonacci numbers into the list

```
fibo_list = []

fibo_list.append(0)

fibo_list.append(1)

for i in range(2, 10):
  fibo = fibo_list[i-1] + fibo_list[i-2]
  fibo_list.append(fibo)
```




```
i=2
fibo = fibo_list[1] + fibo_list[0] = 1 + 0 = 1
fibo_list.append(fibo)
i=3
fibo = fibo_list[2] + fibo_list[1] = 1 + 1 = 2
fibo_list.append(fibo)
i=4
fibo = fibo_list[3] + fibo_list[2] = 2 + 1 = 3
fibo_list.append(fibo)
i=5
fibo = fibo_list[4] + fibo_list[3] = 3 + 2 = 5
fibo_list.append(fibo)
...
```

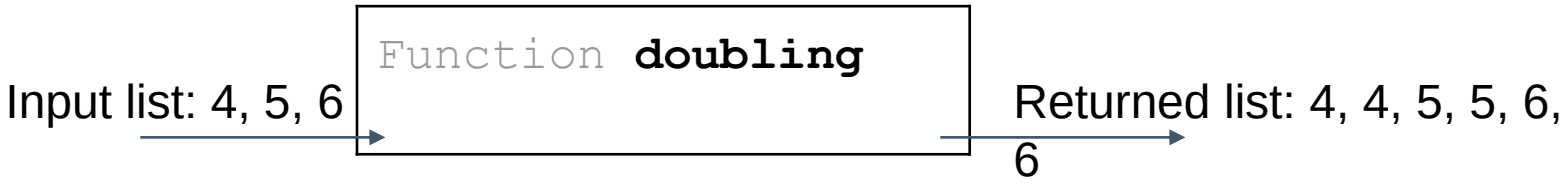
Example - Doubling

Write a function named `doubling` that has 1 input argument and return 1 value.

`doubling(list)` returns `new_list`

- The input `list` of the function is a list
- The function returns a new list where each element of the input list get repeated twice.

For example, if the input of the function is the list 4, 5, 6, then the function returns the list 4, 4, 5, 5, 6, 6.



Example – Doubling

```
def doubling(list):
  # create an empty list first
  new_list = []

  for i in range(0, len(list)):
    # go through each list element
    element = list[i]

    # add the element to the new list TWICE
    new_list.append(element)
    new_list.append(element)

  # return the new list
  return new_list
```

```
# main program
# testing
list1 = [4,5,6]
print(list1)

list2 = doubling(list1)
print(list2)
```

Output:

```
[4, 5, 6]
[4, 4, 5, 5, 6, 6]
```

Example – manual dot multiplication

Write a function named `list_multiply` that
- Takes in 2 input arguments
- Assumes the input `list1` and `list2` of the function are 2 lists of integers **containing the same number of elements**
- Multiplies the two list elements one by one
- returns the result as a new list.

`list_multiply(list1, list2)` returns `new_list`

For example, if
list1 is 4, 5, 6; and
list2 is 10, 0, 1; then
the function returns the list: 40, 0, 6.

Example – manual dot multiplication

```
def list_multiply(list1, list2):
    # create an empty list first
    new_list = []

    for i in range(0, len(list1)):
        # go through each list element
        list1_element = list1[i]
        list2_element = list2[i]

        # multiply them
        result = list1_element * list2_element

        # add the multiply result to the new list
        new_list.append(result)

    # return the new list
    return new_list
```

```
# main program
# testing
list1 = [4,5,6]
list2 = [10, 0, 1]
list3 = list_multiply(list1,
list2)
print(list1)
print(list2)
print(list3)
```

Output:

```
[4, 5, 6]
[10, 0, 1]
[40, 0, 6]
```

Example

During winter break, each student can choose exactly one intensive subject to study. Write a program to

- ***Step 1:*** *let a student select a number of preferred subjects;*
- ***Step 2:*** *then among the preferred subjects the student selected, choose a random subject for student enrolment.*

Example

- ***Step 1:*** *let a student select a number of prefered subjects;*

```
# create a list of preferred subject, start with an empty list
subject_list = []

# repeatedly ask the user to enter subject code
while True:
  subject = input("Enter preferred subject code (enter QUIT to
quit): ")

  if(subject == "QUIT"):
    break

  # add subject to subject list
  subject_list.append(subject)

# display subjects the user has entered
print("You have chosen: " + str(subject_list))
```

Example

- ***Step 1:*** *let a student select a number of prefered subjects;*

```
Enter preferred subject code (enter QUIT to quit): MATH300
Enter preferred subject code (enter QUIT to quit): COMP222
Enter preferred subject code (enter QUIT to quit): ACCY100
Enter preferred subject code (enter QUIT to quit): BUSS200
Enter preferred subject code (enter QUIT to quit): QUIT
You have chosen: ['MATH300', 'COMP222', 'ACCY100', 'BUSS200']
```

Example

- ***2:*** *then among the prefered subjects the student selected,* ***choose a random subject*** *for student enrolment.*

How can we choose a random subject?

```
Subject list: ['MATH300', 'COMP222', 'ACCY100', 'BUSS200']
Index:                 0          1          2          3
```

We need to choose a random list index:

The index is a random number from **0** *to* **`len(subject_list)-1`**

Example

- ***2:** then among the prefered subjects the student selected, **choose a random subject** for student enrolment.*

```
# choose a random index from 0 to len(subject_list)-1
random_index = random.randint(0, len(subject_list)-1)
random_subject = subject_list[random_index]

# display the random subject enrolled for the user
print("You have been approved to enrol into " + random_subject)
```

```
You have chosen: ['MATH300', 'COMP222', 'ACCY100', 'BUSS200']
You have been approved to enrol into ACCY100
```

```
# import random module
import random
# create a list of preferred subject, start with an empty list
subject_list = []

# repeatedly ask the user to enter subject code
while True:
  subject = input("Enter preferred subject code (enter QUIT to quit): ")
  if(subject == "QUIT"):
    break
  # add subject to subject list
  subject_list.append(subject)

# display subjects the user has entered
print("You have chosen: " + str(subject_list))

# choose a random index from 0 to len(subject_list)-1
random_index = random.randint(0, len(subject_list)-1)
random_subject = subject_list[random_index]

# display the random subject enrolled for the user
print("You have been approved to enrol into " + random_subject)
```

remember to import random module at the top of the code

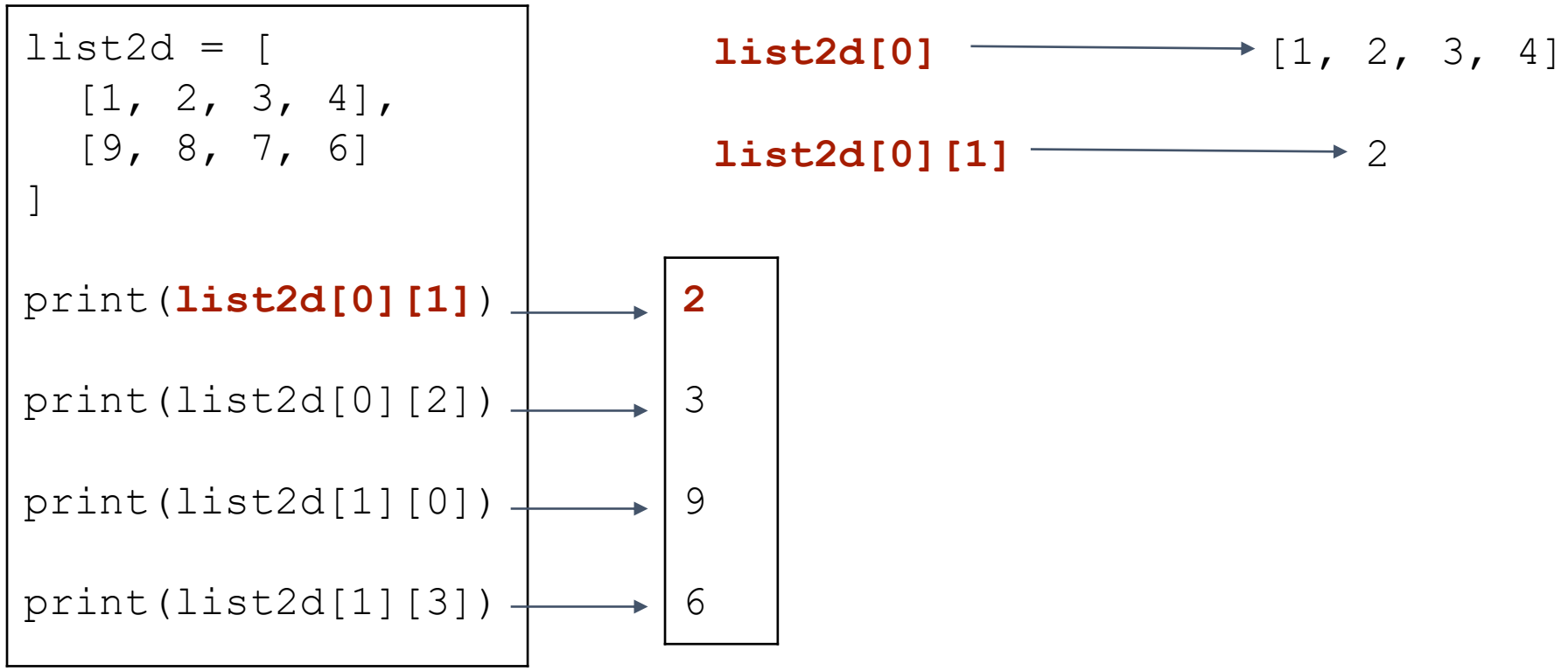
Tuple

A tuple is similar to list but:

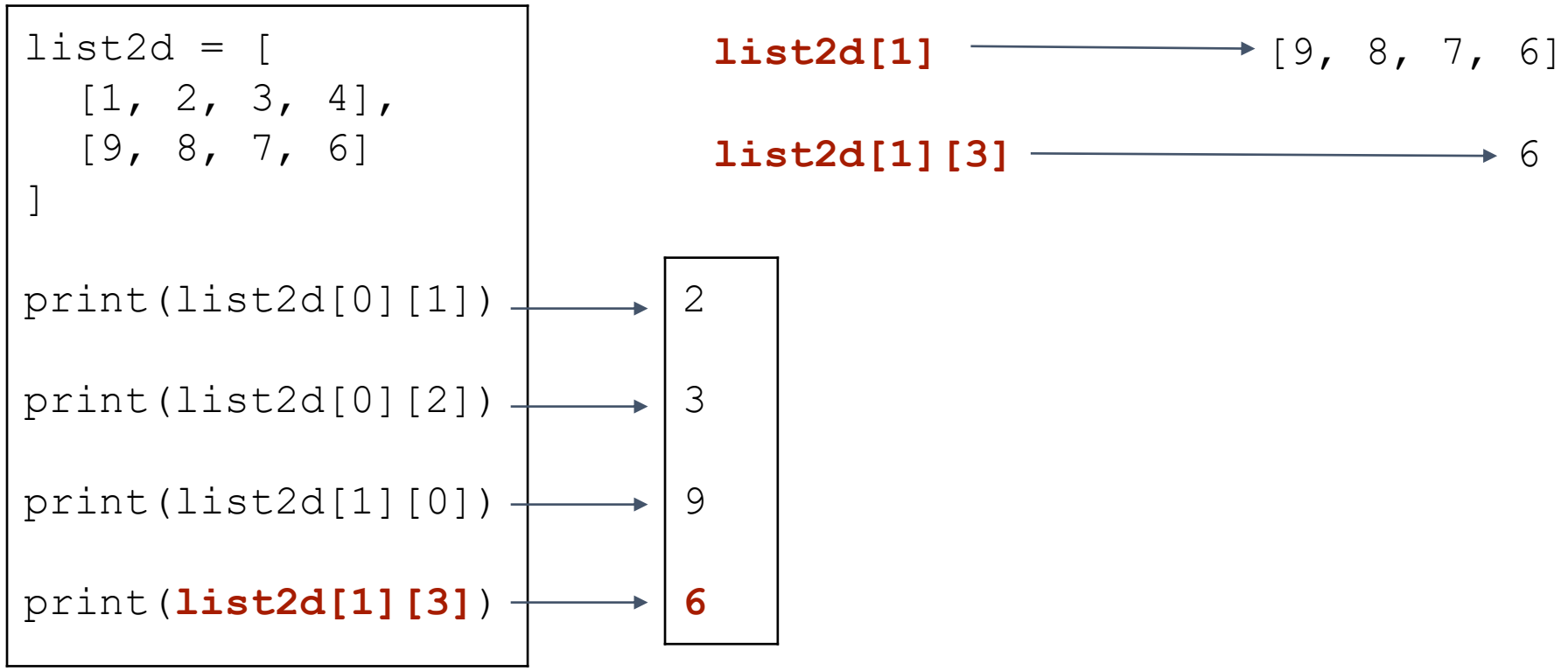
- A list can be changed
- A tuple is fixed

```
animal_list = ["dog", "cat", "frog"]

animal_tuple = ("dog", "cat", "frog")

# we can change list
animal_list[0] = "elephant"

# but we canNOT change tuple
animal_tuple[0] = "elephant"   ERROR
```

Two-dimensional list



Two-dimensional list



Euler's magic square

68^2	29^2	41^2	37^2
17^2	31^2	79^2	32^2
59^2	28^2	23^2	61^2
11^2	77^2	8^2	49^2

Sum of numbers on each row, each column, and each diagonal is the same!

Euler's magic square

```
euler = [
  [68**2, 29**2, 41**2, 37**2],
  [17**2, 31**2, 79**2, 32**2],
  [59**2, 28**2, 23**2, 61**2],
  [11**2, 77**2,  8**2, 49**2]
]
```

68^2	29^2	41^2	37^2
17^2	31^2	79^2	32^2
59^2	28^2	23^2	61^2
11^2	77^2	8^2	49^2

```
# row sums
row1 = euler[0][0] + euler[0][1] + euler[0][2] + euler[0][3]
row2 = euler[1][0] + euler[1][1] + euler[1][2] + euler[1][3]
row3 = euler[2][0] + euler[2][1] + euler[2][2] + euler[2][3]
row4 = euler[3][0] + euler[3][1] + euler[3][2] + euler[3][3]

# column sums
column1 = euler[0][0] + euler[1][0] + euler[2][0] + euler[3][0]
column2 = euler[0][1] + euler[1][1] + euler[2][1] + euler[3][1]
column3 = euler[0][2] + euler[1][2] + euler[2][2] + euler[3][2]
column4 = euler[0][3] + euler[1][3] + euler[2][3] + euler[3][3]

# diagonal sums
diagonal1 = euler[0][0] + euler[1][1] + euler[2][2] + euler[3][3]
diagonal2 = euler[0][3] + euler[1][2] + euler[2][1] + euler[3][0]
```

Euler's magic square

```
euler = [
  [68**2, 29**2, 41**2, 37**2],
  [17**2, 31**2, 79**2, 32**2],
  [59**2, 28**2, 23**2, 61**2],
  [11**2, 77**2,  8**2, 49**2]
]
```

68^2	29^2	41^2	37^2
17^2	31^2	79^2	32^2
59^2	28^2	23^2	61^2
11^2	77^2	8^2	49^2

```
print("row1={0}, row2={1}, row3={2}, row4={3}"
        .format(row1, row2, row3, row4))

print("column1={0}, column2={1}, column3={2}, column4={3}"
        .format(column1, column2, column3, column4))

print("diagonal1={0}, diagonal2={1}"
        .format(diagonal1, diagonal2))
```

```
row1=8515, row2=8515, row3=8515, row4=8515
column1=8515, column2=8515, column3=8515, column4=8515
diagonal1=8515, diagonal2=8515
```

Any questions?