| **Data Type** | **iterable** | **Mutable** | **indexable** | **hashable** |
| --- | --- | --- | --- | --- |
| **int** | No | No | No | Yes |
| **float** | No | No | No | Yes |
| **str** | Yes | No | Yes | Yes |
| **tuple** | Yes | No | Yes | Yes |
| **list** | Yes | Yes | Yes | No |
| **set** | Yes | Yes | No | No |
| **dict** | Yes | Yes | Yes | No |

**mutable** (Can change), **indexable** (support get element by a[i]), **hashable** (keep id until lifetime end)

**bool false**: False, None, 0, 0.0, 0j, “” (empty string), [] (empty list) {} (empty dict), range(0), set() (empty set)

**Namespace:**

> *Built-in*: built-in names, print, int, NameError

> *Global*: global variables

> *Enclosed*: for variables in inside function (wrapped in a function)

> *Local*: For variables in functions

> Each imported module has its own namespace, parallel with local

**Function:**

> **import math**: import whole math class, when use objects need to type math.sin()

> **from math import sin**: import sin object, when use only type sin()

> **Positional argument**: number and order of the argument is important

> **Keyword argument:** order is not important **func(x=2, z='123', y=1234)**

> **Default/optional argument:** can be omitted, has default value

> **Pure function**: function without side-effect (I/O task); only mapping; output depend only on input (can not use global variables)

> **Generator Function**: return is changed to **yield**. **yield** will pause the function, keep the state and resume when the next calling (the value of variable will keep)

> **Inner function:** can read global and outer function variable. Can modify global variable by **global x**, can modify **nearest enclosing namespace (outer function)** by **nonlocal x**

> Function can read global variable directly, modify global variable by adding global x

**Access the global variable:**

> In a function, global variable with global can: modify, both mutable and immutable; read

> Global variable without global can: modify mutable only by append or sort, etc.; read

**Pass by assignment**: similar with pointer pass. When a mutable is passed, it will modify the original. For immutable variable, it will create a new object

**Loop and recursion**

**while(x<10):** when x<10, keep running. Once x>=10, stop

**Recursive**: Calling itself, solve smaller problem (divide & conquer), more running time for function calling. Often use DP instead of recursive

**Iterative**: for or while loop, faster

**String**:

> 'b' in 'banana' -> True

> len('hi') -> 2

> chr(123) -> ‘{’ (Unicode to character)

> ord('{') -> 123 (Character to ASCII)

> ‘string’[0::1] -> First number: start (inclusive), Second number: end (exclusive), Third number: interval(skip no. of character-1)

> 'IT5001'[0::3] -> I0 (Start from ‘I’, skip two)

> 'IT5001'[-1] -> 1 (last one)

> 'IT5001'[1:3:1] -> T50 (Start from the second, end at the third, no skip)

> 'I' not in 'IT5001' -> False (Case sensitive)

> 'abcde'[::-1] -> ‘edcba’ (reverse)

**List:**

> Mutable, can modify the element. Dynamic arrays.

> Can contain one or more types in a list, defined using []

> Can be sorted. **sort()** returns a sorted list, **sorted()** modify the origin to sorted.

> Can be reversed. **reverse()**

> **a[i],** return i-th element of a. **a[i:j]**, returns elements i up to j-1. **len(a),** **min(a),** **max(a).** **x in a** return True if x is a part of a. **a+b**, concatenates a and b. **n\*a**, creates n copies of sequence a. **Also, for tuple**

> append: **a.append()** add an element in the end of list.

> concatenate: **a+b**, join two or more lists

> append is same as std::vector, pre-allocate space, fast; concat is slow.

> cannot delete iteratively, since the **next()** will be also deleted

> 当创建一个list并赋值给一个变量时，该变量实际上只是一个指向对象的引用。这意味着，当在函数中修改一个可变对象（list, dict,）时，你实际上是修改了该对象的内容，而不是引用。也就是说，函数内可以修改函数外的list。

> **insert(), pop(), remove(), in, index()** with O(1), others O(n)

**List Comprehension:** list = [i for i in range(1,101)]

**Generator Expression:**

> list\_gen = (i for i in range(1,101))

> returns an iterator, generate element in demand.

> requires less memory

**Tuple:**

> Immutable, cannot be modified, static array.

> Can contain one or more types in a list, defined using ()

> With only one element: **tuple1 = (3,)**

> List usually stores a large collection of data with the **same type**

> Tuple usually stores a small collections of items with **various types**

> **list():** Change tuple to list. **tuple():** change list to tuple

> **len()** has O(1), others has O(n)

**Set:**

> unordered, mutable, no duplicate elements

> only len(a), min(a), max(a), x in a

>>> setA = {1,2,3,4}  
>>> setB = {3,4,5,6}  
>>> setA | setB #Union  
{1,2,3,4,5,6}  
>>> setA & setB #Intersection  
{3,4}  
>>> setA - setB #A-B  
{1,2}  
>>> setA ^ setB #(A|B)-A&B (Symmetric Difference)  
{1,2,5,6}

> **add(),** add single element. **update()**, add multiple elements.

> **delete()**, **discard()** remove element, delete will throw error if element is not exist.

> **pop()** delete and return an element

> **clear()** delete all elements

> **set(), list()** for list and set ONLY

> 所有操作都是*O*(*1*),

**Dictionary:**

> search key in the dict: dict.get("apples") or dict["apples"], each key has a correspondent value.

> 使用dict.get()时，如果键不存在会返回None。使用dict[key]时会返回KeyError

> each pair has a key(left) and a value(right)

> can store any type

> delete: dict.pop("apples") or del dict["apples"]

> clear(): clear all. copy(): make a copy. keys():return all keys.

> values(): return all values. items(): return all keys + values

> 不能修改正在迭代的容器的大小或结构，但可以改现有键的值

> 如果在插入键值对时,键已经存在,那么此键对应的值会被覆写为新值

> **dict[key].append()** is valid

> **dict.keys(), values(), items()** 是 *O*(*n*), 其余操作都是 O(1)

**Lambda:**

>>> (lambda x:x)(10) # Identity function  
10  
>>> (lambda x: 'abc')(5) # Constant function  
‘abc'  
>>> (lambda x,y,z: x+y+z)(4,5,9) # Multiple arguments  
18

>>> def func\_a(n)  
 return lambda x:x+n  
>>> f1 = func\_a(10)  
>>> f1(1)

11

**Variable store a function:**

> say\_hello = greet(), store the output.

> say\_hello = greet, store the function

> Their id are identical

> function can store in list, tuple, set, dict

> function can be passed as argument to functions

> function can be returned from function

图示

描述已自动生成

**Closures:**

> remember the state and the environment

> returns an inner function

> preserve function state across function calls

**Decorators:**

> all decorators are closures

> for decorators, the outer function accepts a function as input arg

**Pastpaper Question**

> **int('-12.210')** throws an error, cannot be string

> **['a','b','c','d'][::-1]**即倒序排列，即**`['d','c','b','a']`**

> **['a','b','c','d'][-1] = ['d']**

> **['a','b','c','d'][1:-1] = ['b','c']**

> **[].append('IT5001')** 不打印任何结果，应该选none

> **3 in {1,2,{3,4}}** 此set包含了一个set，而set中的元素必须是可散列的(hashable)，然而set本身是不可散列的，所以此set是非法的，同理，tuple中包含tuple也是非法的

> **(lambda x: x (3))(lambda x: x\*4)**前面一个lambda是带常数的，并且没有附加计算，所以为3。第一个lambda的输出可以看作是第二个lambda的输入。即这个表达式可以写为lambda x: x\*4 (3)。所以输出为12

> **1(2+3)%4**此表达式中的1会被python理解为函数名称，所以会抛出错误

> **[1, 2] + (3, 4)** list和tuple不能相加，因为是不同的数据结构，可以将list或tuple转换成对方的结构后相加。

> **x = [5, 0, 0, 1] += 'IT'** string是一个可以被迭代的，所以IT会被拆分I和T，输出为**[5, 0, 0, 1, 'I', 'T']**

> **[1, 2, 3][4:5] and 'IT5001!'** 其中，**[1, 2, 3][4:5]**会返回一个空列表`[]`，and会返回第一个逻辑为false的值，如果所有制都为True，则返回最后一个值。空列表被看作是False，而任何非空的对象都会是True。所以此表达式会返回空列表`[]`

> **list(filter(bool, [0, 1, 2]))** bool会测试每个元素的布尔值，然后filter会只保留布尔值为True的值，所以输出为[1,2]

**Built-in Functions**

> round() 舍入到最近的偶数, round(2.5)=2, round(3.5)=4

> input() 函数总是返回一个字符串类型的值

> split() 按照指定的分隔符将字符串拆分成一个子字符串列表，如果没有指定分隔符，那么默认是空白字符，如空格，换行符，制表符。split(‘w’)

> strip() 移除开头和结尾的指定字符，若未指定，则移除空白字符。还可分为lstrip()移除开头的指定字符，rstrip()移除末尾指定字符

**逻辑运算与计算**

> 逻辑运算符（如 or）是短路求值的。这意味着如果左边的操作数已经确定了整个表达式的值，那么右边的操作数就不会被评估。

例如 1>1+1 or 3>7-6 or 6>7/0 ，第二个操作数为True，那么python不会计算之后的操作数，所以不会识别到ZeroDivisionError：

> 逻辑运算符中，and的运算顺序要优于or

> 11&4: 这个表达式使用了按位与运算符 & 来计算两个整数 11 和 4 的二进制按位与结果。 1011 & 0100 = 0000 = 0

> 在多重比较时, 会从左到右进行评估. 例如False == True == False，其实是False == True and True == False

> 连续的正负号会按照它们的顺序进行评估。每个`+`操作符不改变数的正负性，而每个`-`操作符会翻转数的正负性。例如`9-+-+-+-9`,第一个`-`将`9`变为`-9`,每个`+`不改变数值,之后的每个`-`翻转数字的正负性，所以最终是`9+9=18`

**Break, continue, pass**

> break 用于完全退出循环。continue 用于跳过当前迭代并继续下一个循环。pass是一个空操作，仅作为占位符

**map() & filter()**

> map和filter函数都返回一个可迭代的对象，只能读取一次

**Lambda Function**

> Lambda函数的输入如果在for loop中，那么他只会捕获for loop的最终值.例如lambda x: i + x for i in range(3)，此处的i只会是3

**OOP**

> super() 函数在Python中用于调用父类（或超类）的方法。用法: super().function(arg)

> 当一个类使用了多重继承时class sub3(sub1, sub2)，那么super()函数会按照顺序依次调用父类的对应函数，顺序为sub1, sub1的父类，sub1父类的父类…， sub2, sub2的父类…。若sub1和sub2共享一个父类，那么sub1之后为sub2

> \_\_function\_name() is a private member function, use object. \_function\_name() to access

**成员函数:**

> 子类会自动继承父类的所有成员函数。如果子类重定义了某个成员函数，那么该成员函数在子类中的版本会覆盖父类中的版本。子类可以通过super()函数来调用父类的成员函数。

**构造函数 (\_\_init\_\_):**

> 如果子类没有定义自己的构造函数，那么它会自动继承父类的构造函数。

如果子类定义了自己的构造函数，那么它需要明确地调用父类的构造函数（如果希望执行父类的构造操作）。这通常通过super().\_\_init\_\_()来实现。

> 如果子类的构造函数没有调用父类的构造函数，那么父类的构造函数不会自动执行。

**成员变量:**

> 子类不会“继承”父类构造函数中初始化的成员变量的值。但是，如果子类的构造函数调用了父类的构造函数，那么父类的构造函数会执行，从而初始化其成员变量。如果子类和父类具有相同名称的成员变量，并且子类的构造函数没有调用父类的构造函数，那么子类的成员变量会覆盖父类的成员变量。

**Read File**

> b for binary format, all mode with b open the file in binary format

> + for reading and writing, all mode with + will open the file with R/W

> r for read only, all mode with r has file ptr at the beginning of the file

> w for write only, overwrite the file if exists, create file otherwise. File ptr at the beginning of the file

> a for appending. File ptr at the end. Create new file if not exist

> r, rb, r+, rb+, w, wb, w+, wb+, a, ab, a+, ab+

**Try-Except-Finally Clause and Errors**

> 当try中的代码抛出错误时，程序会立即停止try中的其他代码，去匹配except

> 没有指定error类型的except必须放在所有except的最后，并在前面的except没有匹配到error后匹配任意一个error。

> 只有当except中的error类型不能匹配try中产生的error时，才会进入else

> Finally无论如何都会执行

> Assert 会返回一个AssertionError如果assert中的语句为False

> Error includes SyntaxError and Exceptions

| **Type of Exception** | **Description** |
| --- | --- |
| **NameError** | If an identifier is used before assignment |
| **TypeError** | If wrong type of parameter is sent to a function |
| **ValueError** | If function parameter has invalid value Eg: log(-1) |
| **ZeroDivisionError** | If 0 is used as divisor |
| **StopIteration** | Raised by next(iter) |
| **IndexError** | If index is out of bound for a sequence |
| **KeyError** | If non-existent key is requested for set or dictionary |
| **IOError** | If I/O operation fails (Eg: opening a file) |
| **EOFError** | If end of file is reached for console of file input |
| **AttributeError** | If an undefined attribute of an object is used |

**Time Complexity**

| **Algorithm** | **Best Case** | **Worst Case** | **Average** |
| --- | --- | --- | --- |
| **Bubble Sort** |  |  |  |
| **Merge Sort** |  |  |  |
| **BFS** |  |  |  |
| **DFS** |  |  |  |
| **Dijkstra** |  |  |  |
| **Binary Search** |  |  |  |

> V for node num, E for edge num