香港中文大學(深圳)
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Introduction to Computer Science: Programming Methodology

Lecture 4 Function

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Key points

function

def

局部变量 argument

global variables

local variables

全局变量

return value

参数，变量.

void

parameter

无效的

Stored (and reused) steps

def 关键字用于定义函数.

Program

```
def Hello():
    print('Hello')
    print('Funny')

Hello()
print('Something in the middle.')
Hello()
```

Output

```
Hello
Funny
Something in the middle.
Hello
Funny
```

→ reuse code easily.

This reusable paragraph of code is usually called function

Python functions

- There are two types of functions in Python
  - ✓ Built-in functions which are part of Python, such as print(), int(), float(), etc
  - ✓ Functions that we define ourselves and then use

- The names of built-in functions are usually considered as new reserved words, i.e. we do not use them as variable names

Function definition

- In Python, a function is some reusable code which can take arguments as input, perform some computations, and then output some results

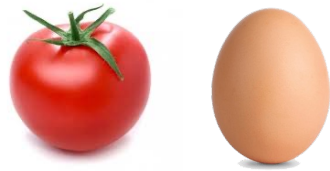
- Functions are defined using reserved word def

- We call/invoke a function by using the function name, parenthesis and arguments in an expression

把argument给function.

Argument

```
big = max('Hello world')
```



return/store in big

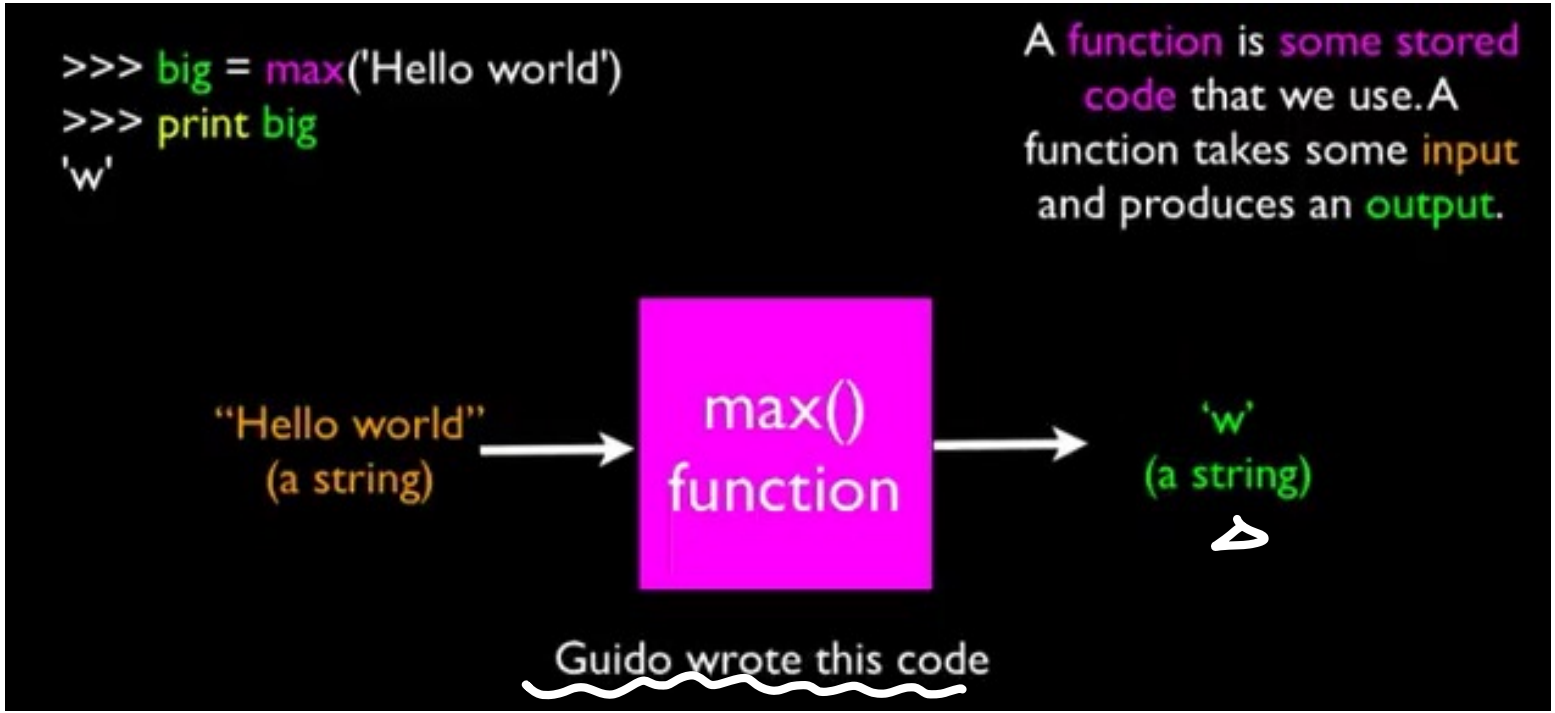
w

Result

```
>>> big = max('Hello world')
>>> print(big)
w
>>> small = min('Hello world')
>>> print(small)
```

- max( ), min( )
  用于返回字符串中最大/最小的字母
  (可迭代对象)

max() function



Building our own functions

- We create a new function using the def key word, followed by optional parameters in parenthesis

跟着括号中的可选参数.

- We indent the body of the function

缩进函数体.

- This defines the function, but does not execute the body of the function

A sample code

前 后

(x, y = a)

必选参数

可选参数.
可以不返回.

(return必有)

def <函数名>(<参数列表>):

Program

```
x=5
print('Hello')

def print_lyrics():
    print('I am a lumberjack, and I am okay.')
    print('I sleep all night and I work all day.')

print('Yo')
x=x+2
print(x)
```

Output

```
Hello
Yo
7
```

e.g. def gongshi(x,y):

$\boxed{x = x*2}$ 函数体.

print(x, y) / return <返回值列表>

In gongshi(3,2)

☆: 注意顺序

output : (4, 2)

A sample code

Program

```
x=5
print('Hello')


def print_lyrics():
    print('I am a lumberjack, and I am okay.')
    print('I sleep all night and I work all day.')

print('Yo')
print_lyrics()
x=x+2
print(x)
```

Output

```
Hello
Yo
I am a lumberjack, and I am okay.
I sleep all night and I work all day.
7
```

Argument


- An argument is a value we pass into the function as its input when we call the function

实参→传递给函数作为输入的值.

- We use arguments so we can direct the function to do different kinds of work when we call it at different times

形参

放在函数名后的( )里.

- We put the argument in parenthesis after the name of the function

big = max('I am the one')

argument

Parameters 参数

- A parameter is a variable which we use in the function definition that is a 'handle' that allows the code in the function to access the arguments for a particular function invocation

parameter

```
def greet(lang):
    if lang=='es':
        print('Hola')
    elif lang=='fr':
        print('Bonjour')
    else:
        print('Hello')

>>> greet('en')
Hello
>>> greet('es')
Hola
>>> greet('fr')
Bonjour
```

Return values

- Often a function will take its arguments, do some computation and return a value to be used as the value of the function call in the calling expression. The return keyword is for this purpose.

如果无return，也只有 a=1.
output将为None

Program

```
def greet():
    return 'Hello'

print(greet(),'Glenn')
print(greet(),'Sally')
```

Output

```
Hello Glenn
Hello Sally
```

☆ 如果是 greet( )
将输出 nothing.

return value

of greet(

Return values

- A fruitful function is one that produces a result (or return value)

- The return statement ends the function execution and 'sends back' the result of the function

definition

```
def greet(lang):
    if lang=='es':
        return 'Hola'
    elif lang=='fr':
        return 'Bonjour'
    else:
        return 'Hello'
```

```
>>> print(greet('en'),'Glenn')
Hello Glenn
>>> print(greet('es'),'Sally')
Hola Sally
>>> print(greet('fr'),'Michael')
Bonjour Michael
```

Argument, parameter, and result

```
>>> big = max('I am the one')
>>> print(big)
t
```

参数.变量.

Parameter

```
def max(inp):
    blah
    blah
    for x in y:
        blah
        blah
    return 't'
```

Result

```
t
```

```
'I am the one'
```

Argument

Multiple parameters/arguments

- We can define more than one parameter in a function definition
- We simply add more arguments when we call the function
- We match the number and order of arguments and parameters

```
def AddTwo(a, b):
    total = a+b
    return total

x=AddTwo(3, 5)
print(x)
```

函数体

8.

Void functions 无效/空白函数

- When a function does not return a value, it is called a “void” function
- Functions that return values are “fruitful” functions
- Void functions are “not fruitful”

Functions without return

可正常运行；

- When a function has no return statement, it will return None

```
# Print grade for the score
def printGrade(score):
    if score >= 90.0:
        print('A')
    elif score >= 80.0:
        print('B')
    elif score >= 70.0:
        print('C')
    elif score >= 60.0:
        print('D')
    else:
        print('F')

def main():
    score = eval(input("Enter a score: "))
    print("The grade is ", end = " ")
    printGrade(score)

main() # Call the main function
```

Scope of variables 变数范畴

- The scope of a variable is the part of program where this variable can be accessed

- A variable created inside a function is referred to as a local variable

局部变量.

- Global variables are created outside all functions and are accessible to all functions in their scope

全局变量.

```
globalVar = 1
def f1():
    localVar = 2
    print(globalVar)
    print(localVar)

f1()
print(globalVar)
print(localVar) # Out of scope, so this gives an error
```

新：localVar=2

f1() → 1, 2.

print(globalVar) → 1.

只有在f1()内部才能认出localVar=2.

☆ Scope of variables

- Different variables may share a name if they have different scopes

不同范围共享名字.

int, float

```
x = 1
def f1():
    x = 2
    print(x) # Displays 2

f1() → 2
print(x) # Displays 1
```

within the function

global

Global variable

- In a function, you can use keyword global to specify that a variable is a global variable

前面加global，函数外部就可打出来（最终结果）

- Be very careful when define and use global variable

```
x = 1
def increase():
    global x
    x =  x + 1
    print(x) # Displays 2

increase()→2
print(x) # Displays 2
```

```
print(...)
    print(value, ..., sep=' ', end='\n', file=sys.stdout, flush=False)

    Prints the values to a stream, or to sys.stdout by default.
    Optional keyword arguments:
    file:  a file-like object (stream); defaults to the current sys.stdout.
    sep:   string inserted between values, default a space.
    end:   string appended after the last value, default a newline.
    flush: whether to forcibly flush the stream.
```

Default argument

默认参数值.

- Python allows you to define functions with default argument values
- The default argument values will be passed to the function, when it is invoked without arguments

不带参数调用.

```
def printArea(width = 1, height = 2):
    area = width * height
    print("width:", width, "\theight:", height, "\tarea:", area)

printArea() # Default arguments width = 1 and height = 2
printArea(4, 2.5) # Positional arguments width = 4 and height = 2.5
printArea(height = 5, width = 3) # Keyword arguments width
printArea(width = 1.2) # Default height = 2
printArea(height = 6.2) # Default width = 1
```

位置参数.

(默认的)

把值重新赋给 width, height.

Return multiple values

☆ sort(num1=2, num2) X.

- Python allows a function to return multiple values

sort(num1, num2=2) ✓

- The sort function returns two values; when it is invoked, you need to pass the returned values in a simultaneous assignment

同时分配(多个变量同时赋值).

```
def sort(number1, number2):
    if number1 < number2:
        return number1, number2
    else:
        return number2, number1

n1, n2 = sort(3, 2)
print("n1 is", n1)
print("n2 is", n2)
```

Q: 能否 n = sort(3,2) ✓

To function or not function…

- Organize your code into paragraphs - capture a complete thought and name it
- Don’t repeat yourself – name it to work once and reuse it
- If something goes too complex, break up them into several blocks, and put each of them into a function
- Make a library of common stuffs that you do over and over again – perhaps share with other people

Practice

```
a=float(input("...")
b= float(input("..."))
```

- Write a function to instruct the user to input the working hours and hourly rate, and then return the salary. If the working hours exceed 40 hours, then the extra hours received 1.5 times pay.

```
def salary(a,b):
    if a<=40:
        print(a*b)
    else:
        print(40*b+(a-40)*1.5b).
```

SALARY = salary(,)

String type

SALARY.

- A string is a sequence of characters
- A string literal uses quotes ‘’ or “”
- For strings, + means “concatenate” 连接
- When a string contains numbers, it is still a string
- We can convert numbers in a string into a number using int() or float()

Reading and converting

- We prefer to read data in using strings and then parse and convert the data as we need

- This gives us more control over error situations and/or bad user inputs

原始输入数字

- Raw input numbers must be converted from strings

转换

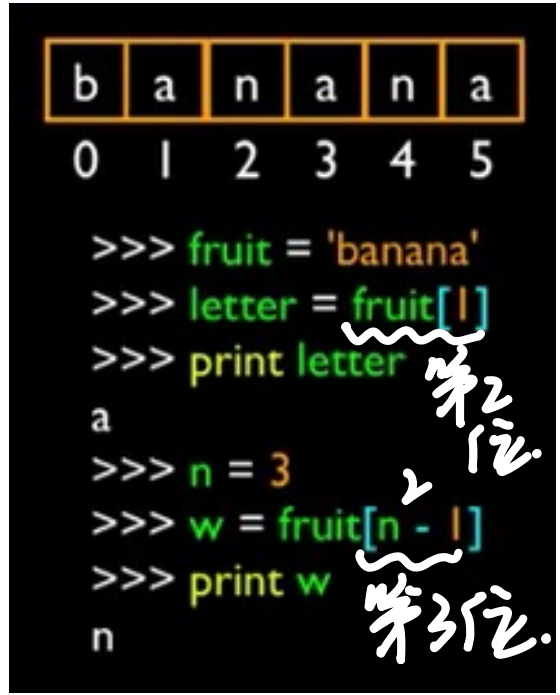
Looking inside strings

- We can get any character in a string using an index specified in square brackets

索引.

- The index value must be an integer which starts from zero

- The index value can be an expression



Index out of range

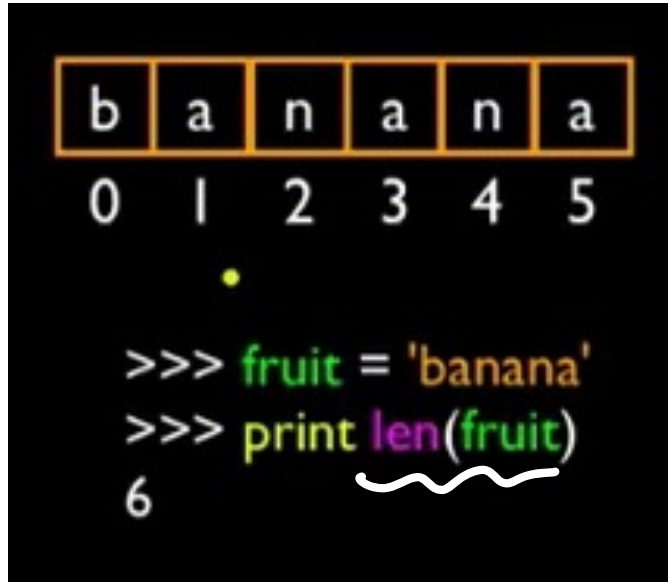
- You will get an Python error if you attempt to index beyond the end of a string

- Be careful when specifying an index value

```
>>> name = 'Junhua'
>>> name[6]
Traceback (most recent call last):
  File "<pyshell#10>", line 1, in <module>
    name[6]
IndexError: string index out of range
```

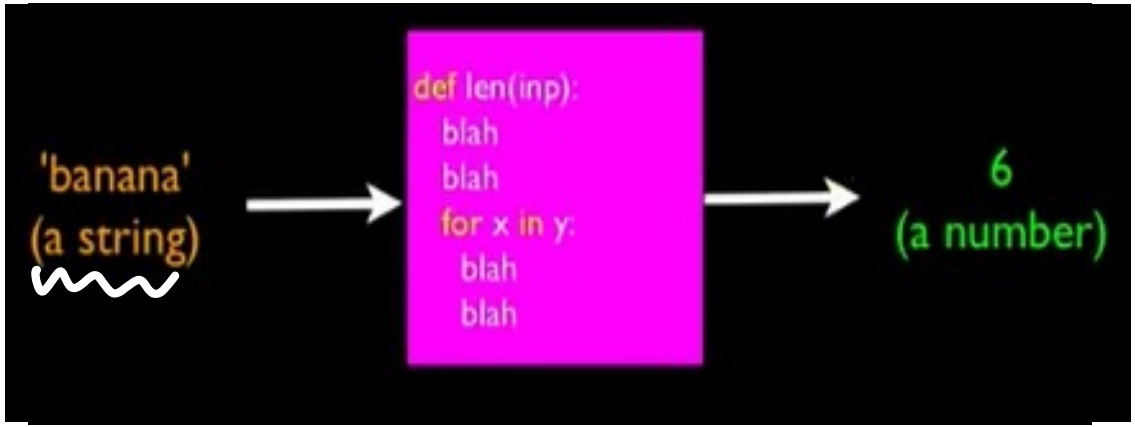
Strings have length

- There is a built-in function len() which gives us the length of a string



Len() function

```
>>> fruit = 'apple'
>>> length = len(fruit)
>>> print(length)
5
```



Looping through strings

- Using a for statement, we can easily loop through each character in a string

- String is essentially a list in Python

```
fruit = 'I am the one, Morpheus'

n = 0
for i in fruit:
    print(n, i)
    n=n+1

print('finished')
```

循环

注意打出来的顺序

易错：空格也会被打印!!

```
0 I
1   (空格)
2 a
3 m
4
5 t
6 h
7 e
8
9 o
10 n
11 e
12 ,
13 M
14 o
15 r
16 p
17 h
18 e
19 u
20 s
finished
```

else

Practice

利用while, len()循环字符串.

- Write a program to use a while statement together with len() function to loop through a given string

```
a= input("Enter a string:")
b= len(a)
n=0
while n<=b:
        print(a[n:n+1])
        n=n+1
```

else : print("finished")

Loop and counting

- This is a simple statement that loops through each letter in a string and counts the number of times the loop encounters the ‘a’ character

```
word = 'banana'
count = 0
for letter in word:
    if letter=='a':
        count = count+1
print("The number of 'a' we have seen is:",count)
```

数数用count.

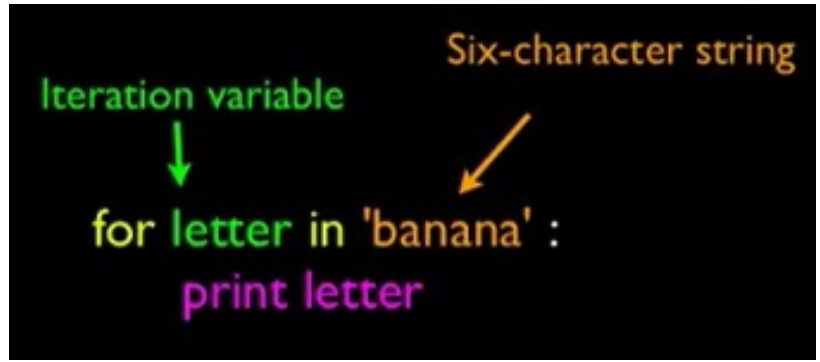
Look deeper into in

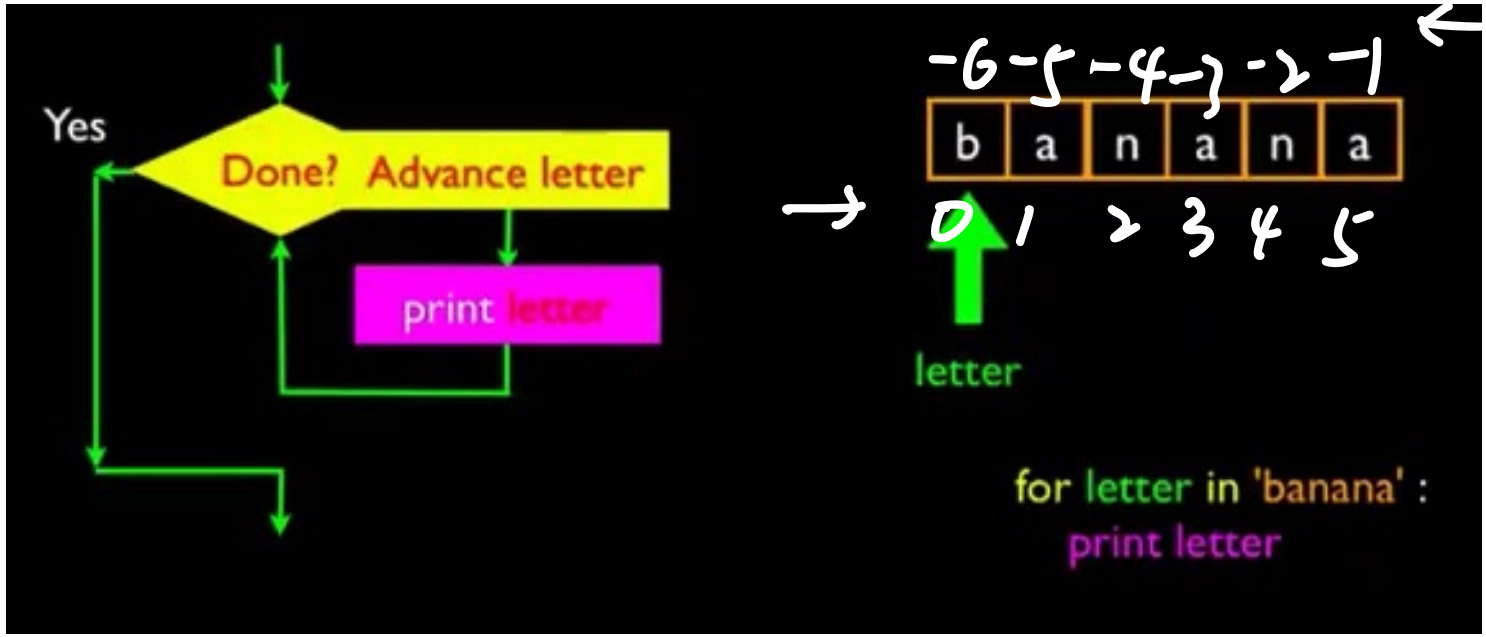
迭代变量.

- The iteration variables "iterates" through the sequence (ordered set)

- The block (body) of the loop is executed once for each value in the sequence

- The iteration variable moves through all the values in the sequence





- The iteration variable loops through the string, and the body of the loop is executed once for each character in that string

☆分片超范围不会报错，索引会.

s[0:1000] ✓

s[1000] X

link: 和 range(a,b) 相似.

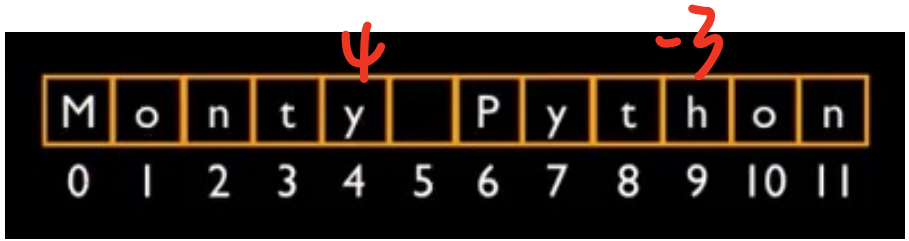
Slicing strings

- We can also look at any continuous section of a string using colon operator

前一位.

- The second number is one beyond the end of the slice – i.e. "up to but not including"

- If the second number is beyond the length of the string, it stops at the end



(string)

```
>>> s = 'Monty Python'
>>> print(s[0:4])
Mont
>>> print(s[6:7])
P
>>> print(s[6:20])
Python
```

☆字符串切片后不可变.

若 >>> print(s[-3:4])

Slicing strings

无输出 → 若为s[4:-3]有.
从左往右.

△空格也占一位!!!

- If we leave off the first or second number of the slice, it is assumed to be the beginning or end of the string respectively


```
>>> s='Monty Python'
>>> print(s[:6])
Monty
>>> print(s[3:])
ty Python
>>> print(s[:])
Monty Python
```

[-3:] → hon

☆切片操作符:

[start: stop: step]

☆负数索引: 末尾开始切片:

sequence="Hello, world!"

sequence[-6:-1] = World

[:-3] → Monty Pyt

Using 'in' in conditional statement

★若步长为负数，例如 -1：相反顺序返回子序列，也就是将序列翻转

- The in keyword can also be used to check whether one string is in another string

sequence[::-1] = "dlrow, olleH"

- The in expression is a logical expression and returns True or False

sequence[::-2] = drWolH.

- It can be used in if or while statement

```
>>> fruit = 'banana'
>>> 'n' in fruit
True
>>> 'm' in fruit
False
>>> 'nan' in fruit
True
>>> if 'a' in fruit:
        print('Got cha!')


Got cha!
```

lower( ) 大写全转小写

String library

- Python has a number of string functions which are in the string library
- These functions are built-into every string, we invoke them by appending the function to the string variable
- These function do not modify the original string, instead they return a new string altered from the original string

```
>>> greet = 'Hello, President Xu'
>>> zap = greet. lower()
>>> print(zap)
hello, president xu
>>> print(greet)
Hello, President Xu
>>> print('Hello, Junhua'.lower())
hello, junhua
```

X. lower( )

⇓

将X中的有大⇒小.

```
>>> stuff = 'hello world'
>>> type(stuff)
<class 'str'>
>>> dir(stuff)
['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__', '__ge__', '__getattribute__', '__getitem__', '__getnewargs__', '__gt__', '__hash__', '__init__', '__iter__', '__le__', '__len__', '__lt__', '__mod__', '__mul__', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__repr__', '__rmod__', '__rmul__', '__setattr__', '__sizeof__', '__str__', '__subclasshook__', 'capitalize', 'casefold', 'center', 'count', 'encode', 'endswith', 'expandtabs', 'find', 'format', 'format_map', 'index', 'isalnum', 'isalpha', 'isdecimal', 'isdigit', 'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace', 'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip', 'maketrans', 'partition', 'replace', 'rfind', 'rindex', 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split', 'splitlines', 'startswith', 'strip', 'swapcase', 'title', 'translate', 'upper', 'zfill']
```

https://docs.python.org/3/library/stdtypes.html#string-methods

4.7.1. String Methods

Strings implement all of the common sequence operations, along with the additional methods described below.

Strings also support two styles of string formatting, one providing a large degree of flexibility and customization (see `str.format()`, Format String Syntax and String Formatting) and the other based on C `printf` style formatting that handles a narrower range of types and is slightly harder to use correctly, but is often faster for the cases it can handle (printf-style String Formatting).

The Text Processing Services section of the standard library covers a number of other modules that provide various text related utilities (including regular expression support in the `re` module).

`str.` **`capitalize`**()

Return a copy of the string with its first character capitalized and the rest lowercased.

`str.` **`casefold`**()

Return a casefolded copy of the string. Casefolded strings may be used for caseless matching.

Casefolding is similar to lowercasing but more aggressive because it is intended to remove all case distinctions in a string. For example, the German lowercase letter `'ß'` is equivalent to `"ss"`. Since it is already lowercase, `lower()` would do nothing to `'ß'`; `casefold()` converts it to `"ss"`.

The casefolding algorithm is described in section 3.13 of the Unicode Standard.

New in version 3.3.

`str.` **`center`**(*width*[, *fillchar*])

Return centered in a string of length *width*. Padding is done using the specified *fillchar* (default is an ASCII space). The original string is returned if *width* is less than or equal to `len(s)`.

`str.` **`count`**(*sub*[, *start*[, *end*]])

Return the number of non-overlapping occurrences of substring *sub* in the range [*start*, *end*]. Optional arguments *start* and *end* are interpreted as in slice notation.

string.find(s, [start], [stop])

Searching a string

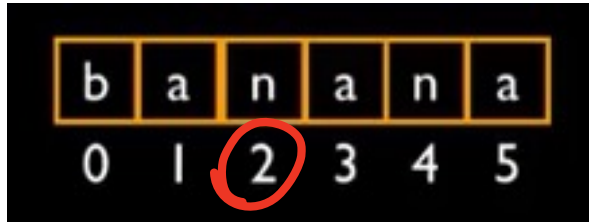
- We can use the find() function to search for a substring in a string

第一次出现的第一位.

- find() finds the first occurrence of the target sub-string

- If the sub-string is not found, it returns -1

- Important: the string position starts from 0




```
>>> fruit = 'banana'
>>> pos = fruit.find('na')
>>> print(pos)
2
>>> aa = fruit.find('z')
>>> print(aa)
-1
```

→先出现.

Making everything upper or lower case

upper( ) lower( )

- You can convert a string into upper case or lower case

- Hint: often when we use find() to find a substring, we convert the original string into lower case first, so that we don't need to worry about case

```
>>> myStr = 'I am the one, I will beat Matrix'
>>> newStr = myStr.upper()
>>> print(newStr)
I AM THE ONE, I WILL BEAT MATRIX
>>> newStr = myStr.lower()
>>> print(newStr)
i am the one, i will beat matrix
```

replace(a, b)

Search and replace

定位 替换.

- The replace() function is like a "search and replace" operation in a word processor

- It replaces all occurrences of the search string with the replacement string

```
>>> greet = 'Hello, Bob'
>>> newStr = greet.replace('Bob', 'Jane')
>>> print(newStr)
Hello, Jane
>>> newStr = greet.replace('o','X')
>>> print(newStr)
HellX, BXb
>>> newStr = greet.replace('z','X')
>>> newStr
'Hello, Bob'
```

没有出现.

原样print.

Stripping whitespace

- Sometimes we want to take a string and remove whitespaces at the beginning and/or end

- lstrip() and rstrip() to the left and right only

- Strip() removes both beginning and ending whitespaces

```
>>> greet = '   Hello Bob   '
>>> greet.lstrip()
'Hello Bob   '
>>> greet.rstrip()
'   Hello Bob'
>>> greet.strip()
'Hello Bob'
```

Prefixes

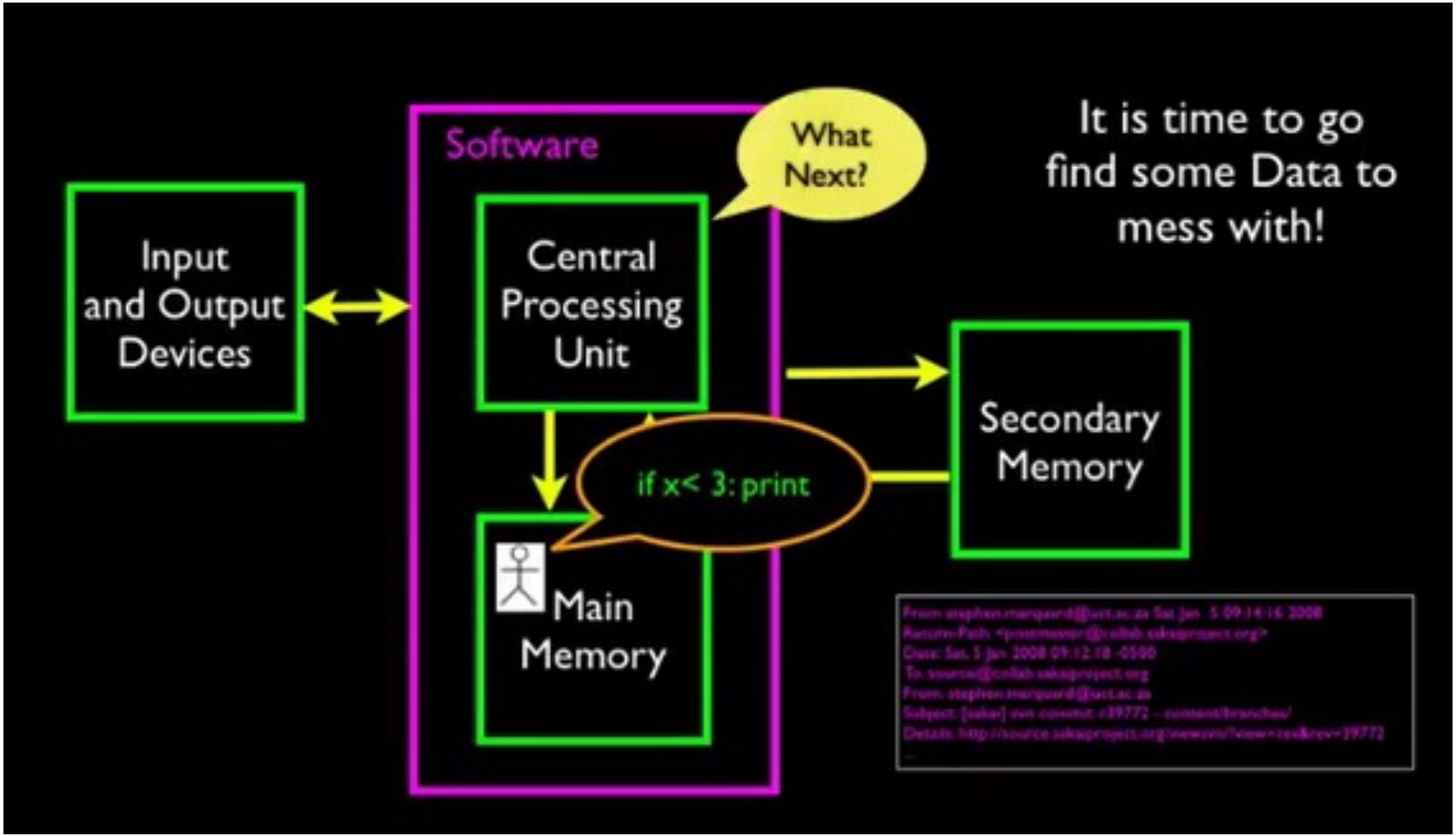
- startswith() function checks whether a string is starting with a given string

```
>>> line = 'Please submit your application'
>>> line.startswith('Please')
True
>>> line.startswith('p')
False
```

Example

```
>>> data = 'From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2016'
>>> atpos = data.find('@')
>>> print(atpos)
21
>>> sppos = data.find(' ',atpos)
>>> print(sppos)
31
>>> host = data[atpos+1:sppos]
>>> print(host)
uct.ac.za
```

21 → [start]


Software
What Next?
It is time to go find some Data to mess with!
Input and Output Devices
Central Processing Unit
Secondary Memory
if x< 3: print
Main Memory

File processing

- A text file can be thought of as a sequence of lines

```
# Gmail web Start
216.239.38.125  chatenabled.mail.google.com
216.239.38.125  filetransferenabled.mail.google.com
216.239.38.125  gmail.com
216.239.38.125  gmail.google.com
216.239.38.125  googlemail.l.google.com
216.239.38.125  inbox.google.com
216.239.38.125  isolated.mail.google.com
216.239.38.125  m.gmail.com
216.239.38.125  m.googlemail.com
216.239.38.125  mail.google.com
216.239.38.125  www.gmail.com
# Gmail web End
```

Opening files

- Before we can read the contents of a file, we must tell Python which file we are going to work with and what we will do with that file
- This is done with the open() function
- Open() returns a "file handle" - a variable used to perform operations on files
- Kind of like "File -> Open" in a word processor

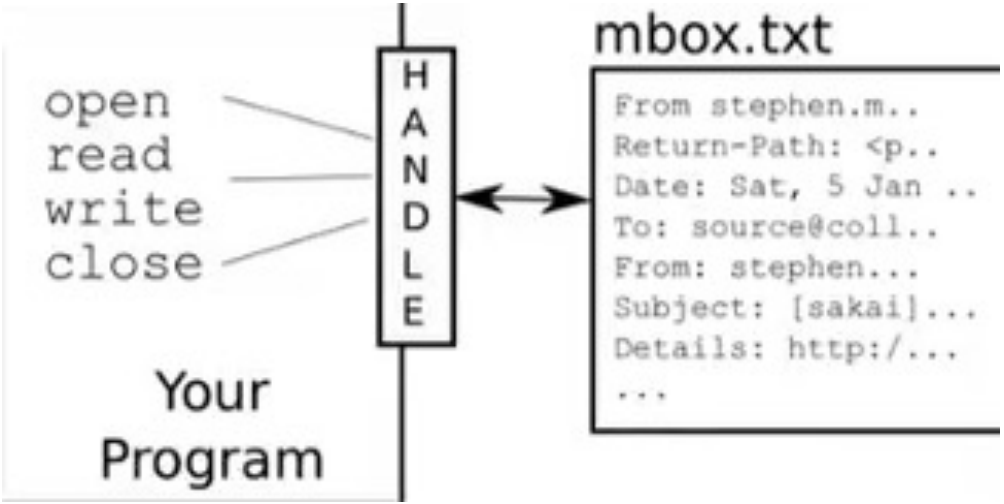
Using open()

txt. ✓ py. X

- handle = open(filename, mode)
- Returns a handle used to manipulate the file
- Filename is a string
- Mode is optional, use ‘r’ if we want to read the file, and ‘w’ if we want to write to the file

Handle

```
>>> fhand = open('c:\Python35\myhost.txt','r')
>>> print(fhand)
<_io.TextIOWrapper name='c:\\Python35\\myhost.txt' mode='r' encoding='cp936'>
```



When files are missing

```
>>> fhand = open('notExisting.txt','r')
Traceback (most recent call last):
  File "<pyshell#14>", line 1, in <module>
    fhand = open('notExisting.txt','r')
FileNotFoundError: [Errno 2] No such file or directory: 'notExisting.txt'
```

The newline character \n

- We use a new character to indicate when a line ends called "newline"
- We represent it as '\n' in strings
- Newline is still one character, not two

```
>>> stuff = 'Hello\nWorld'
>>> stuff
'Hello\nWorld'
>>> print(stuff)
Hello
World
>>> stuff = 'X\nY'
>>> print(stuff)
X
Y
>>> len(stuff)
3
```

File processing

- A text file can be thought of as a sequence of lines
- A text file has newline at the end of each line

```
# Gmail web Start
216.239.38.125  chatenabled.mail.google.com
216.239.38.125  filetransferenabled.mail.google.com
216.239.38.125  gmail.com
216.239.38.125  gmail.google.com
216.239.38.125  googlemail.l.google.com
216.239.38.125  inbox.google.com
216.239.38.125  isolated.mail.google.com
216.239.38.125  m.gmail.com
216.239.38.125  m.googlemail.com
216.239.38.125  mail.google.com
216.239.38.125  www.gmail.com
# Gmail web End
```

File handle as a sequence

- A file handle open for read can be treated as a sequence of strings where each line in the file is a string in the sequence

- We can use the for statement to loop through a sequence

```
fhand = open('myhost.txt','r')

for line in fhand:
    print(line)

fhand.close()
```

打出每一行

print(line, end="")

否则会多行

☆ for 循环 → powerful !!

空开回车

统自带"\n".

Practice

- Write a program to open a file and count how many lines are included in this file

```
a= open('file', 'r')
count = 0
for line in a :
    count = count + 1
a.close()
print(count)
```

Reading the whole file

- We can read the whole file into a single string

```
fhand = open('myhost.txt','r')
allText = fhand.read()
print('The length of the file:',len(allText))
print('The first 20 characters of the file:', allText[:20])
```

→ string

Searching through a file

- We can put an if statement in the for loop to print the lines which satisfy certain conditions

```
fhand = open('myhost.txt','r')

for line in fhand:
    if line.startswith('#')==True:
        print(line)

print('finished.')
fhand.close()
```

close the file

Writing to a file

- To write a file, use the open() function with ‘w’ argument

- Use the write() method to write to the file

```
fhand = open('test.txt','w')
fhand.write('The first line\n')
fhand.write('The second line\n')
fhand.write('The third line\n')
fhand.close()
```