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Iterables: List, Tuple, Set, Dictionaries

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Introducing lists

- A list is a collection of items, stored in a variable
- Items should be related
- Items could be of different types (objects)

```
colors = ['red', 'green', 'blue']  
print(colors)  
['red', 'green', 'blue']
```

Naming a list

- since lists are collection of objects, it is a good practice to give them a plural name
- for a list of color, call the list 'colors'
- for a list of student, call the list 'students'
- in this way a single item in the list will be the singular name ('color'), the entire list will be plural ('colors') - **Iteration pattern**

Defining a list

A list is a container which holds comma-separated values (items or elements) between square brackets where items or elements don't need all have the same type.

- elements in a list have an index
- list are zero-index: the first element in a list has 0 as index

List indexes

- index counts elements in a list
- if an index has a positive value, it counts from the beginning
- if an index has a negative value, it counts backward
- you can get the element of a list by its index in square brackets

```
colors = ['red', 'green', 'blue', 'black']
```

item	red	green	blue	black
index (from 0 left)		1	2	3
index (from -4 right)		-3	-2	-1

Python 3.6.2 Shell

Python 3.6.2 (v3.6.2:5fd33b5926, Jul 16 2017, 20:11:06)

[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin

Type "copyright", "credits" or "license()" for more information.

>>> WARNING: The version of Tcl/Tk (8.5.9) in use may be unstable.

Visit <http://www.python.org/download/mac/tcltk/> for current information.

>>> colors = ['red', 'green', 'blue', 'black']

>>> color = colors[0]

>>> color

'red'

>>> green_color = colors[-3]

>>> green_color

'green'

>>> green_color = colors[1]

>>> green_color

'green'

>>>

Ln: 17 Col: 4

```
Python 3.6.2 Shell
>>>
>>>
>>>
>>>
>>> color = colors[5]
Traceback (most recent call last):
  File "<pyshell#20>", line 1, in <module>
    color = colors[5]
IndexError: list index out of range
>>> color = colors[-5]
Traceback (most recent call last):
  File "<pyshell#21>", line 1, in <module>
    color = colors[-5]
IndexError: list index out of range
>>> colors[4]
Traceback (most recent call last):
  File "<pyshell#22>", line 1, in <module>
    colors[4]
IndexError: list index out of range
>>>
```

Ln: 47 Col: 4

Common list operations

Edit element in a list

```
colors[0] = 'orange'
```

```
print(colors)
```

```
['orange', 'green', 'blue', 'black']
```

Common list operations

get the position of an element in list

```
colors = ['red', 'green', 'blue', 'black']  
print(colors.index('green'))
```

1

```
Python 3.6.2 Shell
>>>
>>>
>>>
>>>
>>>
>>>
>>>
>>>
>>>
>>>
>>> print(colors.index('pink'))
Traceback (most recent call last):
  File "<pyshell#43>", line 1, in <module>
    print(colors.index('pink'))
ValueError: 'pink' is not in list
>>>
>>>
>>>
>>>
>>>
>>> |
```

Ln: 80 Col: 4

Common list operations

test if an element is in a list

```
colors = ['red', 'green', 'blue', 'black']
```

```
print('red' in colors)
```

```
True
```

```
print('orange' in colors)
```

```
False
```

Common list operations

Adding item to the end of a list

```
colors = ['red', 'green', 'blue', 'black']  
  
colors.append('orange')  
print(colors)  
['red', 'green', 'blue', 'black', 'orange']
```

Common list operations

Insert item into a list

we specify the position and everything from that point is shifted one position to the right

```
colors = ['red', 'green', 'blue', 'black']
```

```
colors.insert(1, 'orange')
```

```
print(colors)
```

```
['red', 'orange', 'green', 'blue', 'black']
```

Common list operations

removing item by position

we specify the position and everything from that point is shifted one position to the right

```
colors = ['red', 'green', 'blue', 'black']
```

```
del colors[1]  
print(colors)  
['red', 'blue', 'black']
```

Common list operations

removing item by value

remove **only the first** matching value in a list

```
colors = ['red', 'green', 'blue', 'black']
```

```
colors.remove('green')  
['red', 'blue', 'black']
```

Common list operations

popping item from a list

- remove the last item from the list (with no parameter)
- **always** it returns the popped item

```
colors = ['red', 'green', 'blue', 'black']

last_item = colors.pop()
print(last_item)
black
print(colors)
['red', 'green', 'blue']
```

Common list operations

popping item from a list

- or in a specific position
- **always** it returns the popped item

```
colors = ['red', 'green', 'blue', 'black']
```

```
item = colors.pop(1)
```

```
print(item)
```

```
green
```

```
print(colors)
```

```
['red', 'blue', 'black']
```

Common list operations

number of elements of a list

```
colors = ['red', 'green', 'blue', 'black']
```

```
number_item = len(colors)
```

```
print(number_item)
```

```
4
```

Numerical lists

- a list composed by only numbers
- it's not special
- you can use some special function

The `range()` function is a shortcut to create a numerical list ordered

```
range(1,11): [1,2,3,4,5,6,7,8,9,10]
```

range() function

The range() function returns a list of consecutive integers. The function has one, two or three parameters where last two parameters are optional.

- range(a): Generates a sequence of numbers from 0 to a, excluding a, incrementing by 1.

range() function

- `range(a, b)`: Generates a sequence of numbers from `a` to `b` excluding `b`, incrementing by 1.
- `range(a,b,c)`: Generates a sequence of numbers from `a` to `b` excluding `b`, incrementing by `c`.

Numerical lists

min()

```
ages = [22, 38, 33, 50, 9, 16, 28, 11]
```

```
youngest = min(ages)
```

```
print(youngest)
```

```
9
```

Numerical lists

max()

```
ages = [22, 38, 33, 50, 9, 16, 28, 11]
```

```
oldest = max(ages)
```

```
print(oldest)
```

```
50
```

Numerical lists

sum()

```
ages = [22, 38, 33, 50, 9, 16, 28, 11]
```

```
total = sum(ages)
```

```
print(total)
```

```
207
```

exercise

- calculate the ages' average
- add 3 different ages
- remove the last item
- remove age 22
- recalculate the ages'a average

exercise

- Store the values 'python', 'c', and 'java' in a list. Print each of these values out, using their position in the list.

exercise

- Print a statement about each of these values, using their position in the list. Your statement could simply be, 'A nice programming language is *value*.'
- Think of something you can store in a list. Make a list with three or four items, and then print a message that includes at least one item from your list. Your sentence could be as simple as, "One item in my list is a ____."

Lists and Looping

accessing all elements in a list

- we use a loop to access all the elements in a list, no matters how many elements the list was composed
- we are able to "use" all the elements in the list with 3 line of code
- **A loop** is a block of code that repeats itself until it runs out of items to work with or until a certain condition is met

```
colors = ['red', 'green', 'blue', 'black']
```

```
for color in colors:  
    print(color)
```

red

green

blue

black

- the keyword "for" tells Python to get ready to use a loop
- the variable color is a placeholder variable. In this variable python will place each item in the list into, one at a time
- when there are no more items in the list, the loop will end

for loop and range function

```
for a in range(4):  
    print(a)
```

0

1

2

3

Enumerating a list

If you want to enumerate a list, you need to add an index variable to hold the current index

```
colors = ['red', 'green', 'blue', 'black']
```

```
for index, color in enumerate(colors):  
    place = str(index)  
    print("place: " + place + " color: " + color)
```

```
place: 0 color: red
```

```
place: 1 color: green
```

```
place: 2 color: blue
```

```
place: 3 color: black
```

Lists and Looping

FOR Special keywords

Python allows two **keywords** to be used within a for loop: **break** and **continue**.

The two keywords have two **different** meanings:

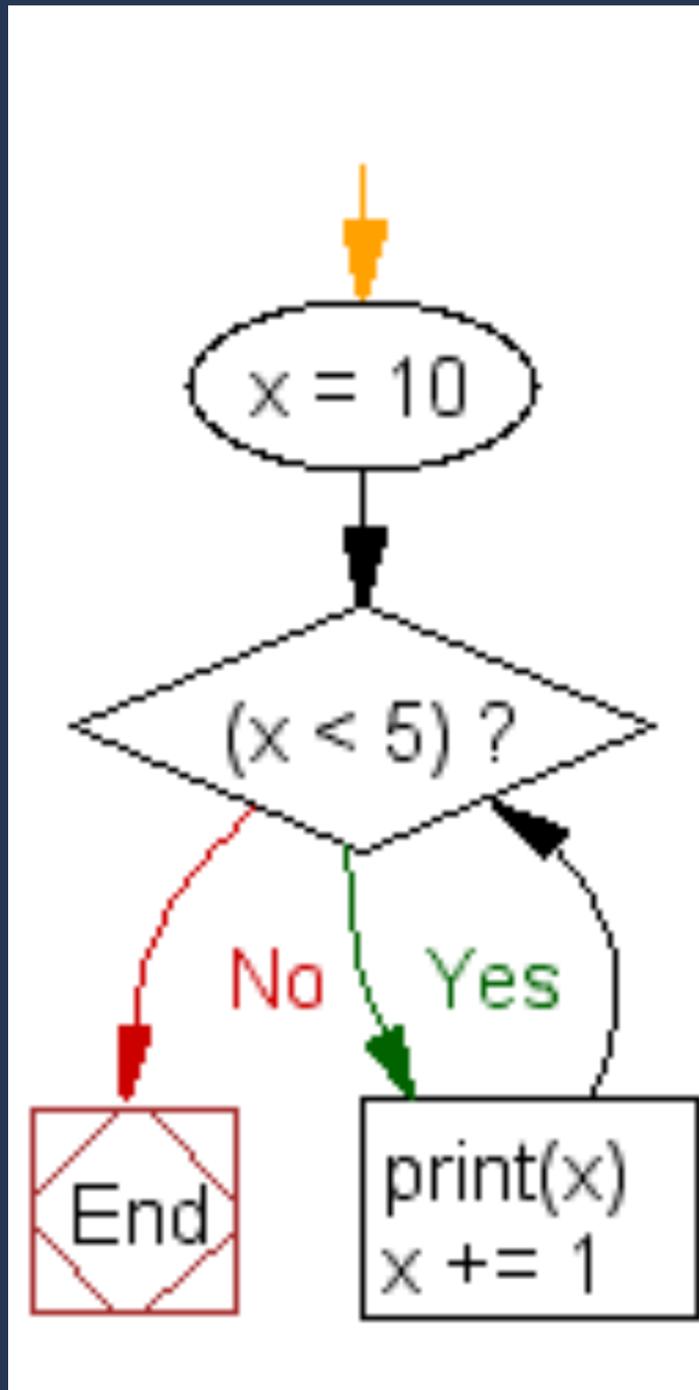
- **Break** used to *immediatly break the loop and exit!*
- **Continue** used to skip to the **next** iteration step!

While loop

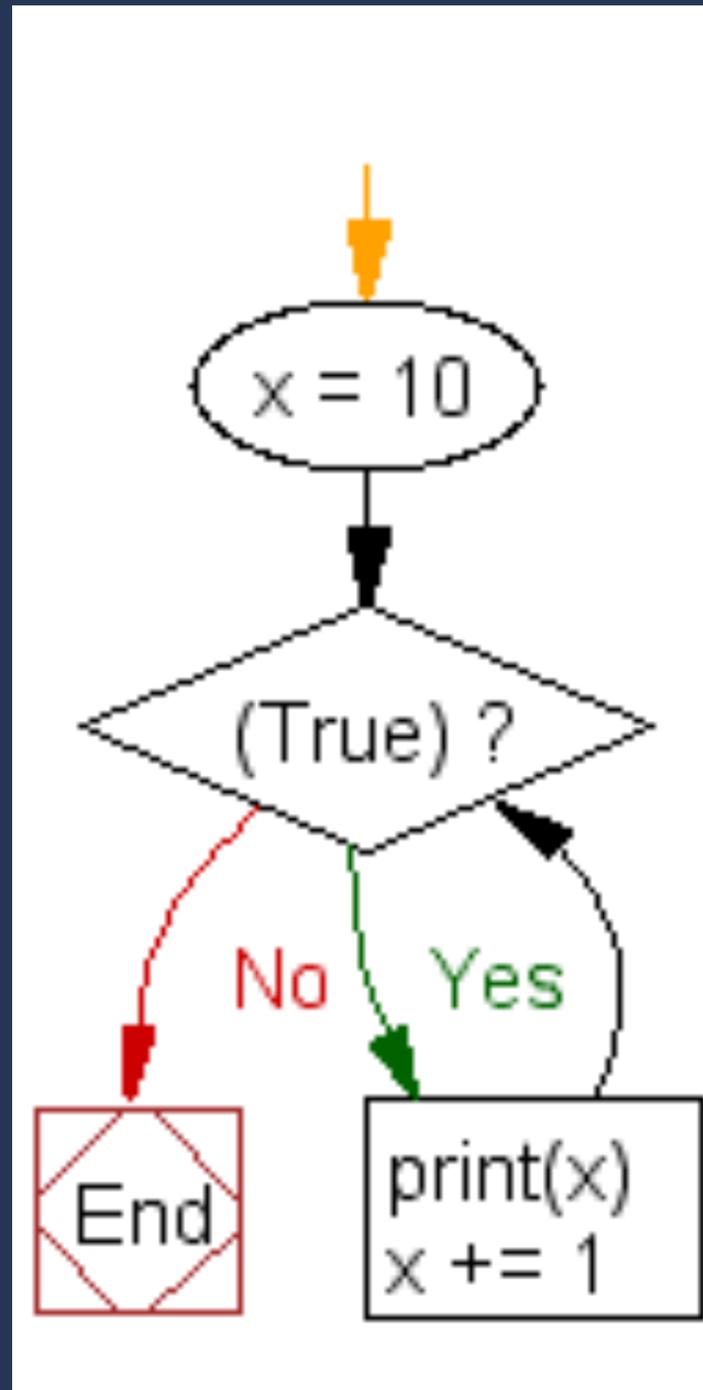
In Python, also the while loops are permitted

The while loop runs as long as the condition evaluates to True and execute the code block

```
x = 0;
while (x < 5):
    print(x)
    x += 1
```



While loop infinite loop

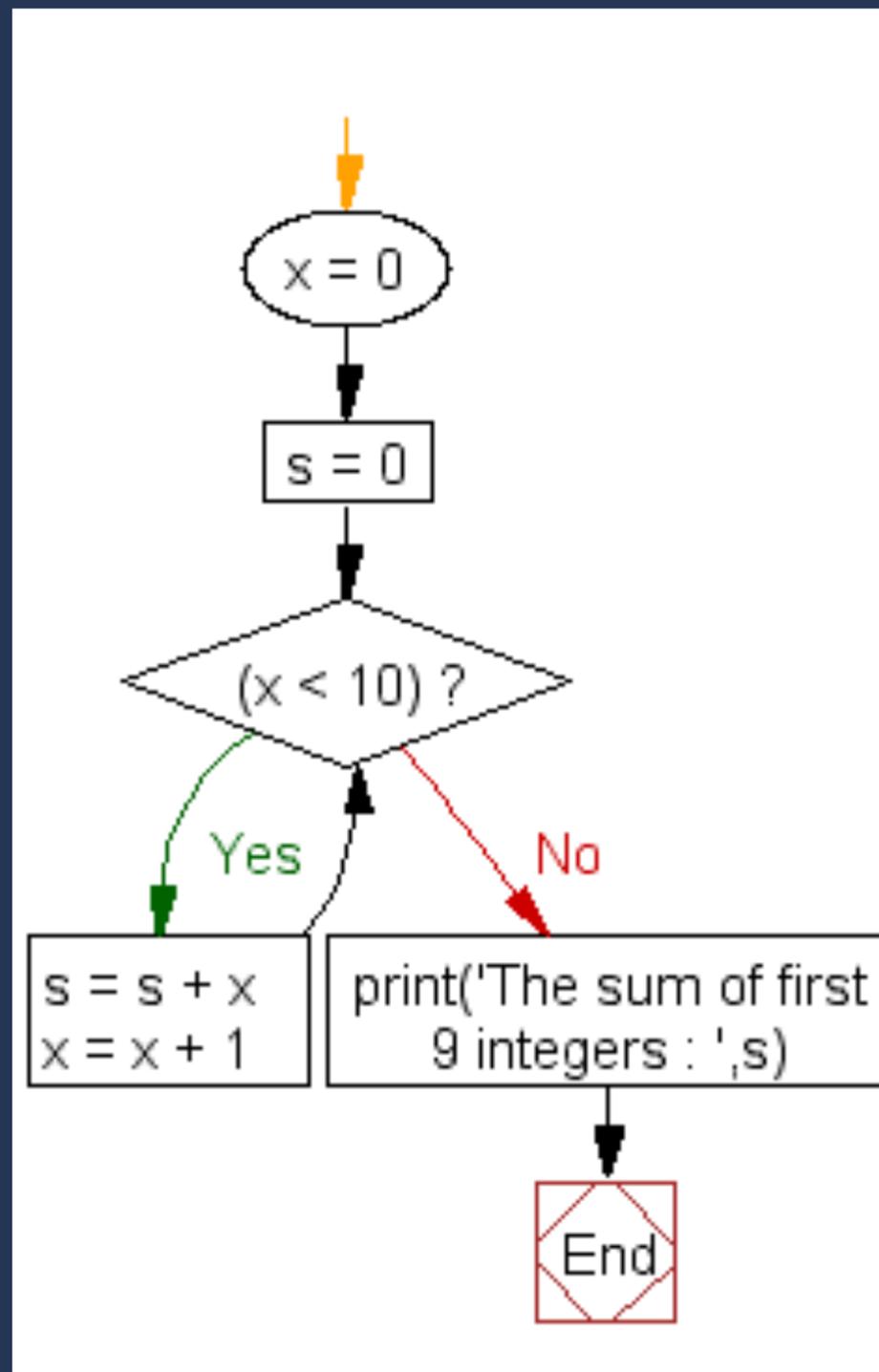


```
x = 10;  
while (True):  
    print(x)  
    x += 1
```

While loop else statement

else statement is executed when the condition is false

```
x = 0;  
s = 0  
while (x < 10):  
    s = s + x  
    x = x + 1  
else :  
    print('The sum of first 9 integers : ',s)
```



exercise

- Repeat *First List*, but this time use a loop to print out each value in the list.
- Repeat *First List*, but this time use a loop to print out your statements. Make sure you are writing the same sentence for all values in your list
- Repeat *First List*, but this time use a loop to print out your message for each item in your list. Again, if you came up with different messages for each value in your list, decide on one message to repeat for each value in your list.

Strings as Lists

- Now that you have some familiarity with lists, we can take a second look at strings.
- A string is really a list of characters, so many of the concepts from working with lists behave the same with strings.

Strings as Lists

```
message = "Hello Lists!"  
message_list = list(message)  
print(message_list)  
['H', 'e', 'l', 'l', 'o', ' ', 'L', 'i', 's', 't', 's', '!']
```

```
for letter in message:  
    print(letter)
```

H
e
l
l
o

L
i
s
t
s
!

Finding substring

A substring is a series of characters that appears in a string

```
>>> message = "I like cats and dogs"
```

```
>>> dog_present = 'dog' in message
```

```
>>> print(dog_present)
```

```
True
```

```
>>> message = "I like cats and dogs, but I prefer cats"
>>> first_cat_index = message.find('cats')
>>> print(first_cat_index)
7
>>> last_cat_index = message.rfind("cats")
>>> print(last_cat_index)
35
```

Replace substrings

You can use `replace()` function to replace any substring with another substring.

```
>>> message = "I like cats and dogs, but I prefer cats"  
>>> new_message = message.replace("cats", "snakes")  
>>> print(new_message)  
I like snakes and dogs, but I prefer snakes
```

Counting substrings

```
>>> number_of_cats = message.count('cats')
```

```
>>> print(number_of_cats)
```

```
2
```

Splitting strings

```
>>> words = message.split(' ')
>>> print(words)
['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
```

Slicing a list /1

A subsets of a list are called slices

```
words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
slice = words[0:3]
>>> for word in slice:
...     print(word)
...
I
like
cats
```

Slicing a list /2

```
words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
slice = words[2:5]
>>> slice = words[2:5]
>>> for word in slice:
...     print(word)
...
cats
and
dogs,
```

Slicing a list /3

```
words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']  
# from 4rd to the end  
>>> slice = words[4:]  
>>> for word in slice:  
...     print(word)  
dogs,  
but  
I  
prefer  
cats
```

Slicing strings

```
>>> message = "I like cats and dogs, but I prefer cats"
>>> first_char = message[0]
>>> last_char = message[-1]
>>> print(first_char, last_char)
I s
>>> first_three = message[:3]
>>> last_three = message[-3:]
>>> print(first_three, last_three)
I l ats
```

Exercise

Store the first 10 square numbers in a list.

Make an empty list that will hold our square numbers

```
>>> squares = []
>>> for number in range(1,11):
...     new_square = number**2
...     squares.append(new_square)
...
>>> for square in squares:
...     print(square)
...
1
4
9
16
25
36
49
64
81
100
```

Exercise

- Make a list of the first ten multiples of ten (10, 20, 30...90, 100). Print out your list.
- Make a list of the first ten cubes(1, 8, 27...) using a list. Print them out
- Store five names in a list. Make a second list that adds the phrase "is awesome!" to each name. Print out the new list

Tuples

- Tuples are basically lists that can never be changed
 - Tuples are not dynamic
 - you cannot modify any element
- Lists are mutable objects and tuple are immutable objects

Defining Tuples

as the lists but use (), not []

```
colors = ('red', 'green', 'blue')
```

```
>>> print(colors[0])
```

```
red
```

```
>>> for color in colors:
```

```
...     print("- " + color)
```

```
...
```

```
- red
```

```
- green
```

```
- blue
```

Adding an element to a Tuple

If you try to add something to a tuple, you will get an error:

```
colors = ('red', 'green', 'blue')
colors.append('purple')
```

```
-----
--
AttributeError                                Traceback (most recent call las
t)
<ipython-input-37-ed1dbff53ab2> in <module>()
      1 colors = ('red', 'green', 'blue')
----> 2 colors.append('purple')
```

AttributeError: 'tuple' object has no attribute 'append'

Sets

- unordered collections of distinct objects
- You define a set just like you define a list, but you have to use **braces** "{}" instead of square brackets "[]"
- you can access individual elements (just like you can with a list and tuple)

```
>>> shapes = {"square", "triangle", "circle"}
>>> for shape in shapes:
...     print(shape)
...
circle
square
triangle
>>> shapes.add("polygon")
>>> shapes
{'polygon', 'circle', 'square', 'triangle'}
>>> shapes2 = set(["circle", "triangle", "hexagon"])
{'hexagon', 'circle', 'triangle'}
```

```
shapes = {'polygon', 'circle', 'square', 'triangle'}
shapes2 = {'hexagon', 'circle', 'triangle'}
>>> shapes.intersection(shapes2)
{'circle', 'triangle'}
>>> shapes.difference(shapes2)
{'polygon', 'square'}
>>> shapes.union(shapes2)
{'hexagon', 'circle', 'polygon', 'square', 'triangle'}
```

Exercise

3 is a Crowd

- Make a list of names that includes at least 4 people
- Write an if test that prints a message about the room being crowded if there are more three people in your list
- Modify your list so that there are only two people in it. Use one of the methods for removing people from the list
- Run your if test again.

Exercise

- Save your program from Three is Crowd under a new name
- add an else statement to your tests. If the else statement is run, have it print a message that the room is not very crowded

Exercise

Six is a Mob

- save the previous program with a new name
- add some names to your list, so that there are at least six people in the list
- modify your tests so that:
 - more 5 people: print a message about there being a mob in the room
 - 3-5 pepole: print a message about there being crowded
 - 1 or 2 people: print a message about the room not being crowded
 - no people: print a message about the room being empty

Dictionaries

- Store information that is connected in some way
- *key:value* pairs
- no order

```
dictionary = { 'key1': "value1",  
               'key2': "value2",  
               'key3': "value3",  
               }
```

```
programming_language = { 'python': "Guido van Rossum",  
                          'perl': "Larry Wall",  
                          'c': "Kerninghan and Ritchie",  
                          }  
print(programming_language)  
{'python': 'Guido van Rossum',  
'perl': 'Larry Wall',  
'c': 'Kerninghan and Ritchie'}
```

Iteration

```
for key, value in programming_language.items():  
    print("name: " + key)  
    print("author: " + value)
```

name: python

author: Guido van Rossum

name: perl

author: Larry Wall

name: c

author: Kernighan and Ritchie

Looping all the keys

```
for key in programming_language.keys():  
    print("name: " + key)
```

```
name: python
```

```
name: perl
```

```
name: c
```

```
# default iteration schema: by key
```

```
for key in programming_language:  
    print("name: " + key)
```

```
name: python
```

```
name: perl
```

```
name: c
```

Looping all the values

```
for value in programming_language.values():  
    print("author: " + value)  
author: Guido van Rossum  
author: Larry Wall  
author: Kernighan and Ritchie
```

Adding an element

```
programming_language['ruby']="Yukihiro 'Matz' Matsumoto"
```

```
for key, value in programming_language.items():  
    print("name: " + key)  
    print("author: " + value)
```

```
name: python  
author: Guido van Rossum  
name: perl  
author: Larry Wall  
name: c  
author: Kernighan and Ritchie  
name: ruby  
author: Yukihiro 'Matz' Matsumoto
```

Modify the value of an item

```
programming_language['ruby']="Matz"  
for key, value in programming_language.items():  
    print("name: " + key)  
    print("author: " + value)
```

name: python

author: Guido van Rossum

name: perl

author: Larry Wall

name: c

author: Kernighan and Ritchie

name: ruby

author: Matz

Removing an element

```
del programming_language['perl']  
for key, value in programming_language.items():  
    print("name: " + key)  
    print("author: " + value)  
name: python  
author: Guido van Rossum  
name: c  
author: Kernighan and Ritchie  
name: ruby  
author: Matz
```

Popping an element

```
programming_language.pop('ruby')
```

```
'Matz'
```

```
for key, value in programming_language.items():
```

```
    print("name: " + key)
```

```
    print("author: " + value)
```

```
name: python
```

```
author: Guido van Rossum
```

```
name: c
```

```
author: Kernighan and Ritchie
```

Nesting Structures

Lists in a Dictionary

- You can use lists as value of your dictionary
- You cannot use lists as keys
- But you can use tuples as keys and int ...

```
# This program stores people's favorite numbers, and displays them.
favorite_numbers = {'eric': [3, 11, 19, 23, 42],
                    'ever': [2, 4, 5],
                    'willie': [5, 35, 120],
                    }

# Display each person's favorite numbers.
print("Eric's favorite numbers are:")
print(favorite_numbers['eric'])

print("\nEver's favorite numbers are:")
print(favorite_numbers['ever'])

print("\nWillie's favorite numbers are:")
print(favorite_numbers['willie'])
```

```
Eric's favorite numbers are:
[3, 11, 19, 23, 42]
```

```
Ever's favorite numbers are:
[2, 4, 5]
```

```
Willie's favorite numbers are:
[5, 35, 120]
```

Dictionary in dictionary

```

# This program stores information about pets. For each pet,
# we store the kind of animal, the owner's name, and
# the breed.
pets = {'willie': {'kind': 'dog', 'owner': 'eric', 'vaccinated': True},
        'walter': {'kind': 'cockroach', 'owner': 'eric', 'vaccinated': False},
        'peso': {'kind': 'dog', 'owner': 'chloe', 'vaccinated': True},
        }

# Let's show all the information for each pet.
print("Here is what I know about Willie:")
print("kind: " + pets['willie']['kind'])
print("owner: " + pets['willie']['owner'])
print("vaccinated: " + str(pets['willie']['vaccinated']))

print("\nHere is what I know about Walter:")
print("kind: " + pets['walter']['kind'])
print("owner: " + pets['walter']['owner'])
print("vaccinated: " + str(pets['walter']['vaccinated']))

print("\nHere is what I know about Peso:")
print("kind: " + pets['peso']['kind'])
print("owner: " + pets['peso']['owner'])
print("vaccinated: " + str(pets['peso']['vaccinated']))

```

```

Here is what I know about Willie:
kind: dog
owner: eric
vaccinated: True

```

```

Here is what I know about Walter:
kind: cockroach
owner: eric
vaccinated: False

```

```

Here is what I know about Peso:
kind: dog
owner: chloe
vaccinated: True

```

Matrix and sparse matrix

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

```
matrix[1][2]
```

```
9
```

```
matrix[0][1]
```

```
5
```

```
sparse_matrix = {}
```

```
sparse_matrix[0] = {1:12.5, 23:25.5}
```

```
sparse_matrix[1] = {3:13.5, 15:1.6}
```

```
sparse_matrix
```

```
{0: {1: 12.5, 23: 25.5}, 1: {3: 13.5, 15: 1.6}}
```

```
---
```