Python Programming

Lecture 4 Dictionaries, Tuples

4.1 Dictionaries (字典)

- A dictionary is like a list, but more general. In a list, the index positions have to be integers; in a dictionary, the indices can be (almost) any type. You can think of a dictionary as a mapping between a set of indices (which are called keys) and a set of values. In general, the order of items in a dictionary is unpredictable.

```
>>> x = {'one':'apple','two':'banana','three':'orange'}

>>> print(x['two'])
'banana'

>>> len(x)
3
>>> x = {} #This is False
```

- The in operator is used to check whether a specified key exists in a dictionary. It returns True if the key is present in the dictionary and False otherwise. To check if a value exists, you must explicitly search in dictionary.values().

```
>>> x = {'one': 'apple', 'two': 'banana', 'three': 'orange'}
>>> print('one' in x)
True
>>> print('uno' in x)
False
>>> print('orange' in x.values())
True
```

- To create a dictionary, start with an empty one, and add the key-value pairs. The keys should be immutable and there is no repeated key. Lists or dictionaries cannot be keys.

```
>>> alien = {}
>>> alien['color'] = 'green'
>>> alien['points'] = 5
>>> print(alien)
{'color': 'green', 'points': 5}
```

- Modifying and Removing Values in a Dictionary

```
>>> alien['color'] = 'yellow'
>>> print(alien)
{'color': 'yellow', 'points': 5}
```

```
>>> del alien['points']
>>> print(alien)
{'color': 'yellow'}
```

- Merge two dictionaries

```
>>> a = { 'x' : 1 , 'y' : 2 }
>>> b = { 'z' : 4 }
>>> print(a|b)
{'x': 1, 'y': 2, 'z': 4}
```

```
>>> a = { 'x' : 1 , 'y' : 2 }
>>> b = { 'y' : 3 , 'z' : 4 }
>>> print(a|b)
{'x': 1, 'y': 3, 'z': 4}
```

Methods of Dictionary

```
>>> stuff = {}
>>> dir(stuff)
```

```
['__class__', '__class_getitem__', '__contains__', '__delattr__', '__delitem__',
 '__dir__', '__doc__', '__eq__', '__format__', '__ge__', '__getattribute__',
 '__getitem__', '__gt__', '__hash__', '__init__', '__init_subclass__', '__ior__',
 '__iter__', '__le__', '__len__', '__lt__', '__ne__', '__new__', '__or__',
 '__reduce__', '__reduce_ex__', '__repr__', '__reversed__', '__ror__',
 '__setattr__', '__setitem__', '__sizeof__', '__str__', '__subclasshook__',
 'clear', 'copy', 'fromkeys', 'get', 'items', 'keys', 'pop', 'popitem',
 'setdefault', 'update','values']
```

```
>>> help(type(stuff).get)
Help on method_descriptor:

get(self, key, default=None, /)
    Return the value for key if key is in the dictionary, else default.
```

- Dictionaries have a method called .get() that takes a key and a default value.

```
>>> counts = { 'chuck' : 1 , 'annie' : 42, 'jan': 100}
>>> print(counts.get('jan', 0)) #0 is the default value
100
>>> print(counts.get('anni', 1550))
1550
```

- Suppose you are given a list and you want to count how many times each letter appears.

```
word_list = ['b','a','n','a','n','a']
d = {}
for c in word_list:
    d[c] = d.get(c,0) + 1
print(d)
```

```
{'b': 1, 'a': 3, 'n': 2}
```

Looping Through Dictionary

.items(), .keys(), .values()

```
favorite={'jen':'python','sarah':'c','edward':'ruby'}

for x, y in favorite.items():
    print(x, y)
# Looping through all key-value pairs
```

```
jen python
sarah c
edward ruby
```

```
for y in favorite.values():
    print(y)
# Looping through all values
```

```
python
c
ruby
```

```
for x in favorite.keys():
    print(x)
# Looping through all keys
```

```
jen
sarah
edward
```

Nesting

- You can nest a set of dictionaries inside a list, a list of items inside a dictionary, or even a dictionary inside another dictionary. A list or a dictionary cannot be the key (The key should be immutable).
- Dictionaries in a list

```
alien_0 = {'color': 'green', 'points': 5}
alien_1 = {'color': 'yellow', 'points': 10}
alien_2 = {'color': 'red', 'points': 15}

aliens = [alien_0, alien_1, alien_2]
```

- A List in a Dictionary

```
pizza = {
    'crust': 'thick',
    'toppings': ['mushrooms', 'extra cheese'],
    }
print(pizza['crust'], pizza['toppings'][1])
```

```
thick extra cheese
```

- A dictionary in a dictionary

```
users = {
    'aeinstein': {
        'first': 'albert',
        'last': 'einstein',
        'location': 'princeton',
        },

    'mcurie': {
        'first': 'marie',
        'last': 'curie',
        'location': 'paris',
        },
    }
```

```
full_name = users['aeinstein']['first']+" "+users['aeinstein']['last']
location = users['aeinstein']['location']

print("Full name: " + full_name)
print("Location: " + location)
```

```
Full name: Albert Einstein
Location: Princeton
```

Dictionaries: Summary

- Elements are key-value pairs. Empty dictionary is {}.
- Features: lists or dictionaries cannot be keys. Do not make repeated keys.
- The "in" operator works on keys (but you can use .values())
- Method: get (value or default value)
- Looping: .items(), .keys(), .values()
- Nesting: A list of dictionaries, a list in a dictionary, a dictionary in a dictionary

4.2 Money Tracker (简易记账本)

Objective: require users to enter expenses one by one, and report the total expenses

Step 1: Create a list containing dictionaries

```
print("简易记账本(March)")
March = []
for date in range(31):
    March.append({})
```

Step 2: Require users to enter the date

```
day = int(input("请问输入几号的开销？\n"))
```

Step 3: Enter the expenses one by one

```
print("请输入每一笔开销，结束请输入0:\n")
while True:
    each = float(input("请输入金额:\n"))
    if each == 0:
        break
    else:
        type = input("请选择类型: a.衣 b.食 c.住 d.行 e.其他\n")
        March[day-1][type] = March[day-1].get(type,0) + each
        print("记录成功\n")
```

- Multiple days: replace the code in Step 2 (Nested loops)

```
while True:
    day = int(input("请问输入几号的开销？结束请输入0:\n"))
    if day == 0:
        break
    else:
        # all the programs in Step 3
```

- indentation: select programs, tab (or space)
- cancel indentation: select programs, shift + tab

```
total=0
for each_day in March:
    total += sum(each_day.values())

print("总支出：", total)
```

```
st = {}
category = ['a', 'b', 'c', 'd', 'e']
for type in category:
    for each_day in March:
        st[type] = each_day.get(type,0)+st.get(type,0)

print("衣：", st['a'], "食：", st['b'])
print("住：", st['c'], "行：", st['d'])
print("其他：", st['e'])
```

4.3 Tuples (元组)

- Lists and tuples are similar, with the only difference being that tuples are immutable (不可变).

```
>>> t = ('a', 'b', 'c', 'd', 'e')

>>> t = () #Empty tuple is False
```

- To create a tuple with a single element, you have to include the final comma:

```
>>> t1 = ('a',)
>>> type(t1)
tuple

>>> t2 = ('a')
>>> type(t2)
str
```

- Because tuples are immutable, they can be used as dictionary keys.

```
>>> d = {}
>>> d[('Taylor', 'Swift')] = 100
>>> print(d)
{('Taylor', 'Swift'): 100}
```

- Most list operators also work on tuples. (编号：从零开始；切片：左闭右开)

```
>>> t = ('a', 'b', 'c', 'd', 'e')
>>> print(t[0])
'a'

>>> print(t[1:3])
('b', 'c')
```

- Tuples cannot be directly assigned or modified; they can only be recreated. (修改：重新创建)

```
>>> t[0] = 'A'
TypeError: object doesn't support item assignment

>>> t = ('A',) + t[1:]
>>> print(t)
('A', 'b', 'c', 'd', 'e')
```

- If you want to modify a tuple, you can convert it to a list, and then convert it back.

```
>>> t = ('a', 'b', 'c', 'd', 'e')
>>> s = list(t)
>>> s[0] = 'A'
>>> t = tuple(s)
```

Other common characteristics of lists and tuples

- Tuples and strings are compared and sorted lexicographically, element by element (the same for lists).

```
>>> (0, 1, 2000000) < (0, 3, 4)
True

>>> t = [(2, 4), (0, 1, 2), (0, 3, 4)]
>>> t.sort()
>>> print(t)
[(0, 1, 2), (0, 3, 4), (2, 4)]
```

- Multiple assignment (the same for lists)

```
>>> m = ('have', 'fun')
>>> x, y = m  #(x, y) = m
>>> print(x, y)
have fun

>>> x, y = y, x #swap
```

- The in operator (the same for lists)

```
>>> t = ('a', 'b', 'c', 'd', 'e')
>>> print('a' in t)
True
```

Nesting of lists and tuples

- Iteration with multiple values (the same for list of lists, tuple of lists)

```
t = [('a',1), ('b',2), ('c',3)]
# t = [['a',1], ['b',2], ['c',3]]
# t = (('a',1), ('b',2), ('c',3))

for x, y in t:
    print(x)
    print(y)
# for x in t?
```

- If you want to modify a list inside a tuple, you can directly assign a new value to an individual element of the list. However, you cannot directly assign a new list to replace the existing one in the tuple.

```
>>> t = ('a', 'b', ['A', 'B'])
>>> t[2][0] = 'X'
>>> t[2][1] = 'Y'
>>> t
('a', 'b', ['X', 'Y'])
```

```
>>> t = ('a', 'b', ['A', 'B'])
>>> t[2] = ['X', 'Y']

TypeError: 'tuple' object does not support item assignment
```

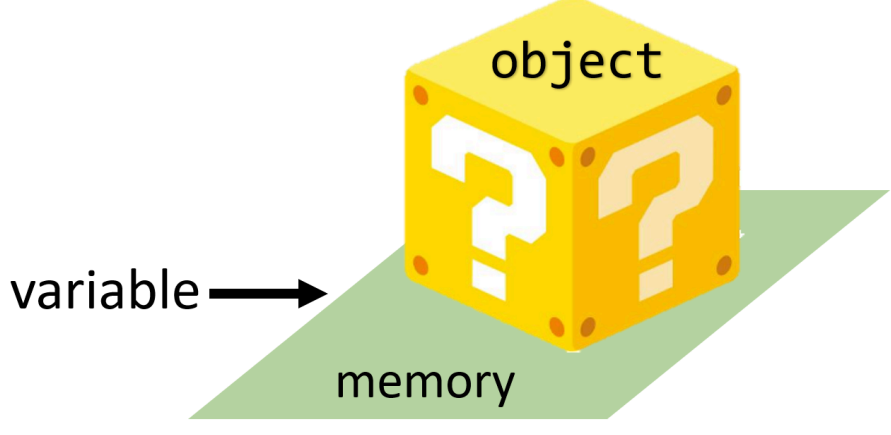
Tuples: Summary

- The element can be any type. The empty is ().
- Features: Ordered, Repeatable, Immutable
- The indices start at 0. Index -1 means the last item. (编号：从零开始)
- In slicing, the start is inclusive, and the end is exclusive. (切片：左闭右开)
- You cannot modify the elements of a tuple by assignment.（修改：重新创建）
- Comparing, multiple assignment, in operator (tuple and list)
- Nesting of lists and tuples. Tuples can be keys of a dictionary.

4.4 Mutable and Immutable (可变和不可变)

    - List: [], ordered, repeatable, mutable (可变的)
    - Tuple: (), ordered, repeatable, immutable (不可变的)
    - Dictionary: {}, not ordered.
        - Values are repeatable, but keys are not repeatable.
        - Dictionary is mutable (key-value pairs are mutable).
        - Values are mutable, but keys must be immutable.
- Numbers, strings, tuples are immutable. Lists, dictionaries are mutable.
- What does it mean for immutable or mutable?

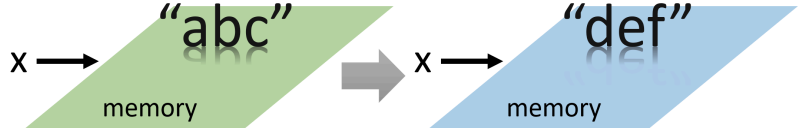
- 1. Assignment: variable $\rightarrow$ computer memory $\rightarrow$ object



2. Modification

- When you want to modify the immutable object, you can only assign a new object. It changes the address in the memory.

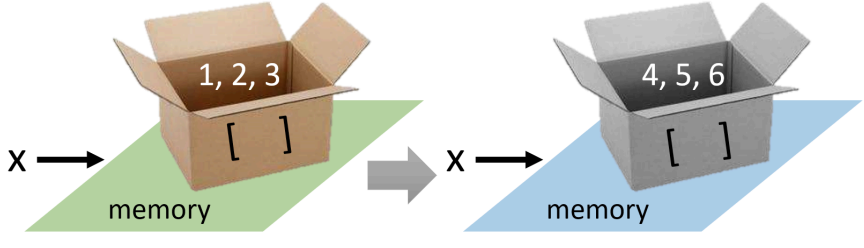
```
1 >>> x = "abc"
2 >>> x = "def"
```



- There are two ways for you to modify the mutable object. (a) make a new assignment; (b) make a modification by methods for lists or some ways for dictionaries.

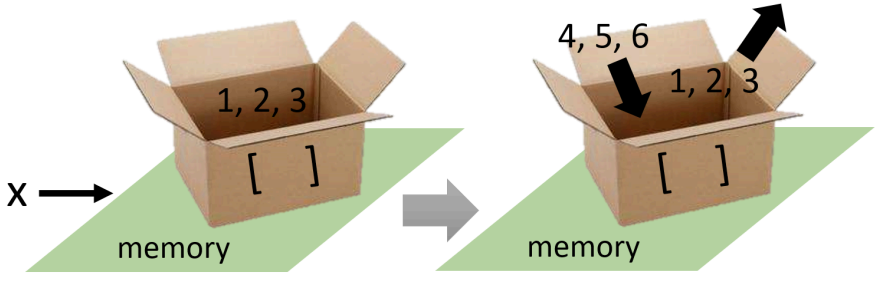
  a. make a new assignment

```
1 >>> x = [1,2,3]
2 >>> x = [4,5,6]
```



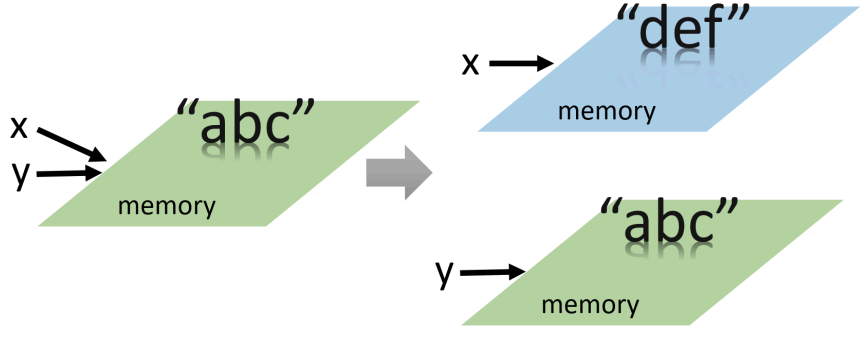
b. make a modification by methods for lists. You do not change the address.

```
>>> x = [1,2,3]
>>> x.pop()
>>> x.pop()
>>> x.pop()
>>> x.append(4)
>>> x.append(5)
>>> x.append(6)
```

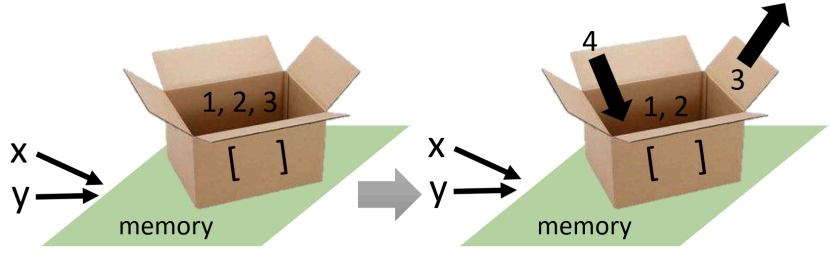


3. Pass by Value

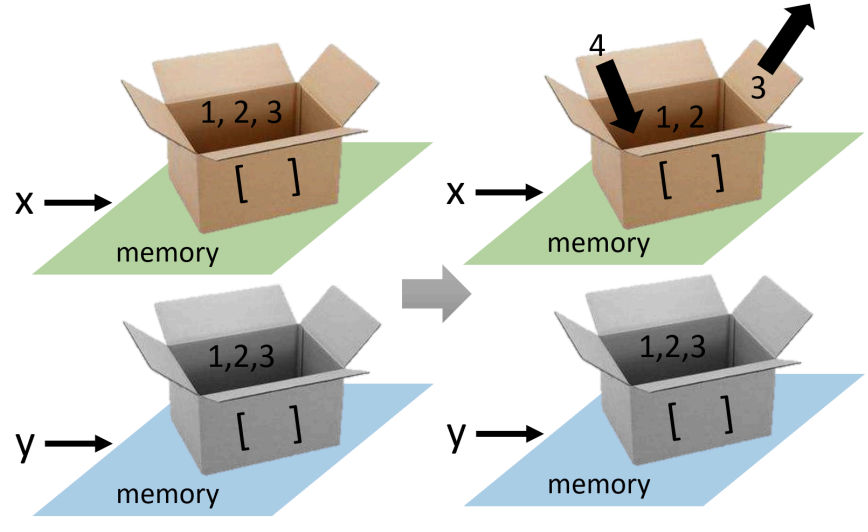
```
>>> x = "abc"
>>> y = x
>>> x = "def"
>>> print(y)
"abc"
```



```
>>> x = [1,2,3]
>>> y = x
>>> x.pop(2)
>>> x.append(4)
>>> print(y)
[1,2,4]
```




```
>>> x = [1,2,3]
>>> y = x[:]
>>> x.pop(2)
>>> x.append(4)
>>> print(y)
[1,2,3]
```



Summary

- Dictionaries, Tuples
- Reading: Python for Everybody
  - Chapter 9, 10.1-10.5, 10.7-10.8