香港中文大學（深圳）
The Chinese University of Hong Kong, Shenzhen

Introduction to Computer Science: Programming Methodology

Lecture 5 List

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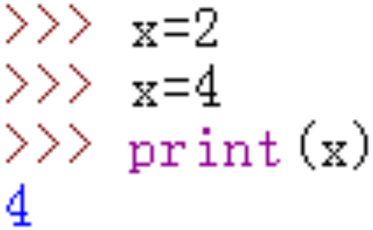
List is kind of a collection

- A collection allows us to put many values in a single "variable"

- A collection is nice because we can carry all many variables around in one convenient package

What is not a collection

- Most of our variables have only one value in them – when we put a new value in the variable, the old value will be over-written



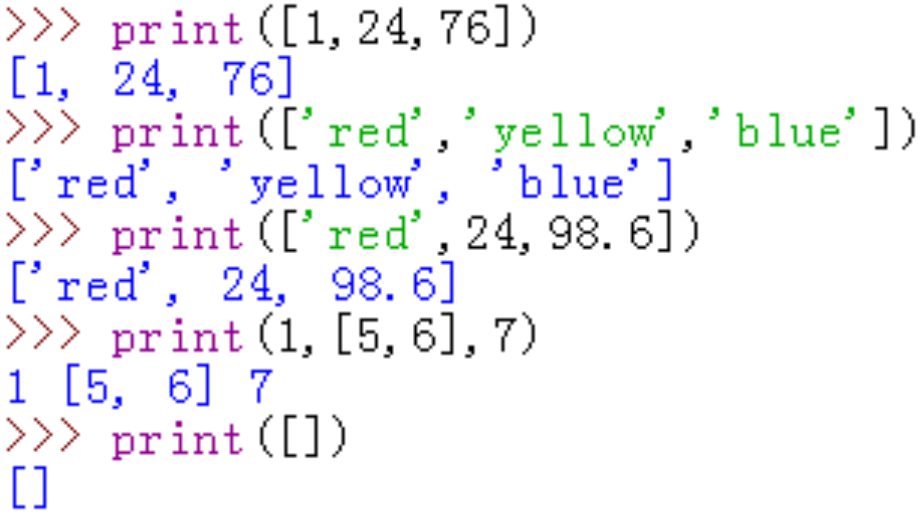
```
>>> x=2
>>> x=4
>>> print(x)
4
```

List constants

- List constants are surrounded by square brackets and the elements in the list are separated by commas

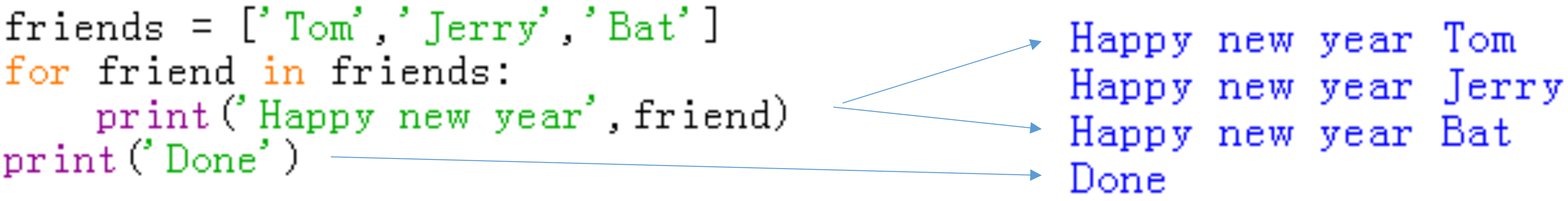
- A list element can be any Python object – even another list

- A list can be empty



```
>>> print([1,24,76])
[1, 24, 76]
>>> print([’red’,’yellow’,’blue’])
[’red’, ’yellow’, ’blue’]
>>> print([’red’,24,98.6])
[’red’, 24, 98.6]
>>> print(1,[5,6],7)
1 [5, 6] 7
>>> print([])
[]
```

List and definite loop - best pal



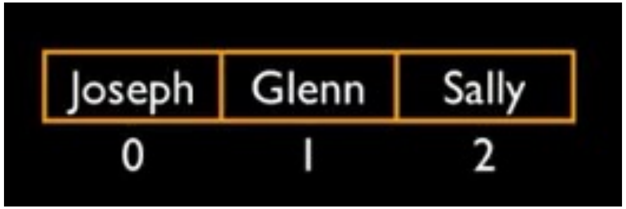
```
friends = ['Tom','Jerry','Bat']
for friend in friends:
    print('Happy new year',friend)
print('Done')
```

```
Happy new year Tom
Happy new year Jerry
Happy new year Bat
Done
```

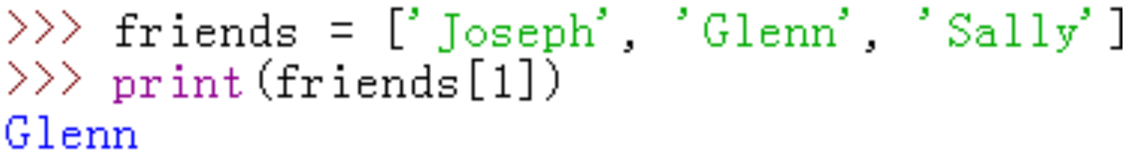
Looking inside lists

- Just like strings, we can access any single element in a list using an index specified in square bracket

列表可索引



Joseph	Glenn	Sally
0	1	2

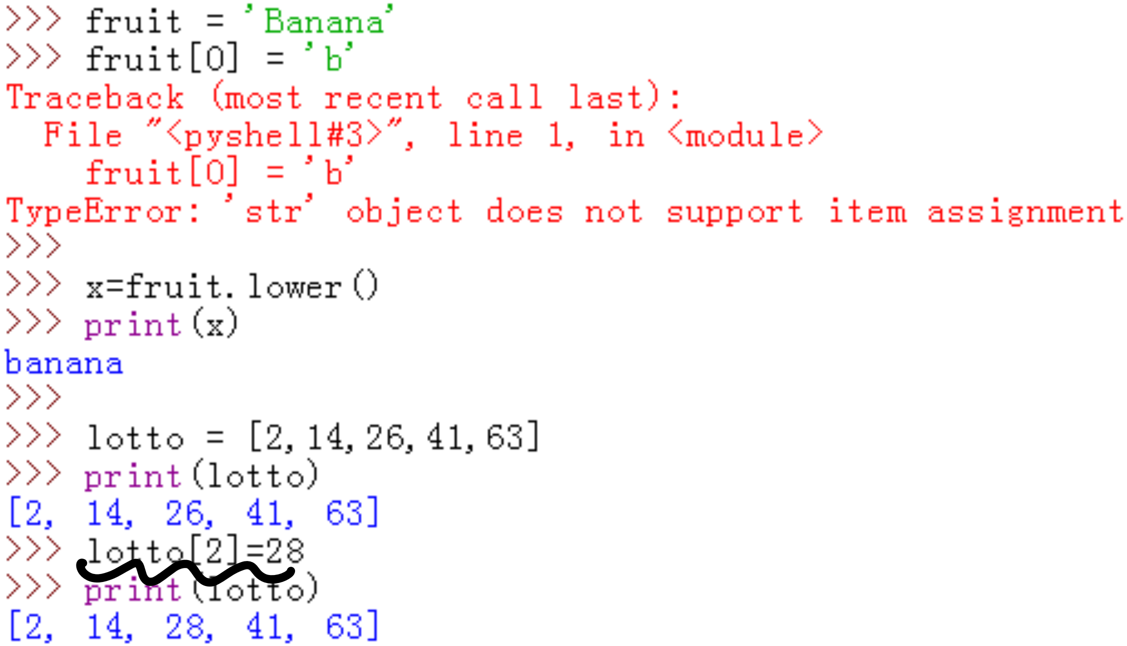


```
>>> friends = ['Joseph', 'Glenn', 'Sally']
>>> print(friends[1])
Glenn
```

Lists are mutable 可更改的

- Strings are “immutable” – we cannot change the contents of a string unless we make a new string

- Lists are “mutable” – we can change an element of a list using index operator



```
>>> fruit = 'Banana'
>>> fruit[0] = 'b'
Traceback (most recent call last):
  File "<pyshell#3>", line 1, in <module>
    fruit[0] = 'b'
TypeError: 'str' object does not support item assignment
>>>
>>> x=fruit.lower()
>>> print(x)
banana
>>>
>>> lotto = [2,14,26,41,63]
>>> print(lotto)
[2, 14, 26, 41, 63]
>>> lotto[2]=28
>>> print(lotto)
[2, 14, 28, 41, 63]
```

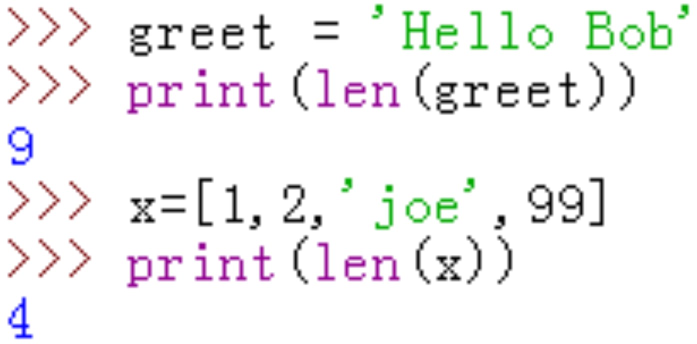
list[location]= new value.

How long is a list?

len( )

- The len() function takes a list as input and returns the number of elements in that list

- Actually len() tells us the number of elements in any sequence (e.g. strings)

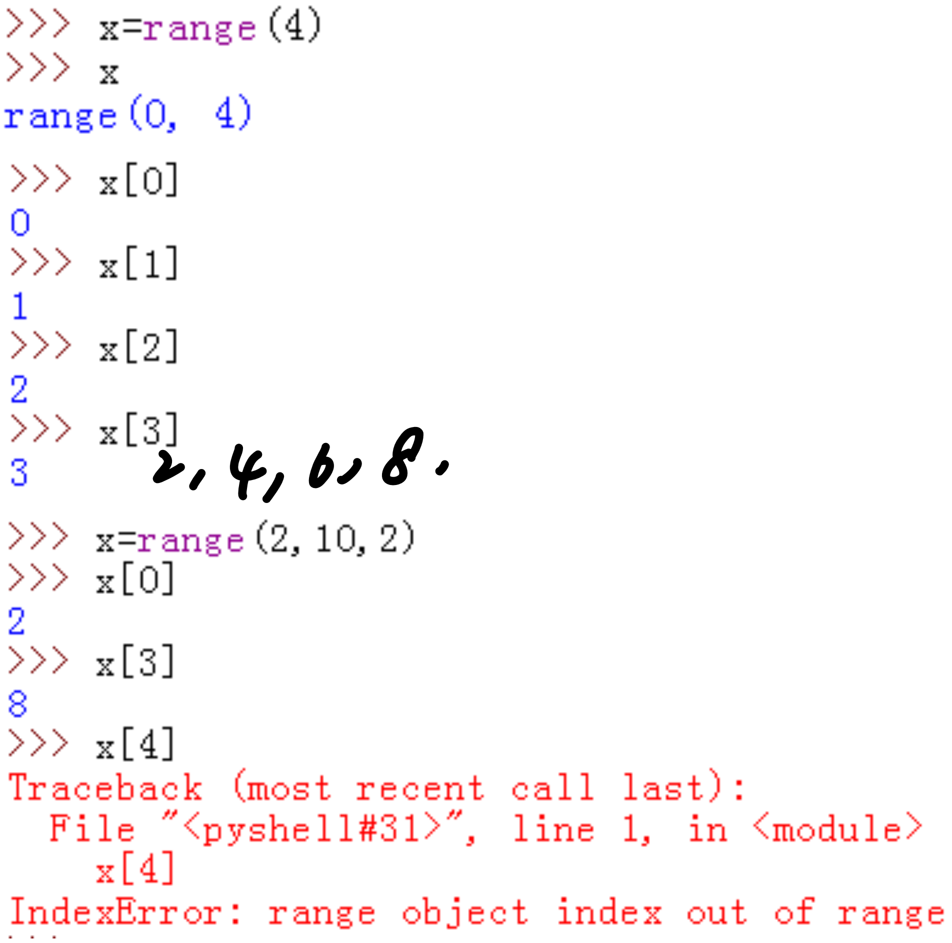


```
>>> greet = ’Hello Bob’
>>> print(len(greet))
9
>>> x=[1,2,’joe’,99]
>>> print(len(x))
4
```

Range() function

- The range() function returns a list of numbers
- We can construct an index loop using for and an integer iterator

左闭右开.



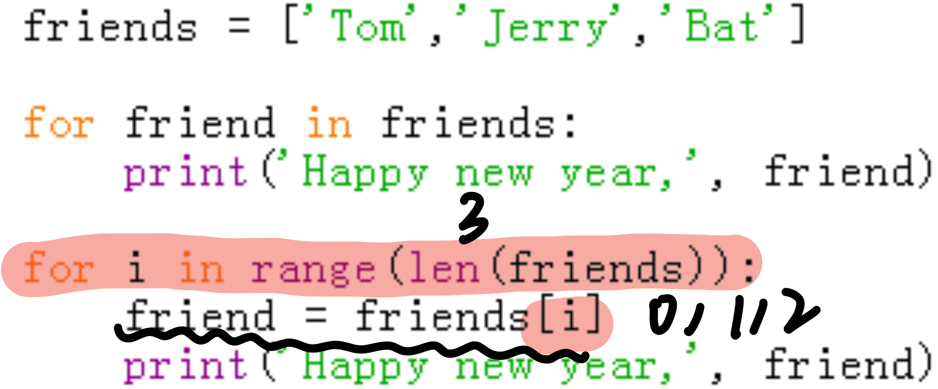
```
>>> x=range(4)
>>> x
range(0, 4)
>>> x[0]
0
>>> x[1]
1
>>> x[2]
2
>>> x[3]
3
>>> x=range(2, 10, 2)
>>> x[0]
2
>>> x[3]
8
>>> x[4]
Traceback (most recent call last):
  File "<pyshell#31>", line 1, in <module>
    x[4]
IndexError: range object index out of range
```

2, 4, 6, 8.

A tale of two loops

☆ for循环 / 用index operator

Example



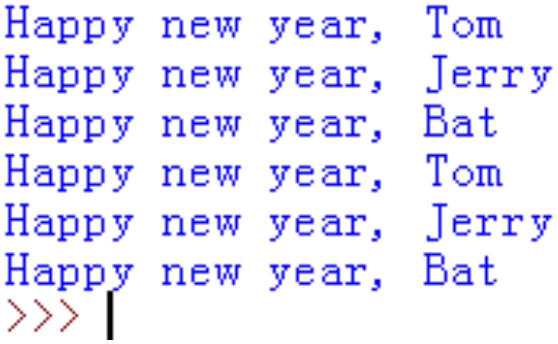
```
friends = ['Tom','Jerry','Bat']

for friend in friends:
    print('Happy new year,', friend)

for i in range(len(friends)):
    friend = friends[i]
    print('Happy new year,', friend)
```

用(

3

0,1,2

Output



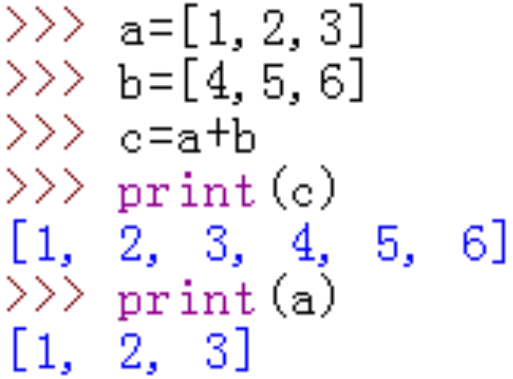
```
Happy new year, Tom
Happy new year, Jerry
Happy new year, Bat
Happy new year, Tom
Happy new year, Jerry
Happy new year, Bat
>>> 
```

连接.

Concatenating lists using +

- Similar to strings, we can add two existing lists together to create a new list

(与string操作类似)

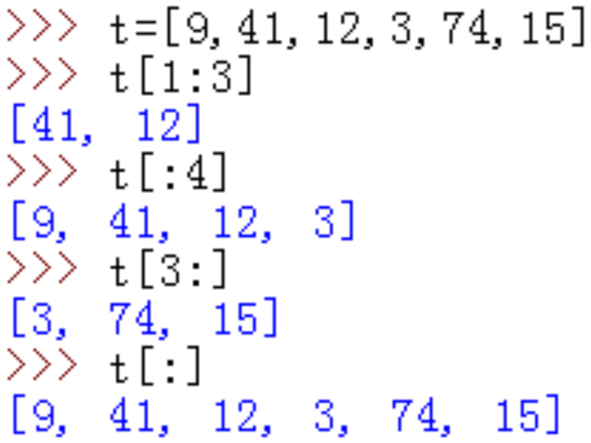


```
>>> a=[1,2,3]
>>> b=[4,5,6]
>>> c=a+b
>>> print(c)
[1, 2, 3, 4, 5, 6]
>>> print(a)
[1, 2, 3]
```

Lists can be sliced using :

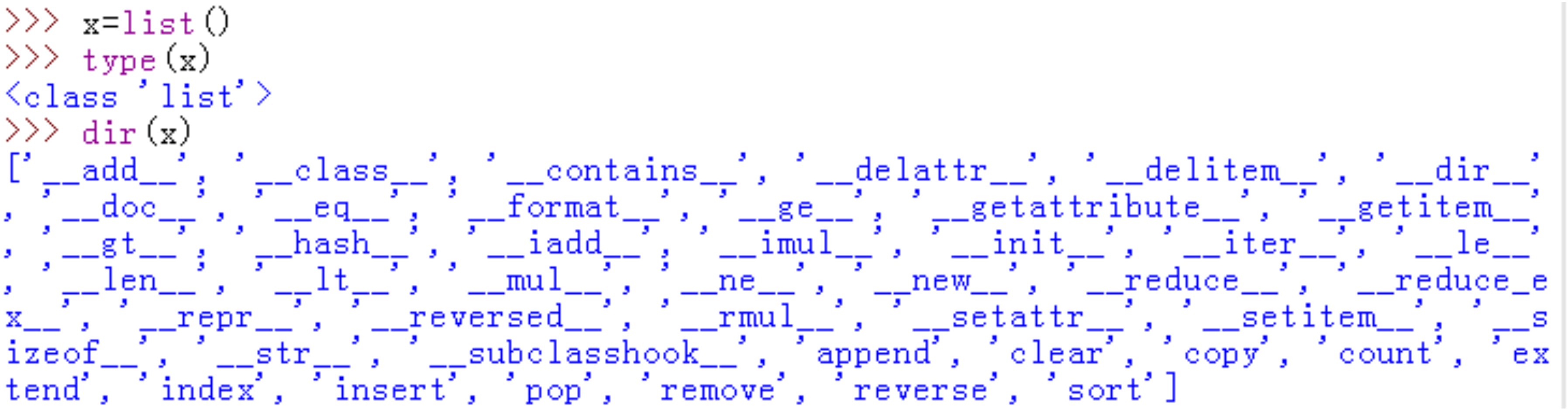
- Remember: similar to strings, the second number is “up to but no including”

list[a:b]



```
>>> t=[9,41,12,3,74,15]
>>> t[1:3]
[41, 12]
>>> t[:4]
[9, 41, 12, 3]
>>> t[3:]
[3, 74, 15]
>>> t[:]
[9, 41, 12, 3, 74, 15]
```

List methods



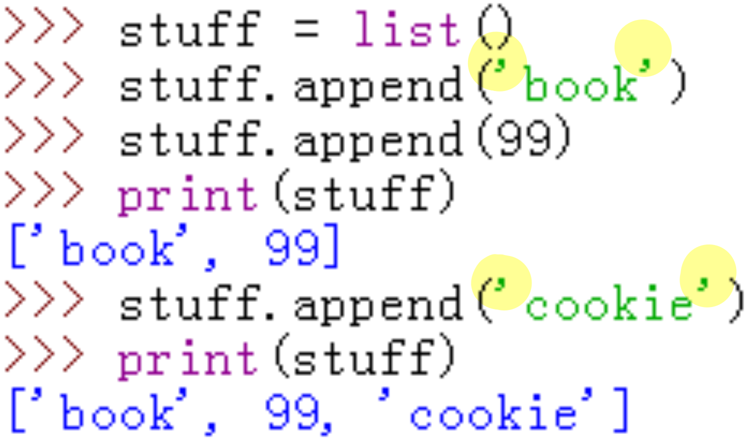
```
>>> x=list()
>>> type(x)
<class 'list'>
>>> dir(x)
['__add__', '__class__', '__contains__', '__delattr__', '__delitem__', '__dir__'
, '__doc__', '__eq__', '__format__', '__ge__', '__getattribute__', '__getitem__'
, '__gt__', '__hash__', '__iadd__', '__imul__', '__init__', '__iter__', '__le__'
, '__len__', '__lt__', '__mul__', '__ne__', '__new__', '__reduce__', '__reduce_e
x__', '__repr__', '__reversed__', '__rmul__', '__setattr__', '__setitem__', '__s
izeof__', '__str__', '__subclasshook__', 'append', 'clear', 'copy', 'count', 'ex
tend', 'index', 'insert', 'pop', 'remove', 'reverse', 'sort']
```

https://docs.python.org/3/tutorial/datastructures.html#more-on-lists

Building a list from scratch

- We can create an empty list using list(), and then add elements using append() method 空集→添加元素

- The list stays in order, and new elements are added at the end of the list



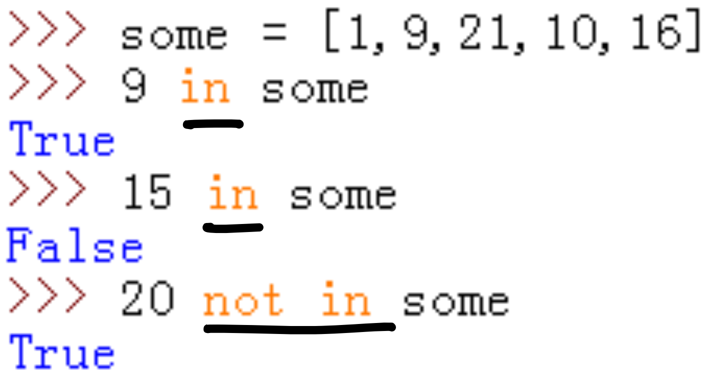
```
>>> stuff = list()
>>> stuff.append('book')
>>> stuff.append(99)
>>> print(stuff)
['book', 99]
>>> stuff.append('cookie')
>>> print(stuff)
['book', 99, 'cookie']
```

Is something in a list

- Python provides two operators to check whether an item is in a list

- These are logical operators that return True or False

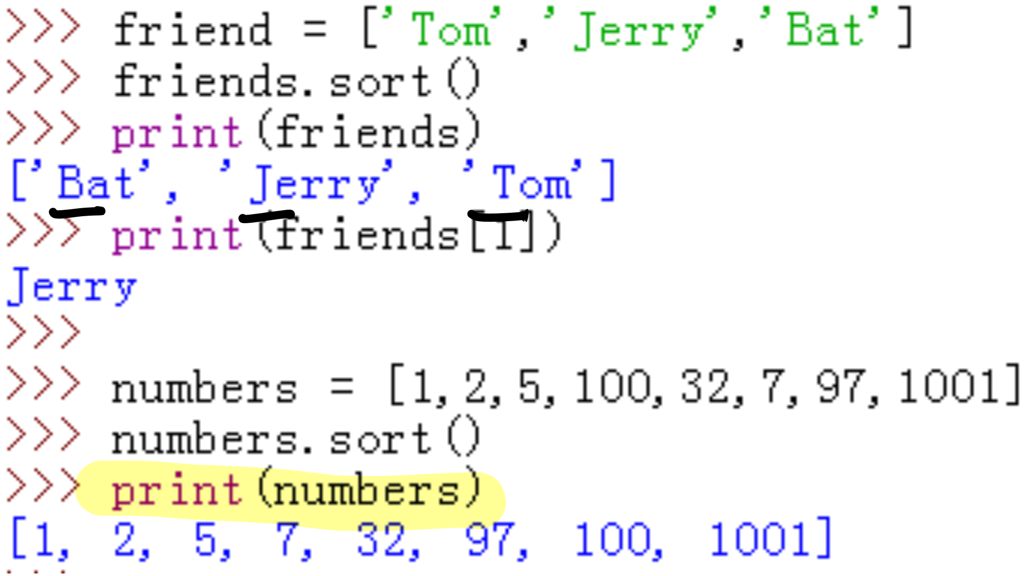
- They do not modify the list 不会修改.



```
>>> some = [1, 9, 21, 10, 16]
>>> 9 in some
True
>>> 15 in some
False
>>> 20 not in some
True
```

A list is an ordered sequence

- A list can hold many items and keeps them in the order until we do something to change the order
- A list can be sorted (i.e. change the order)
- The sort() method means “sort yourself”



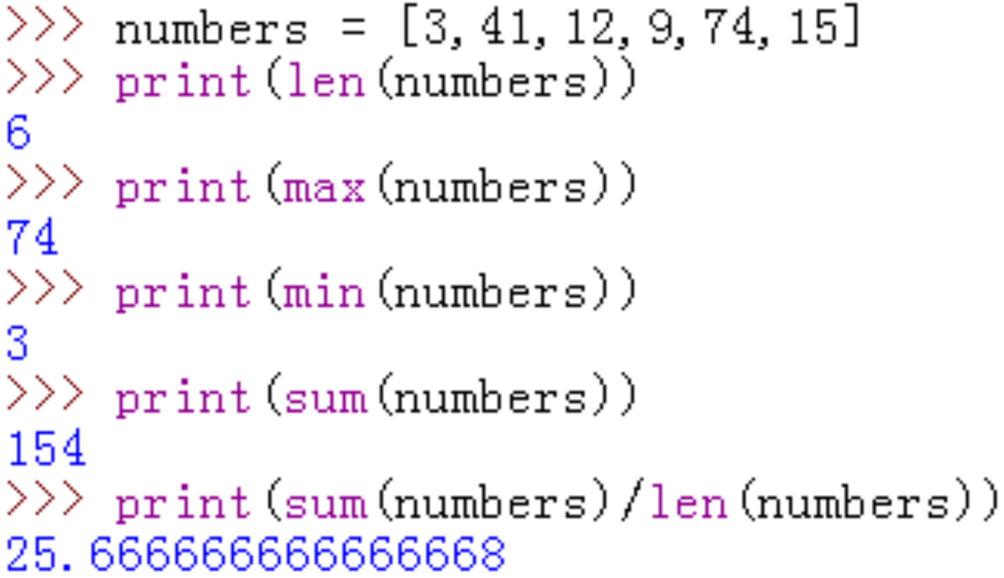
```
>>> friend = ['Tom','Jerry','Bat']
>>> friends.sort()
>>> print(friends)
['Bat', 'Jerry', 'Tom']
>>> print(friends[1])
Jerry
>>>
>>> numbers = [1,2,5,100,32,7,97,1001]
>>> numbers.sort()
>>> print(numbers)
[1, 2, 5, 7, 32, 97, 100, 1001]
```

顺序排列

Built-in functions and lists

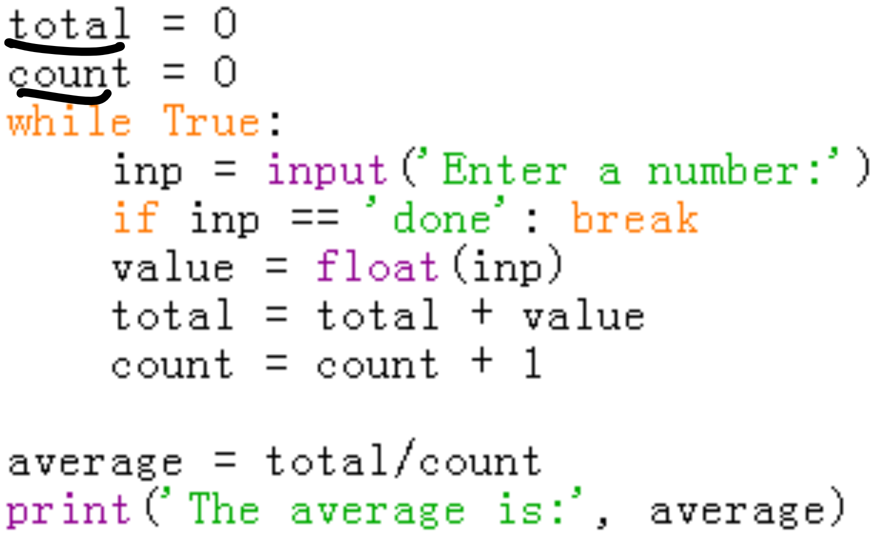
- There are a number of functions built into Python that take lists as inputs

- Remember the loops we built? These are much simpler



```
>>> numbers = [3, 41, 12, 9, 74, 15]
>>> print(len(numbers))
6
>>> print(max(numbers))
74
>>> print(min(numbers))
3
>>> print(sum(numbers))
154
>>> print(sum(numbers)/len(numbers))
25.666666666666668
```

Averaging with a list



```
total = 0
count = 0
while True:
    inp = input(’Enter a number:’)
    if inp == ’done’: break
    value = float(inp)
    total = total + value
    count = count + 1

average = total/count
print(’The average is:’, average)
```

Practice

```
print ( sum(list)/len(list) ).
```

- Write a program to instruct the user to input several numbers and calculate their average using list methods

```
list=[ ]
while True:
    inp = input("enter a number:")
        try:
            float(inp)
            list.append(float(inp))
        except:
```

if inp == "done" :
break

Best friends: strings and lists

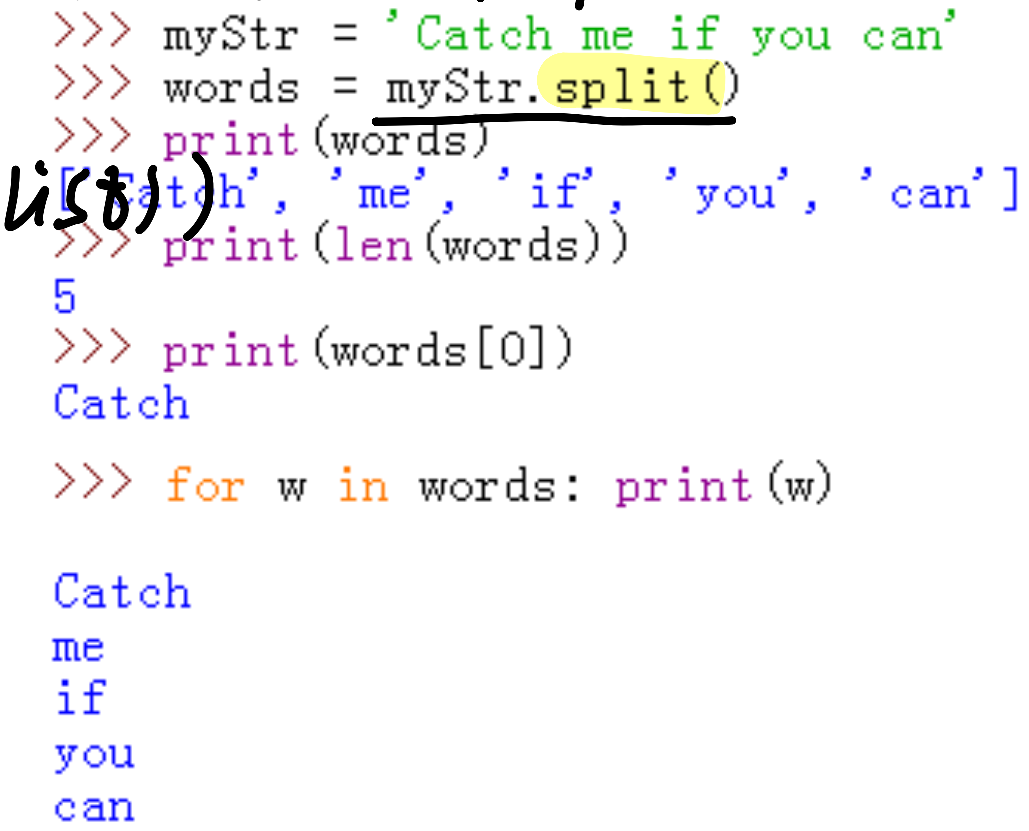
else : print ("reconsider ; p enter a num")

- Use the split() method to break up a string into a list of strings

print(sum(list)/len(list))

- We think of these as words

- We can access a particular word or loop through all the words



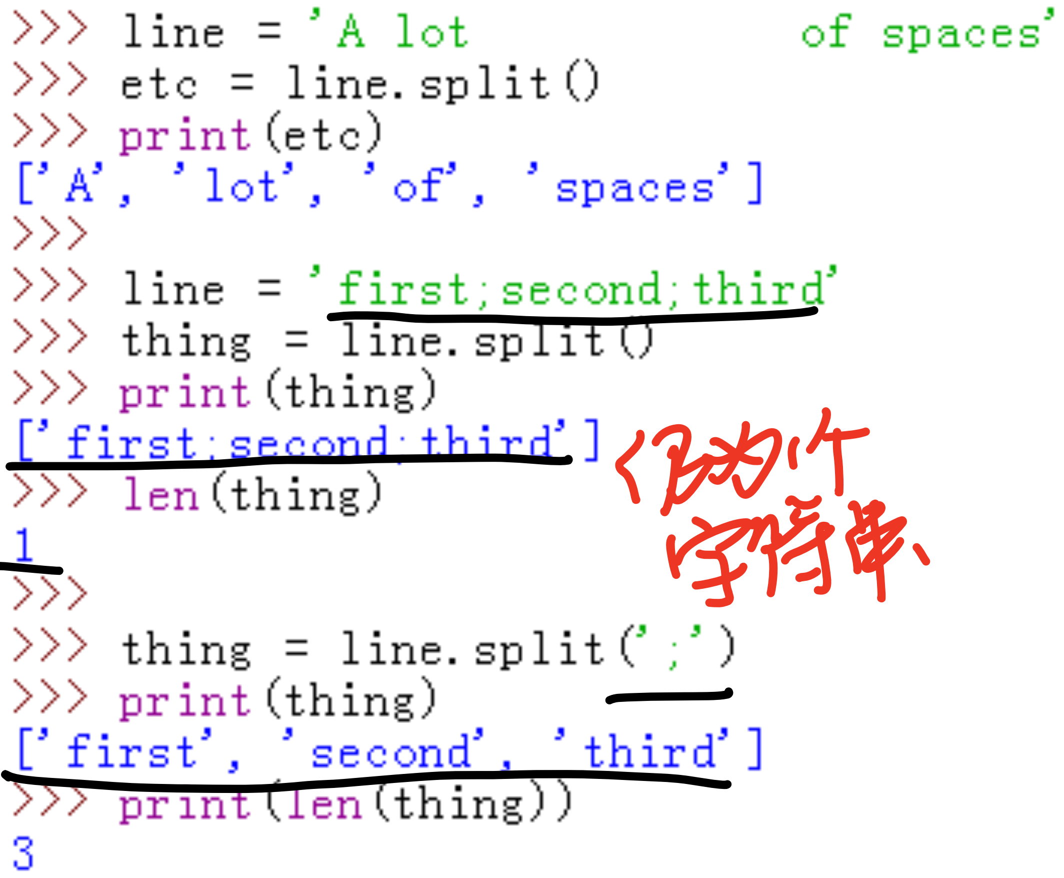
```
>>> myStr = 'Catch me if you can'
>>> words = myStr.split()
>>> print(words)
['Catch', 'me', 'if', 'you', 'can']
>>> print(len(words))
5
>>> print(words[0])
Catch

>>> for w in words: print(w)

Catch
me
if
you
can
```

不指定空隔→多空隔当作一个来看待.

- When you do not specify a delimiter, multiple spaces are treated like "one" delimiter

- You can specify what delimiter character to use in splitting

可用指定分隔符分开.



```
>>> line = 'A lot               of spaces'
>>> etc = line.split()
>>> print(etc)
['A', 'lot', 'of', 'spaces']
>>>
>>> line = 'first;second;third'
>>> thing = line.split()
>>> print(thing)
['first;second;third']
>>> len(thing)
1
>>>
>>> thing = line.split(';')
>>> print(thing)
['first', 'second', 'third']
>>> print(len(thing))
3
```

仍为一个字符串.

Practice

- The header of an email takes the following format:

a= From professor.xman@uct.edu Sat Jan 5 09:14:16 2008

查找域和发送月份

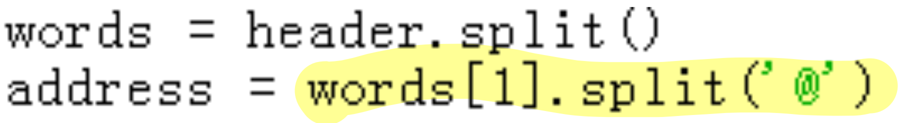
For a given email header, write a program to find out the domain of email address, and the month in which this email is sent

b= a.split(' ')

The double split pattern

- Sometimes we split a line one way, and then grab one piece of the line and split it again

From professor.xman@uct.edu Sat Jan 5 09:14:16 2008



```
words = header.split()
address = words[1].split(’@’)
```

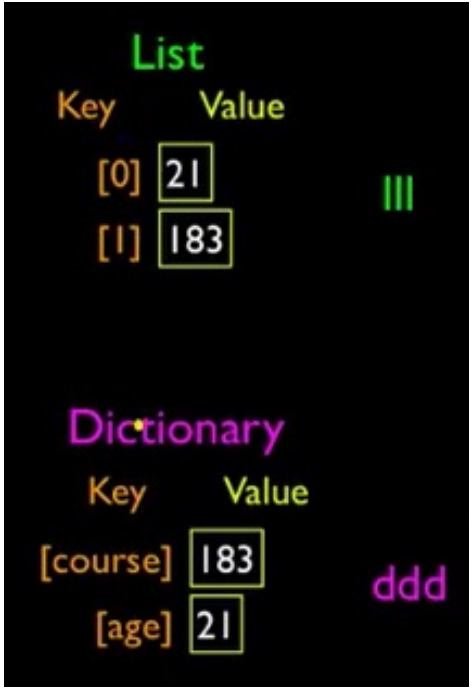
['professor.xman', 'uct.edu']

A story of two collections

保持顺序的值的线性集合.

- List: a linear collection of values that stay in order
- Dictionary: a "bag" of values, each with its own label

Dictionary



https://en.wikipedia.org/wiki/Associative_array

Dictionary 字典,

- Dictionaries are Python’s most powerful data collection
- Dictionaries allow us to do fast database-like operations in Python
- Dictionaries have different names in different languages
- Associative arrays – Perl/PHP
- Properties or Map or HashMap – Java
- Property Bag – C#/.Net

可变类型

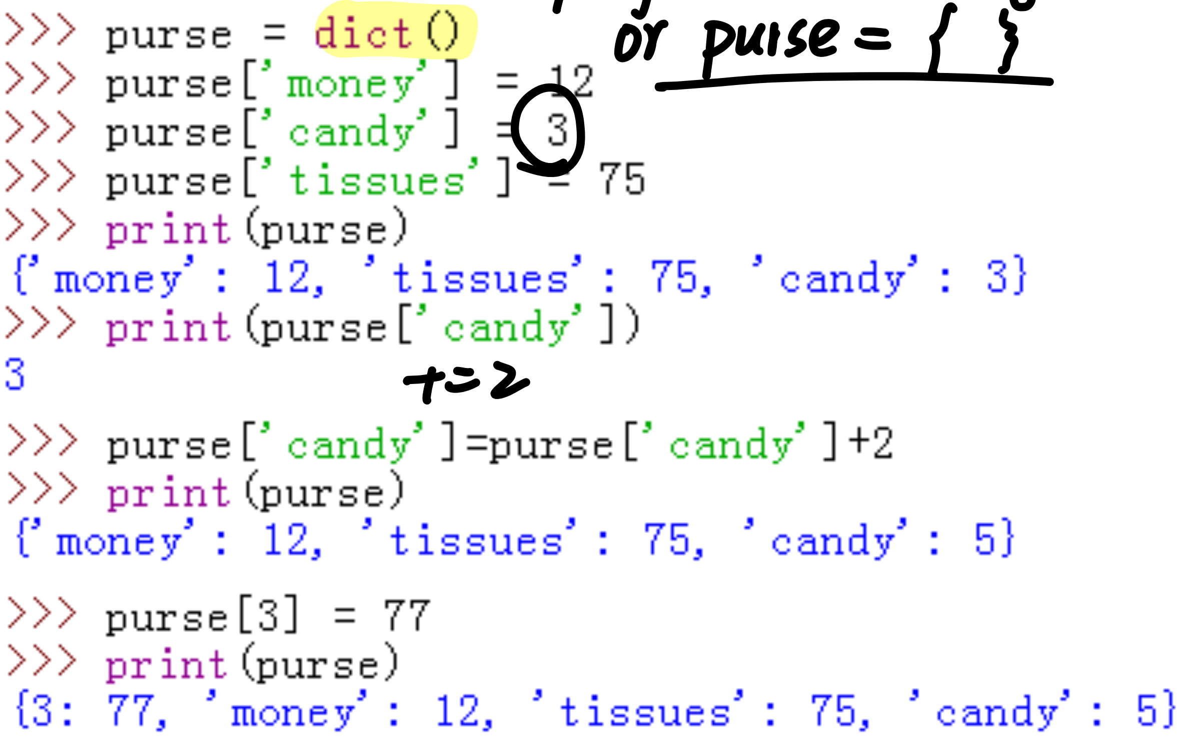
key:不可变类型
value:可变类型.

Dictionary

- Lists index their entries based on the position in the list
- Dictionaries are like bags – no order
- We index the elements we put in the dictionary with a “lookup tag”

create an empty dictionary.

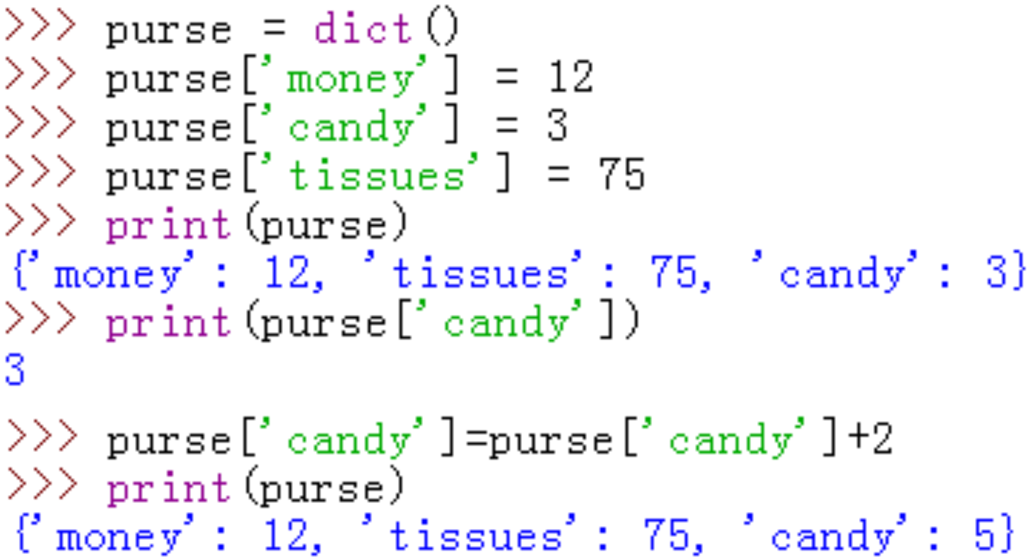
or purse = { }



```
>>> purse = dict()
>>> purse[’money’] = 12
>>> purse[’candy’] = 3
>>> purse[’tissues’] = 75
>>> print(purse)
{’money’: 12, ’tissues’: 75, ’candy’: 3}
>>> print(purse[’candy’])
3
>>> purse[’candy’]=purse[’candy’]+2
>>> print(purse)
{’money’: 12, ’tissues’: 75, ’candy’: 5}
>>> purse[3] = 77
>>> print(purse)
{3: 77, ’money’: 12, ’tissues’: 75, ’candy’: 5}
```

+=2

Dictionary



```
>>> purse = dict()
>>> purse['money'] = 12
>>> purse['candy'] = 3
>>> purse['tissues'] = 75
>>> print(purse)
{'money': 12, 'tissues': 75, 'candy': 3}
>>> print(purse['candy'])
3

>>> purse['candy']=purse['candy']+2
>>> print(purse)
{'money': 12, 'tissues': 75, 'candy': 5}
```

candy
3
tissues
75
money
12

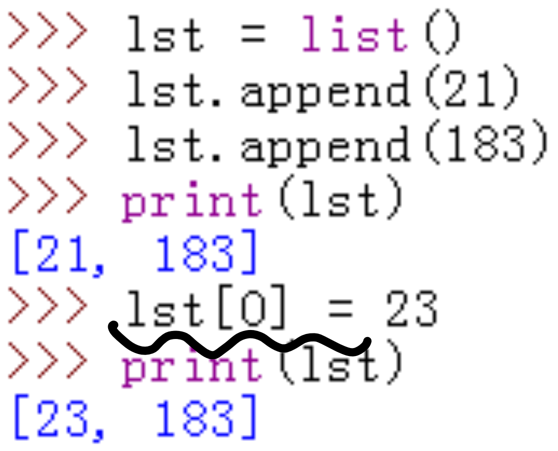
[illegible] mutable:

both mutable

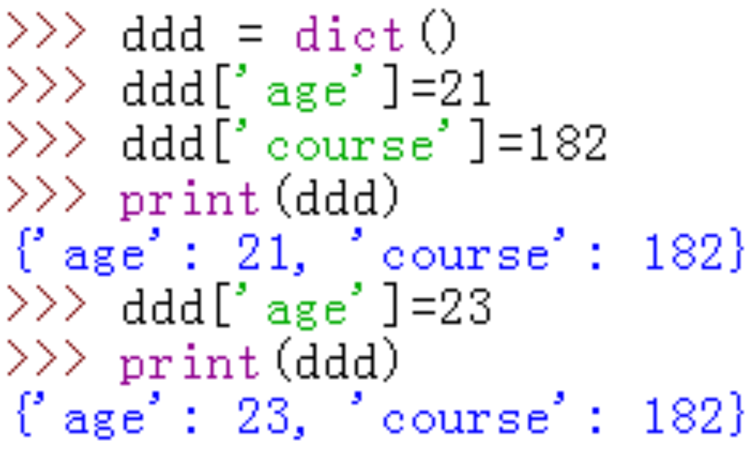
List v.s. dictionary

不用索引，用keys.

- Dictionaries are similar to lists, except that they use keys instead of numbers to look up values



```
>>> lst = list()
>>> lst.append(21)
>>> lst.append(183)
>>> print(lst)
[21, 183]
>>> lst[0] = 23
>>> print(lst)
[23, 183]
```

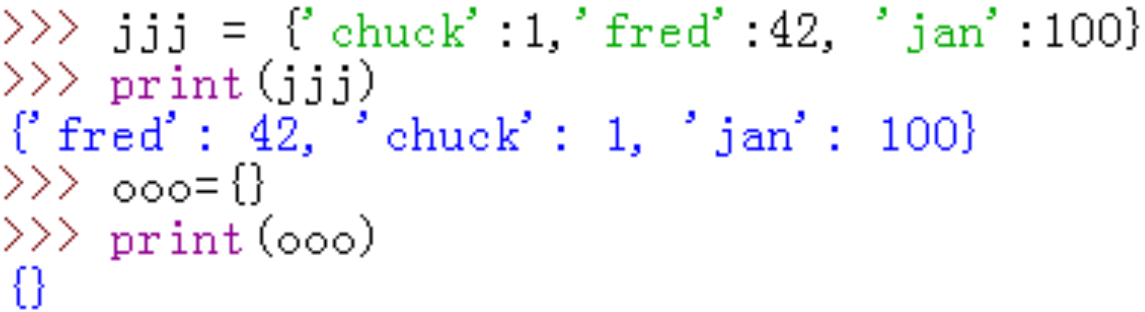


```
>>> ddd = dict()
>>> ddd['age']=21
>>> ddd['course']=182
>>> print(ddd)
{'age': 21, 'course': 182}
>>> ddd['age']=23
>>> print(ddd)
{'age': 23, 'course': 182}
```

Dictionary literals (constants)

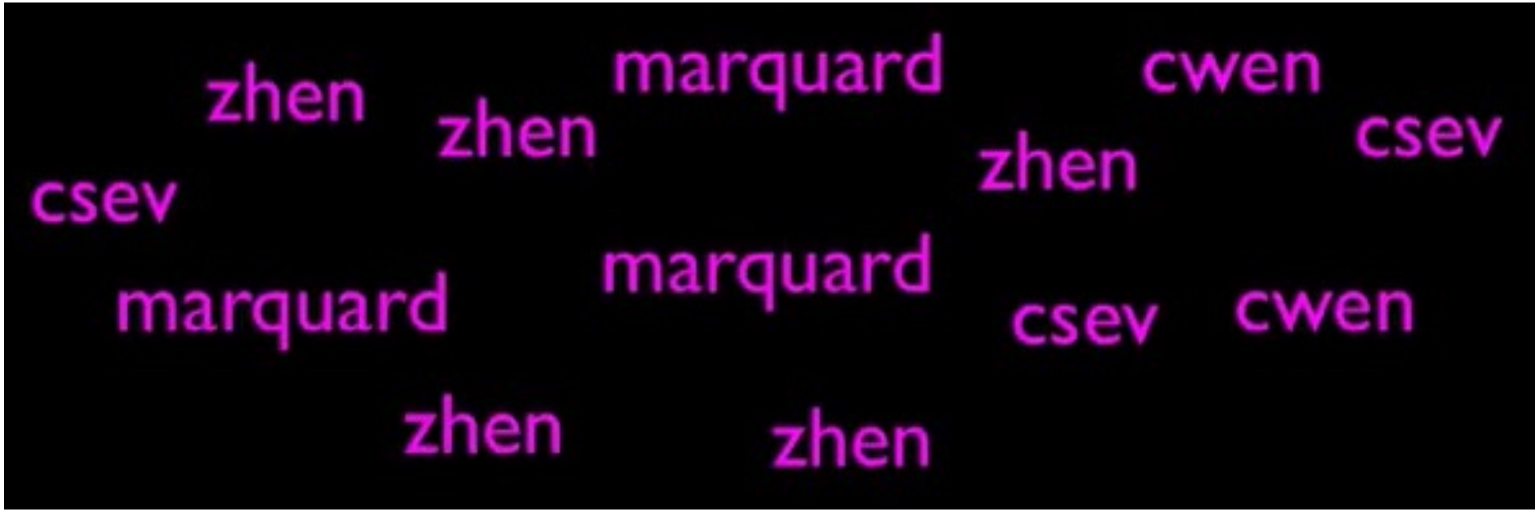
大括号.

- Dictionary literals use curly braces and have list of key:value pairs
- You can make an empty dictionary using empty curly braces



```
>>> jjj = {'chuck':1,'fred':42, 'jan':100}
>>> print(jjj)
{'fred': 42, 'chuck': 1, 'jan': 100}
>>> ooo={}
>>> print(ooo)
{}
```

Most common names



zhen marquard cwen

zhen csev zhen

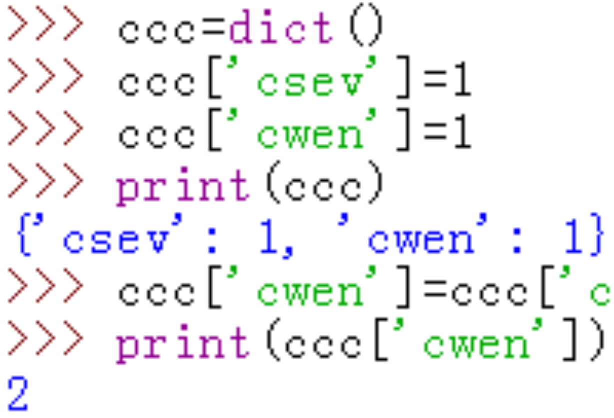
csev

marquard marquard csev cwen

zhen zhen

Counting with a dictionary

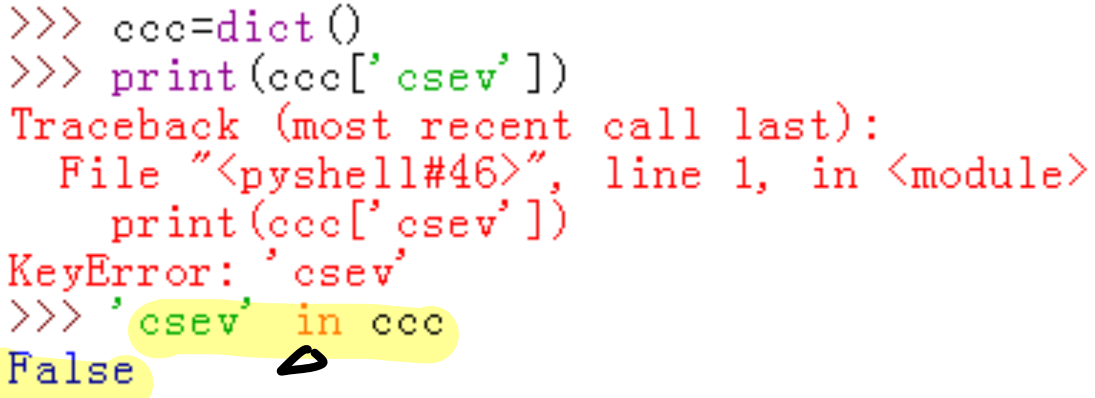
- A common use of dictionary is counting how often we “see” something



```
>>> ccc=dict()
>>> ccc[’csev’]=1
>>> ccc[’cwen’]=1
>>> print(ccc)
{’csev’: 1, ’cwen’: 1}
>>> ccc[’cwen’]=ccc[’cwen’]+1
>>> print(ccc[’cwen’])
2
```

Dictionary tracebacks

- It is an error to reference a key which is not in the dictionary
- We can use the in operator to see if a key is in the dictionary



```
>>> ccc=dict()
>>> print(ccc['csev'])
Traceback (most recent call last):
  File "<pyshell#46>", line 1, in <module>
    print(ccc['csev'])
KeyError: 'csev'
>>> 'csev' in ccc
False
```

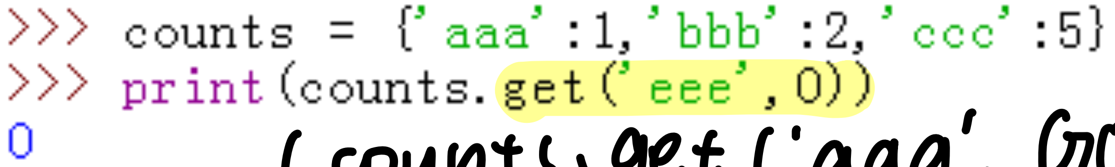
Practice

- Write a program to instruct the user to continuously input some words, and use dictionary to count how many times a word has been inputted before.

The get() method

- This pattern of checking to see if a key is already in a dictionary, and assuming a default value if the key is not there is so common, that there is a method called get() that does this for us

1 5



```
>>> counts = {'aaa':1,'bbb':2,'ccc':5}
>>> print(counts.get('eee',0))
0
```

(counts.get('aaa'. GOOD)

dit. get(key . default)

键不存在时要返回的默认值

的默认值.

Practice

- Write a program to instruct the user to input a line of texts, and use dictionary to count how many times a word has been seen in this line. You should use the get() method in this program.

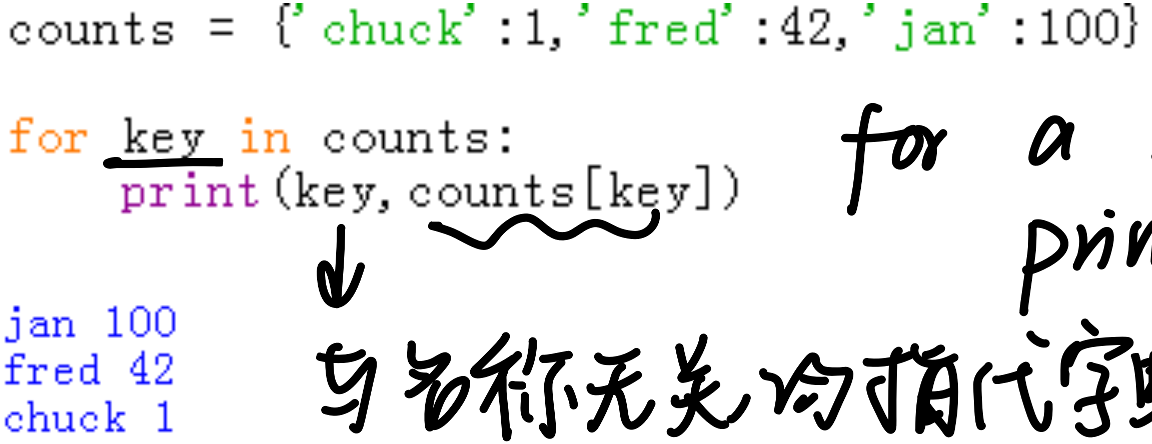
split. → list [ ].

上题.

print(counts. get('...', None))

Definite loops and dictionaries

- Even though dictionaries are not stored in order, we can write a for loop that goes through all elements in a dictionary – actually it goes through all the keys in that dictionary and looks up the values



```
counts = {'chuck':1,'fred':42,'jan':100}

for key in counts:
    print(key, counts[key])
```

```
jan 100
fred 42
chuck 1
```

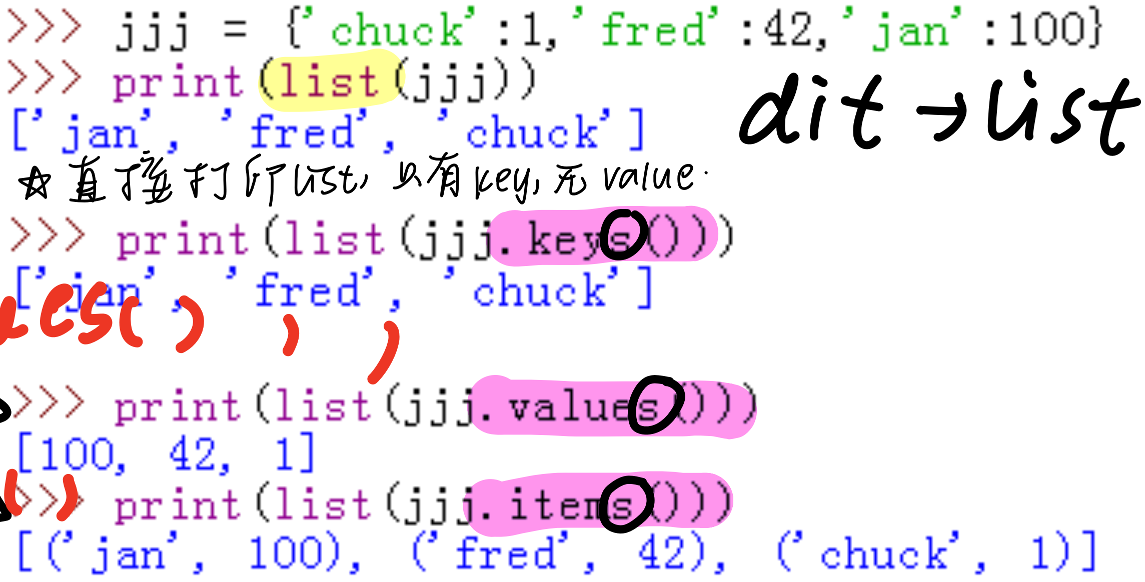
```
for a in counts:
print(a, counts[a]).
```

与名称无关的指代字典中的钥匙.

Retrieving lists of keys and values

- You can get a list of keys, values or items (both) from a dictionary

dit → list



```
>>> jjj = {'chuck':1,'fred':42,'jan':100}
>>> print(list(jjj))
['jan', 'fred', 'chuck']
>>> print(list(jjj.keys()))
['jan', 'fred', 'chuck']
>>> print(list(jjj.values()))
[100, 42, 1]
>>> print(list(jjj.items()))
[('jan', 100), ('fred', 42), ('chuck', 1)]
```

☆直接打印list, 只有key, 无value.

print(list(dic.values()))

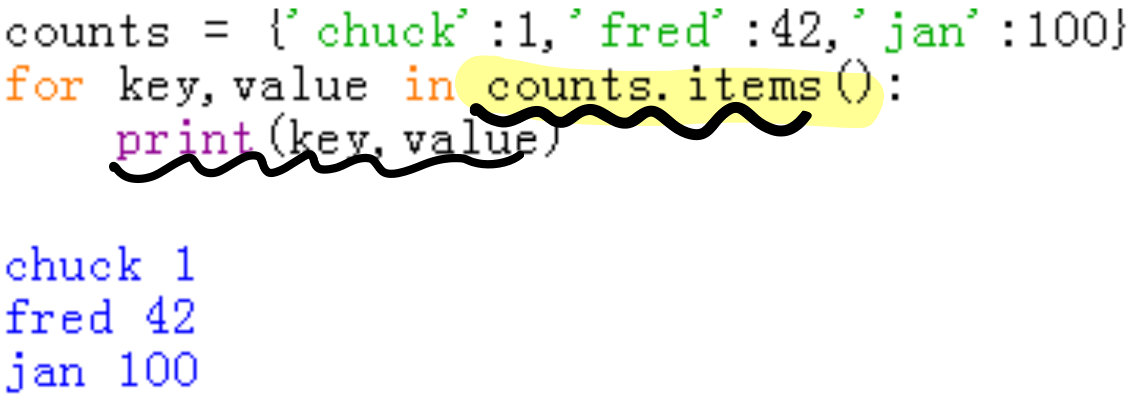
keys()

items()

两个迭代变量.

Bonus: two iteration variables

- We loop through the key-value pairs in a dictionary using two iteration variables
- Each iteration, the first variable is the key, and the second variable is the corresponding value for the key



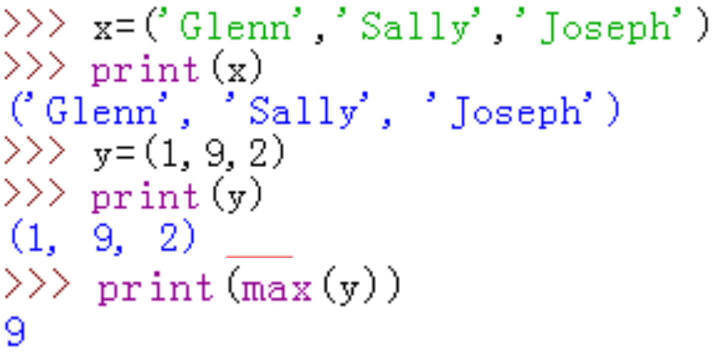
```
counts = {’chuck’:1,’fred’:42,’jan’:100}
for key,value in counts.items():
    print(key,value)

chuck 1
fred 42
jan 100
```

Tuples 元组.

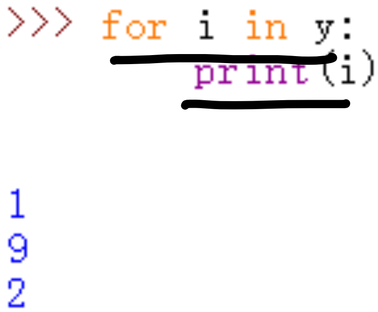
- Tuples are another type of sequence that function more like a list – they have elements which are indexed starting from 0

从0开始

索引.



```
>>> x=('Glenn','Sally','Joseph')
>>> print(x)
('Glenn', 'Sally', 'Joseph')
>>> y=(1,9,2)
>>> print(y)
(1, 9, 2)
>>> print(max(y))
9
```



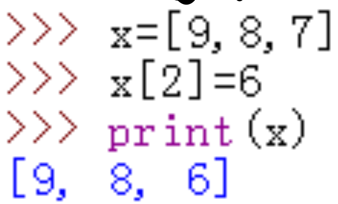
```
>>> for i in y:
        print(i)


1
9
2
```

lists: mutable.

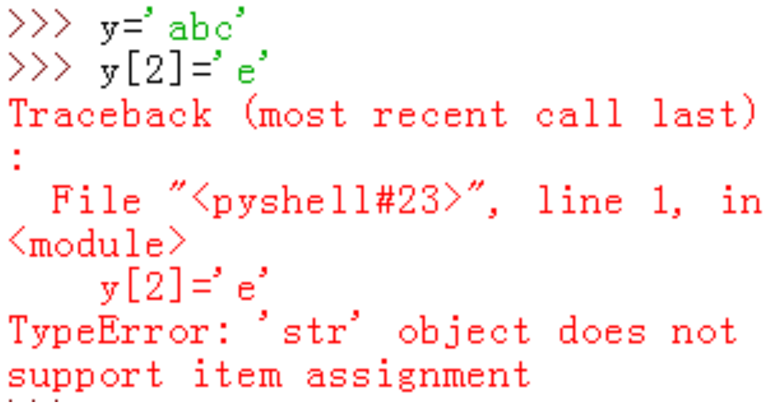
But, tuples are “immutable” 不可变的.

- Unlike a list, once you create a tuple, you cannot change its contents – similar to a string

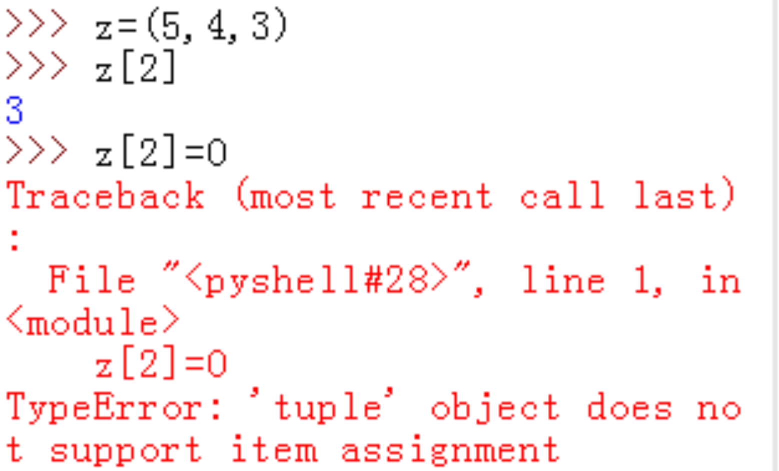
0 1 2



```
>>> x=[9, 8, 7]
>>> x[2]=6
>>> print(x)
[9, 8, 6]
```

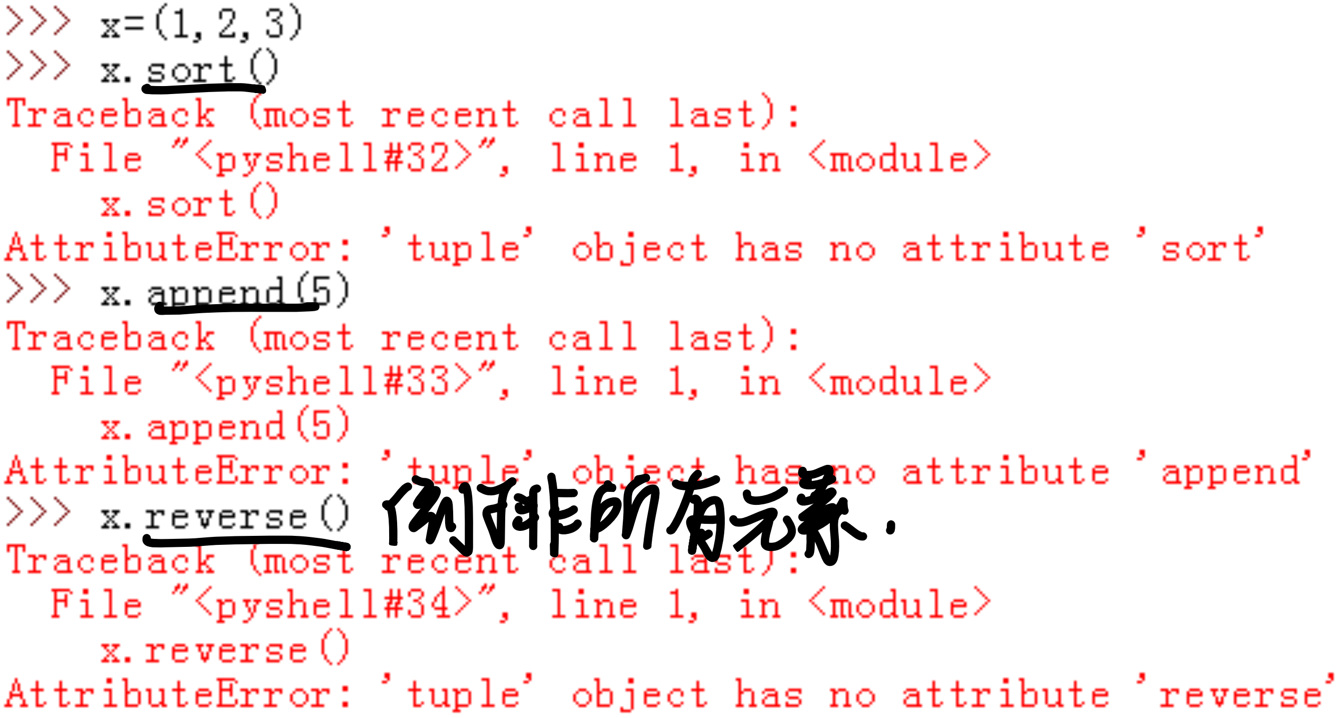


```
>>> y=’abc’
>>> y[2]=’e’
Traceback (most recent call last)
:
  File "<pyshell#23>", line 1, in
<module>
    y[2]=’e’
TypeError: ’str’ object does not
support item assignment
...
```



```
>>> z=(5, 4, 3)
>>> z[2]
3
>>> z[2]=0
Traceback (most recent call last)
:
  File "<pyshell#28>", line 1, in
<module>
    z[2]=0
TypeError: ’tuple’ object does no
t support item assignment
```

Some things that you cannot do with tuples

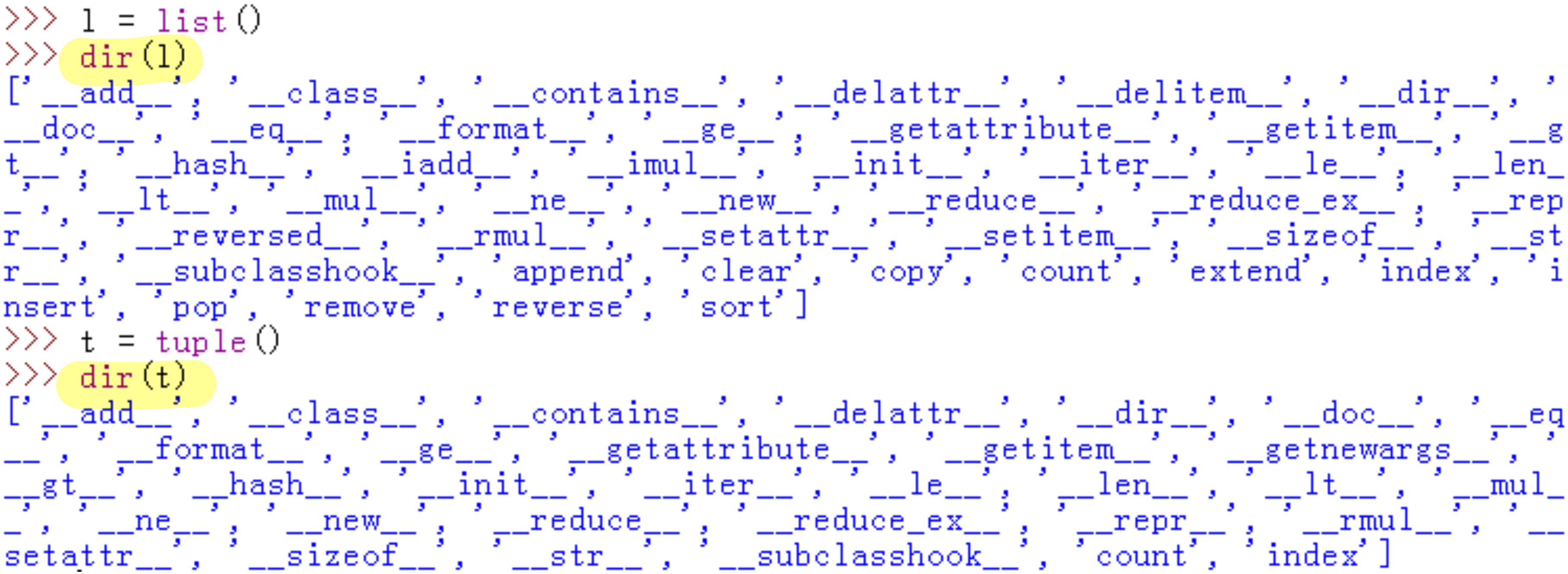


```
>>> x=(1,2,3)
>>> x.sort()
Traceback (most recent call last):
  File "<pyshell#32>", line 1, in <module>
    x.sort()
AttributeError: 'tuple' object has no attribute 'sort'
>>> x.append(5)
Traceback (most recent call last):
  File "<pyshell#33>", line 1, in <module>
    x.append(5)
AttributeError: 'tuple' object has no attribute 'append'
>>> x.reverse()
Traceback (most recent call last):
  File "<pyshell#34>", line 1, in <module>
    x.reverse()
AttributeError: 'tuple' object has no attribute 'reverse'
```

倒排所有元素.

可用函数.

A tale of two sequences



```
>>> l = list()
>>> dir(l)
['__add__', '__class__', '__contains__', '__delattr__', '__delitem__', '__dir__', '
__doc__', '__eq__', '__format__', '__ge__', '__getattribute__', '__getitem__', '__g
t__', '__hash__', '__iadd__', '__imul__', '__init__', '__iter__', '__le__', '__len_
_', '__lt__', '__mul__', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__rep
r__', '__reversed__', '__rmul__', '__setattr__', '__setitem__', '__sizeof__', '__st
r__', '__subclasshook__', 'append', 'clear', 'copy', 'count', 'extend', 'index', 'i
nsert', 'pop', 'remove', 'reverse', 'sort']
>>> t = tuple()
>>> dir(t)
['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq
__', '__format__', '__ge__', '__getattribute__', '__getitem__', '__getnewargs__', '
__gt__', '__hash__', '__init__', '__iter__', '__le__', '__len__', '__lt__', '__mul_
_', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__repr__', '__rmul__', '__
setattr__', '__sizeof__', '__str__', '__subclasshook__', 'count', 'index']
```

有时候函数很重要:

√Tuples are more efficient

- Since Python doe not have to build tuple structures to be modifiable, they are simpler and more efficient in terms of memory use and performance than lists

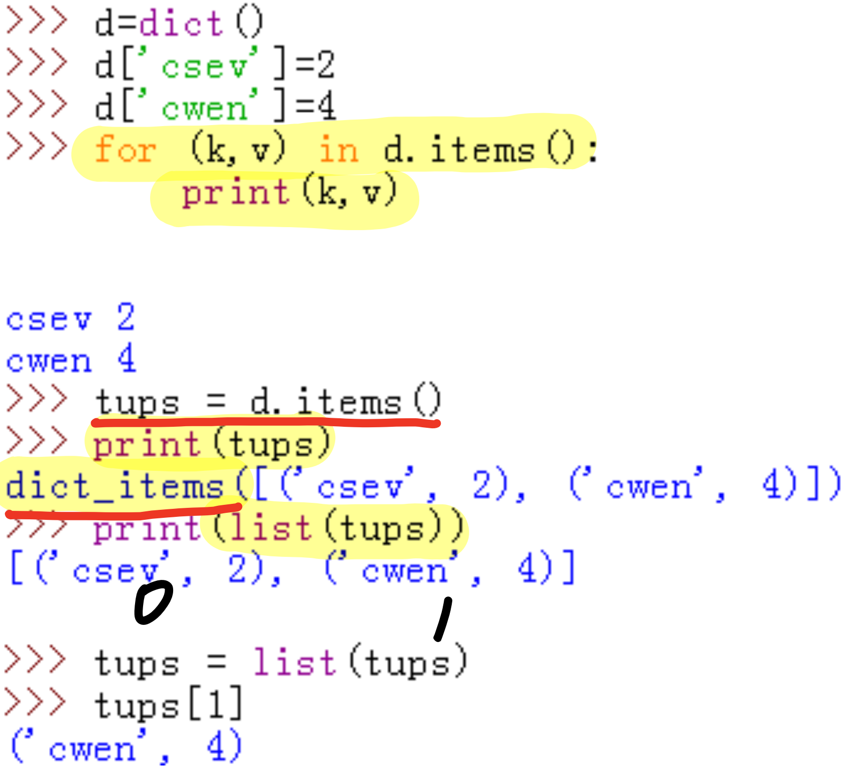
临时变量

- In our program when we are making “temporary variables” we prefer tuples over lists

△

Tuples and dictionaries

- The item() method in dictionaries returns a list of (key, value) tuples

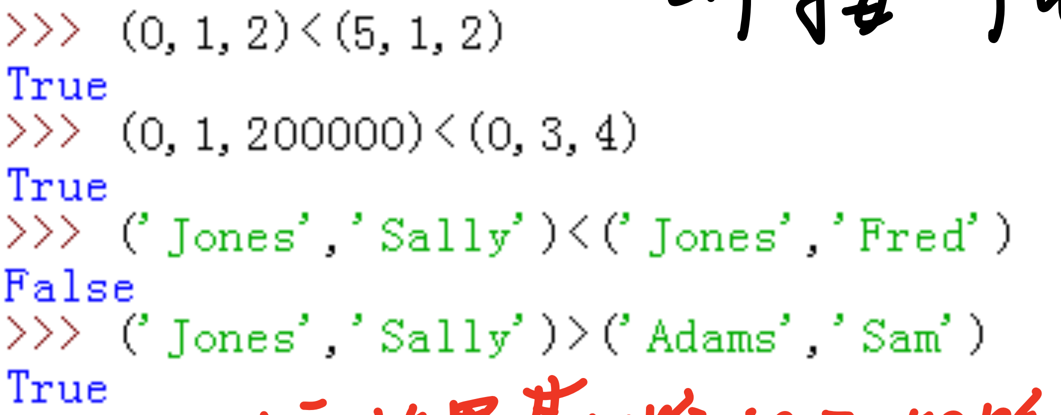


```
>>> d=dict()
>>> d['csev']=2
>>> d['cwen']=4
>>> for (k,v) in d.items():
	print(k,v)


csev 2
cwen 4
>>> tups = d.items()
>>> print(tups)
dict_items([('csev', 2), ('cwen', 4)])
>>> print(list(tups))
[('csev', 2), ('cwen', 4)]
       0               1
>>> tups = list(tups)
>>> tups[1]
('cwen', 4)
```

Tuples are comparable ☆.

- The comparison operators work with tuples and other sequences if the first item is equal. Python goes on to the next element, until it finds the elements which are different

一个接一个地比较.



```
>>> (0, 1, 2)<(5, 1, 2)
True
>>> (0, 1, 200000)<(0, 3, 4)
True
>>> ('Jones','Sally')<('Jones','Fred')
False
>>> ('Jones','Sally')>('Adams','Sam')
True
```

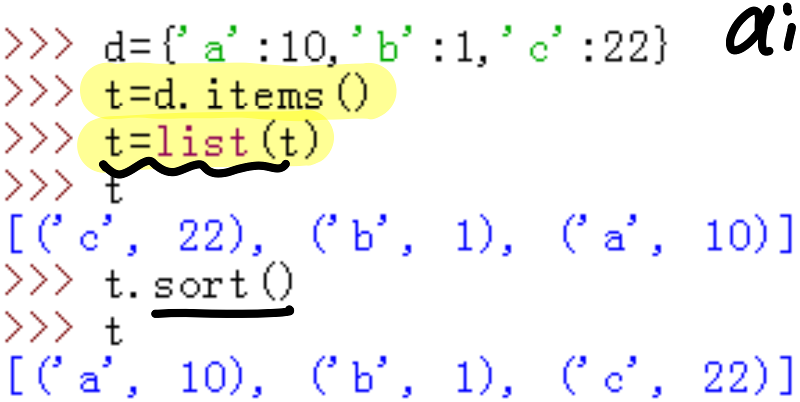
△比较结果基于第一组不相等的元素的比较结果决定!!

Sorting lists of tuples

- We can take advantage of the ability to sort a list of tuples to get a sorted version of a dictionary

tuple不可用sort( ).

- First we sort the dictionary by the key using the items() method



```
>>> d={’a’:10,’b’:1,’c’:22}
>>> t=d.items()
>>> t=list(t)
>>> t
[(’c’, 22), (’b’, 1), (’a’, 10)]
>>> t.sort()
>>> t
[(’a’, 10), (’b’, 1), (’c’, 22)]
```

$$\begin{tikzcd} \text{dic} \arrow[r, "\text{tuple}"] & \text{list} \arrow[d] \\ & \text{sort} \end{tikzcd}$$

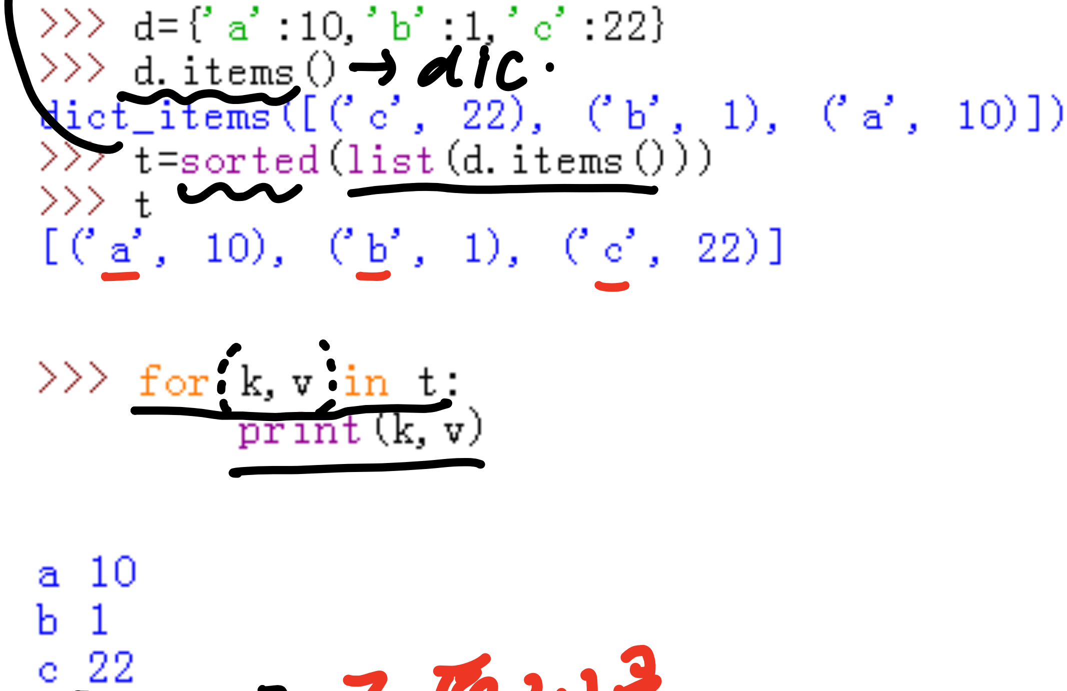
Using sorted()

- We can do this even more efficiently using a built-in function sorted() which takes a sequence as a parameter and returns a sorted sequence

参数

★ a: [3,2,1]
b= a.sort( )
print(b)→ None. 无创建新列表. 在原列表基础上修改
b= sorted(a)

这一步等同于：
t= list(d.items( ))
t.sort( ). 顺序(字母).



```
>>> d={'a':10,'b':1,'c':22}
>>> d.items()
dict_items([('c', 22), ('b', 1), ('a', 10)])
>>> t=sorted(list(d.items()))
>>> t
[('a', 10), ('b', 1), ('c', 22)]

>>> for k, v in t:
        print(k, v)


a 10
b 1
c 22
```

→ dic.

print(b) → [1,2,3].

Practice

根据每个元素的值对元素排序、

- Write a program, which sorts the elements of a dictionary by the value of each element

dict → a list of tuples →

(key, value)

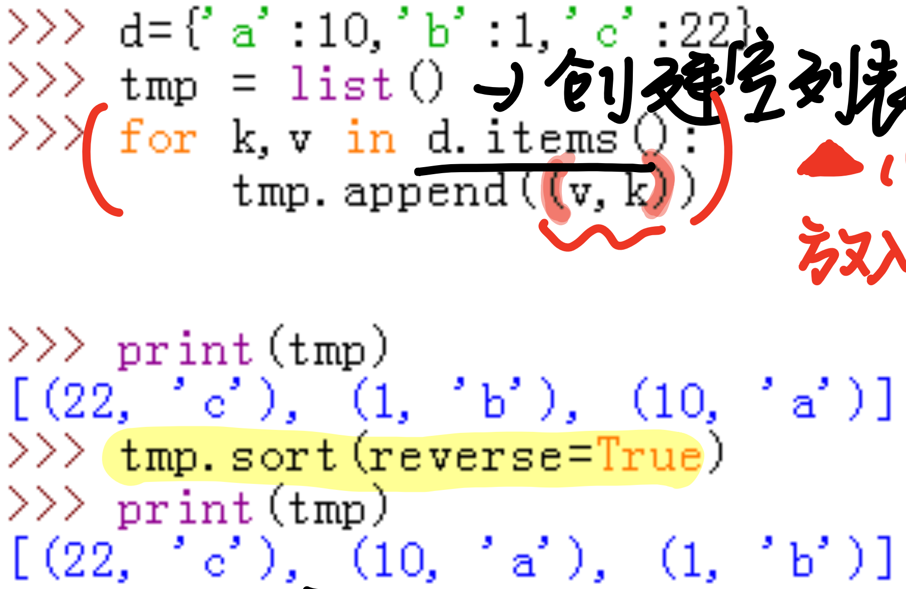
```
for key,value in dict.items( )
    list.append((value,key))
```

Sort by values instead of key

The item() method in dictionaries returns a list of (key, value) tuples

- If we could construct a list of tuples of the form (key, value) we could sort by value

- We do this with a for loop that creates a list of tuples



```
>>> d={'a':10,'b':1,'c':22}
>>> tmp = list()
>>> for k, v in d.items():
        tmp.append((v, k))

>>> print(tmp)
[(22, 'c'), (1, 'b'), (10, 'a')]
>>> tmp.sort(reverse=True)
>>> print(tmp)
[(22, 'c'), (10, 'a'), (1, 'b')]
```

→ 创建空列表.

(v, k) 放入list.

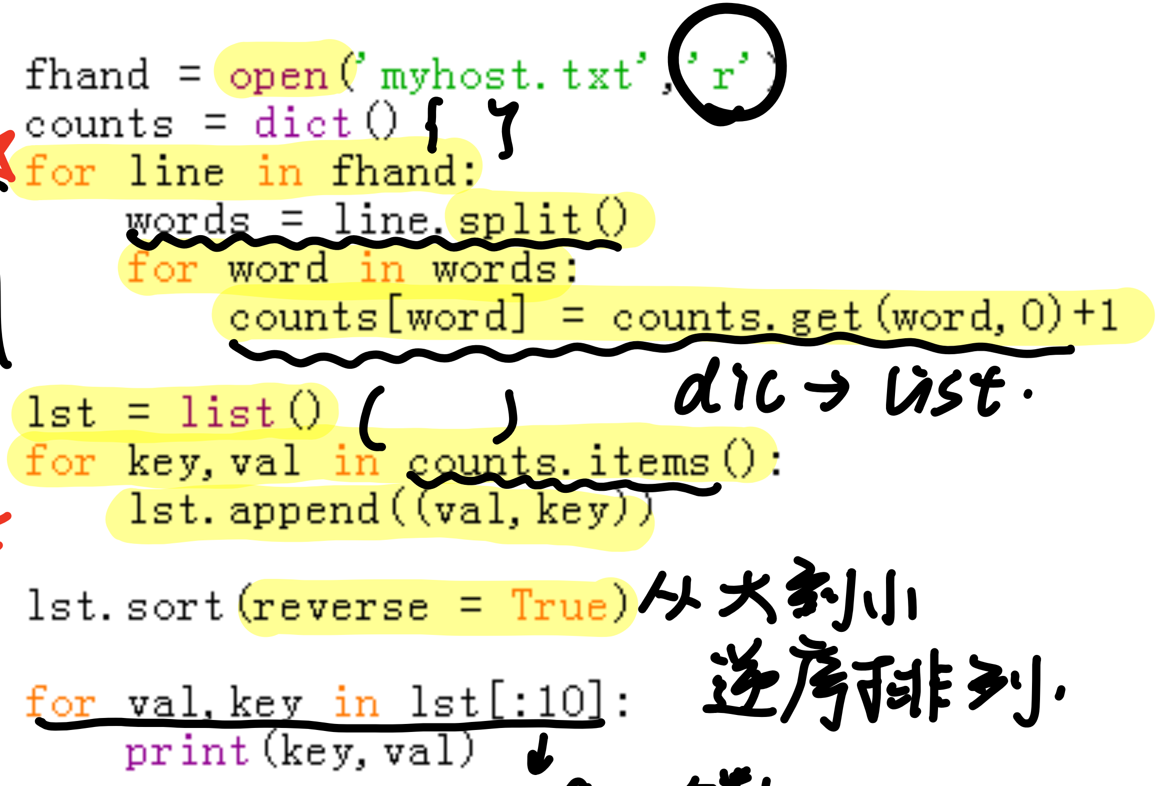
★ sort 只会排序前者. 要按值排应该 (key, value)

sort( )是顺序排序. (如字母顺序). 若应逆 reverse=True, 逆序排列

[illegible] reverse = True/False

reverse( )是反转列表排列顺序.

Example: Finding the 10 most common words in a file



```
fhand = open('myhost.txt','r')
counts = dict() { }
for line in fhand:
    words = line.split()
    for word in words:
        counts[word] = counts.get(word,0)+1

lst = list() (  )
for key,val in counts.items():
    lst.append((val,key))

lst.sort(reverse = True)

for val,key in lst[:10]:
    print(key,val)
```

每个词出现n次

⇓

运用dict方法.

(key, value)

dic → list.

从大到小

逆序排列.

0-9. 10个数.