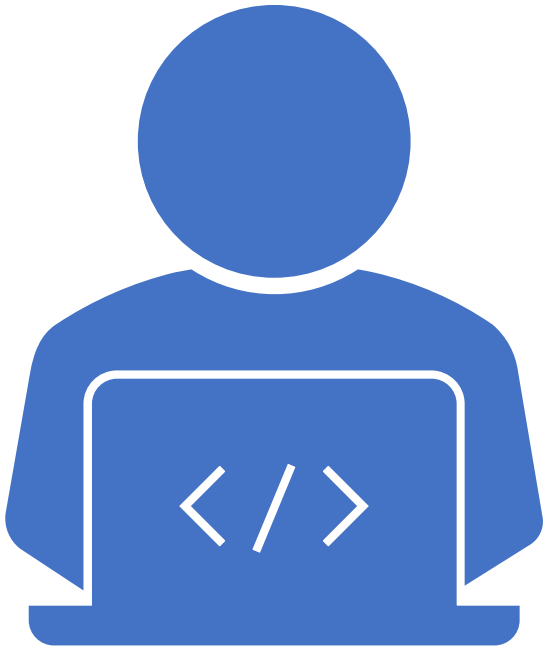
CAN 201

Dr. Fei Cheng

Lab 5
Parallel computing &
Data Structure &
File operation &
…



Demo for Practice of last week

https://box.xjtlu.edu.cn/f/0489e9fb3a5145ed83da/

Contents

- **Parallel computing**
- **Data structure**
- **struct module**
- **File operation**

Parallel computing

- How to use parallel computing in python?
  - ***multiprocessing*** module – process-based parallelism
  - ***threading*** module – thread-based parallelism
- How to support multi-clients for TCP?
  - Using ***threading***

Use Process class - *multiprocessing*

- Try the following example:

```
from multiprocessing import Process
import time


def one_process(name):
    for i in range(10):
        print(name, i)
        time.sleep(0.5)


if __name__ == '__main__':
    p = Process(target=one_process, args=('In sub process',))
    p.start()
    time.sleep(0.2)
    for i in range(5):
        print('In main process', i)
        time.sleep(1)
    p.join()
```

Use Pool class - *multiprocessing*

- Try the following example:

```
from multiprocessing.pool import Pool
from multiprocessing import cpu_count


def one_function(i):
    return i


if __name__ == '__main__':

    pool = Pool(cpu_count() - 1)

    r = pool.map(one_function, (1, 'a', 0.5))
    print(r)
```

Please find more information @ https://docs.python.org/3.9/library/multiprocessing.html

threading Module

- Higher-level threading interfaces on top of the lower level ***_thread*** module
- Try the following example:

```
from threading import Thread
import time


def one_thread(name):
    for i in range(10):
        print(name, i)
        time.sleep(0.5)


if __name__ == '__main__':
    p = Thread(target=one_thread, args=('In thread',))
    p.start()
    time.sleep(0.2)
    for i in range(5):
        print('In main process', i)
        time.sleep(1)
    p.join()
```

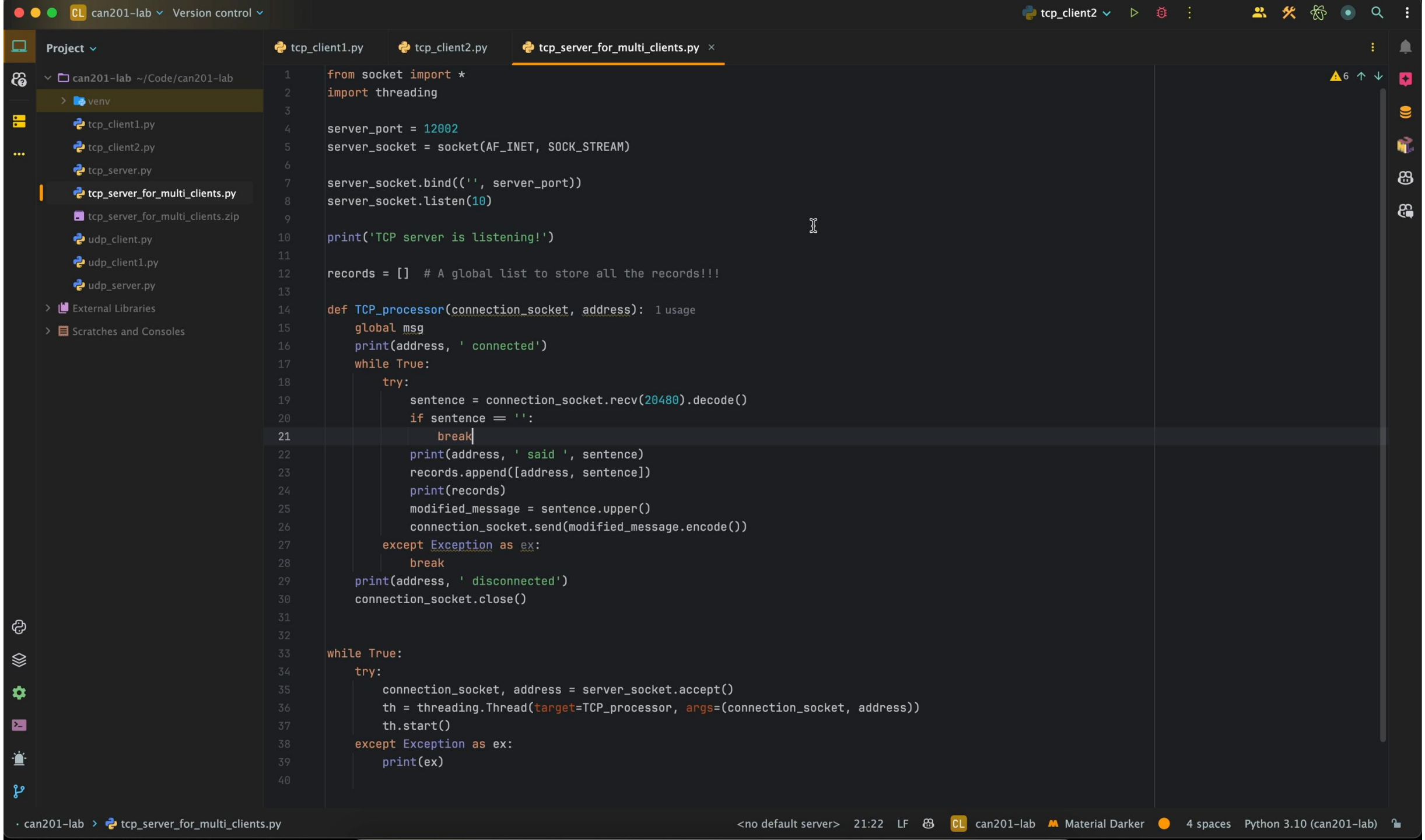
How to support multi-clients for TCP

- Code: https://box.xjtlu.edu.cn/f/f7216f97335c45ab8650/?dl=1
  - PATCH: file tcp_server_for_multi_clients.py line 15
    should be: global records (not global msg)

```
def TCP_processor(connection_socket, address):  1 usage
    global records
    print(address, ' connected')
```

- Video: https://box.xjtlu.edu.cn/f/54de17ea4b814955b818/

For UDP… UDP can support multi-clients directly.


can201-lab
Version control
tcp_client2
Project
tcp_client1.py
tcp_client2.py
tcp_server_for_multi_clients.py
can201-lab ~/Code/can201-lab
venv
tcp_client1.py
tcp_client2.py
tcp_server.py
tcp_server_for_multi_clients.py
tcp_server_for_multi_clients.zip
udp_client.py
udp_client1.py
udp_server.py
External Libraries
Scratches and Consoles
from socket import *
import threading
server_port = 12002
server_socket = socket(AF_INET, SOCK_STREAM)
server_socket.bind(('', server_port))
server_socket.listen(10)
print('TCP server is listening!')
records = [] # A global list to store all the records!!!
def TCP_processor(connection_socket, address): 1 usage
global msg
print(address, ' connected')
while True:
try:
sentence = connection_socket.recv(20480).decode()
if sentence == '':
break
print(address, ' said ', sentence)
records.append([address, sentence])
print(records)
modified_message = sentence.upper()
connection_socket.send(modified_message.encode())
except Exception as ex:
break
print(address, ' disconnected')
connection_socket.close()
while True:
try:
connection_socket, address = server_socket.accept()
th = threading.Thread(target=TCP_processor, args=(connection_socket, address))
th.start()
except Exception as ex:
print(ex)
can201-lab
tcp_server_for_multi_clients.py
<no default server>
21:22
LF
can201-lab
Material Darker
4 spaces
Python 3.10 (can201-lab)

A patch:

- file tcp_server_for_multi_clients.py line 15 should be: global records (not global msg)

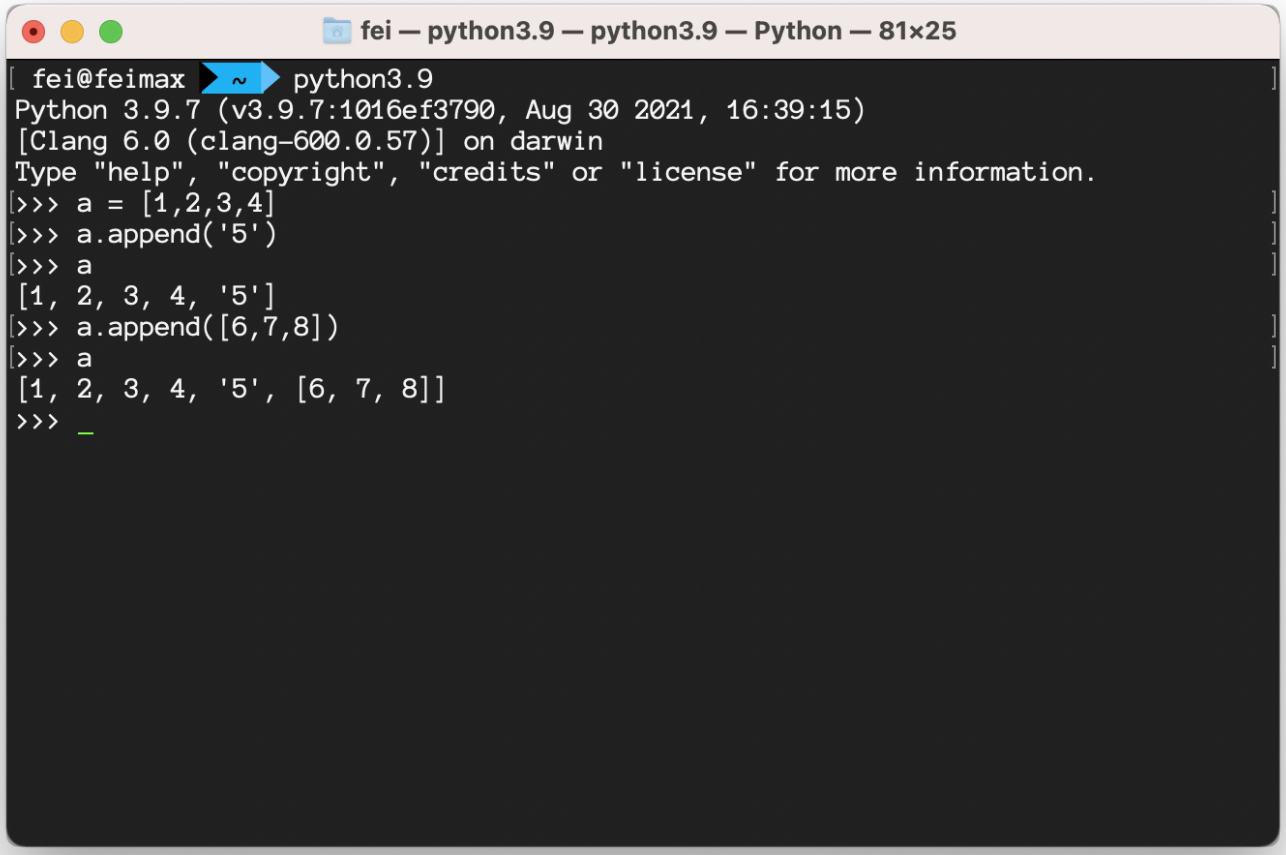
```
def TCP_processor(connection_socket, address):  1 usage
    global records
    print(address, ' connected')
```

Data structure

- List
- Tuple
- Set(optional)
- Dictionary and JSON
- How to handle binary data – ***struct*** module

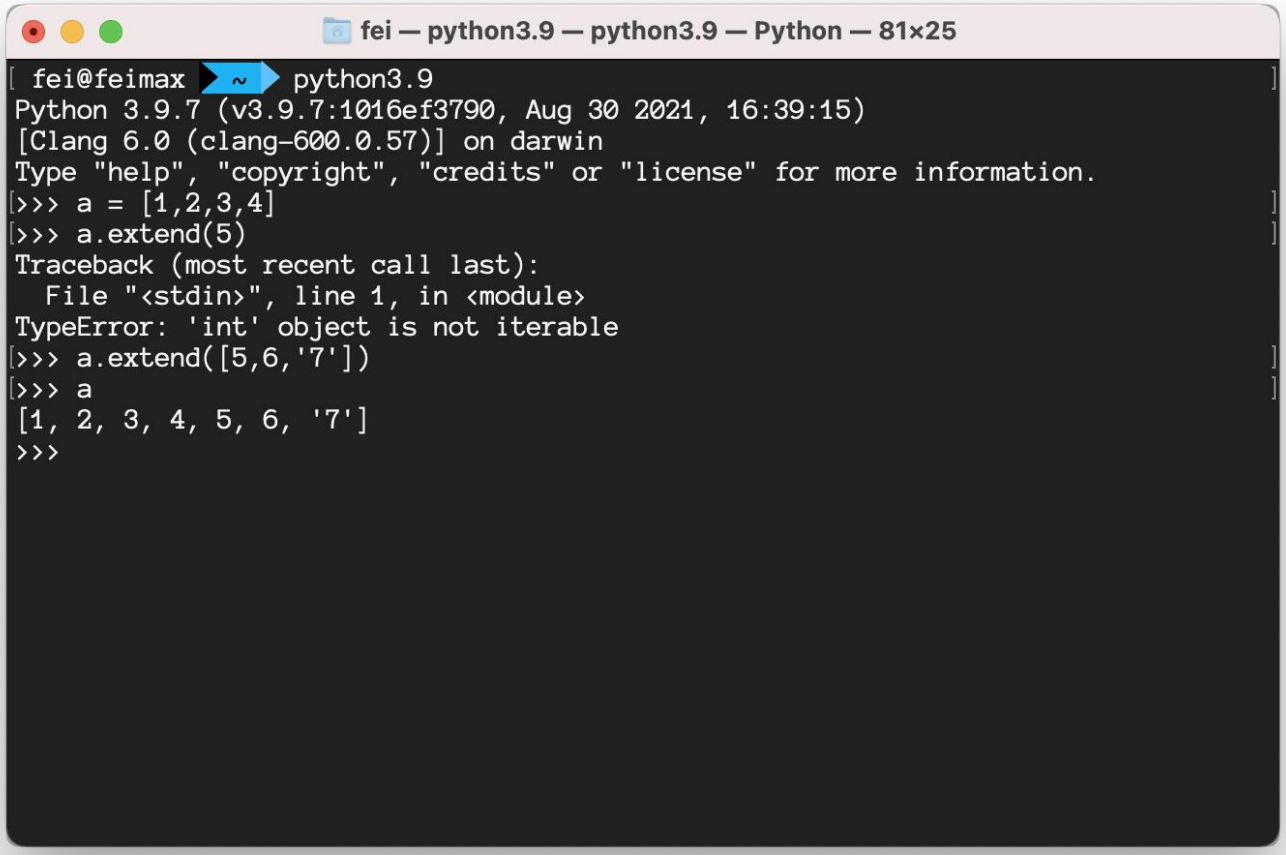
List

- Review
  - `list.append(x)`



List

- Review
  - `list.append(x)`
  - `list.extend(iterable)`



List

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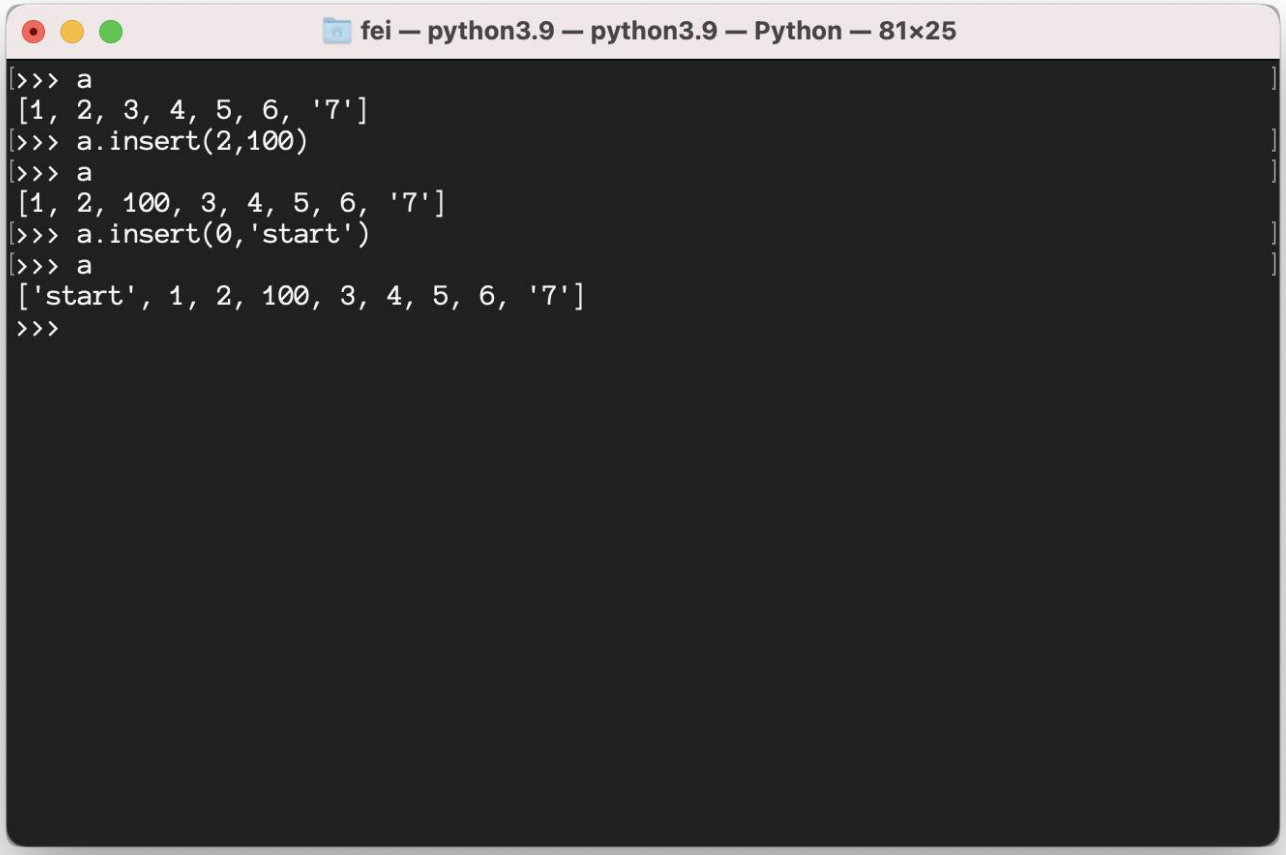
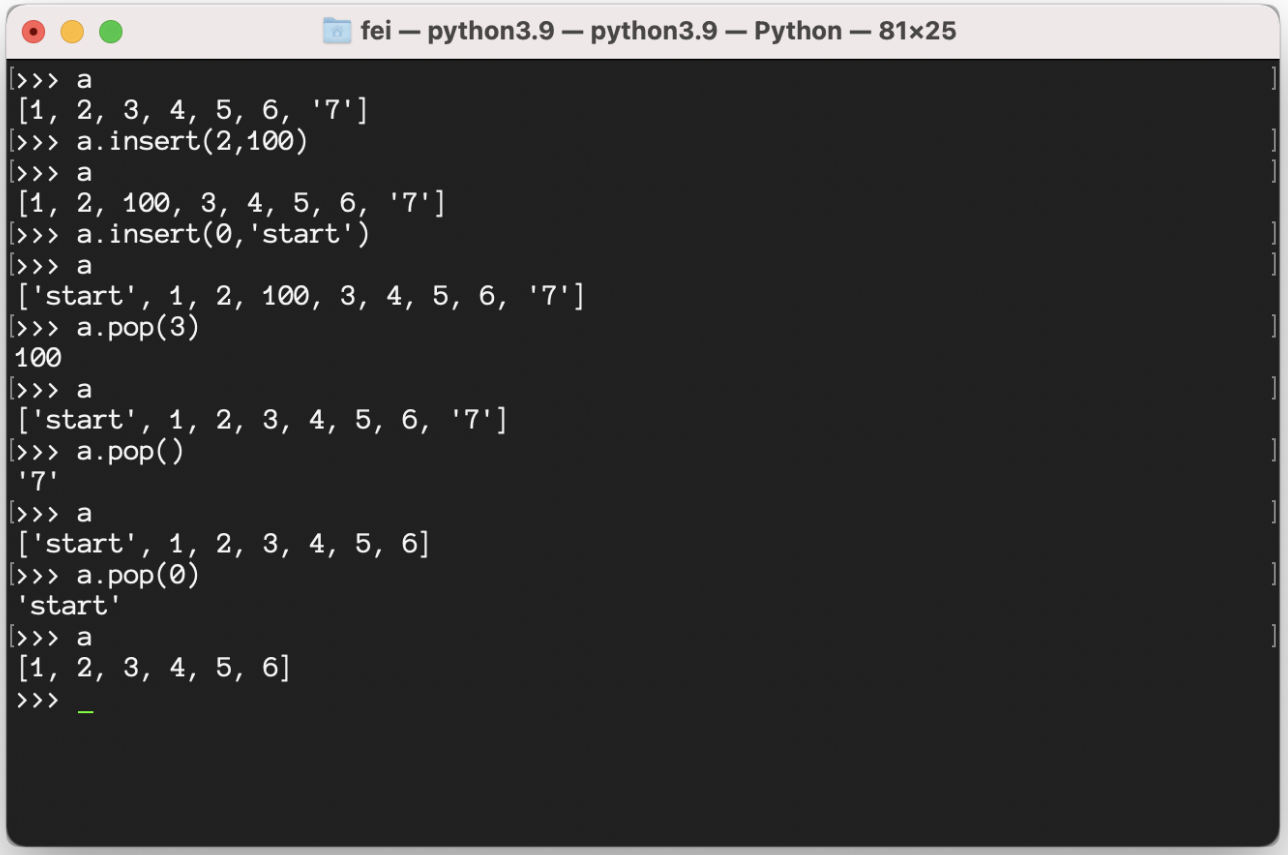
  - `list.append(x)`
  - `list.extend(iterable)`
  - `list.insert(i, x)`



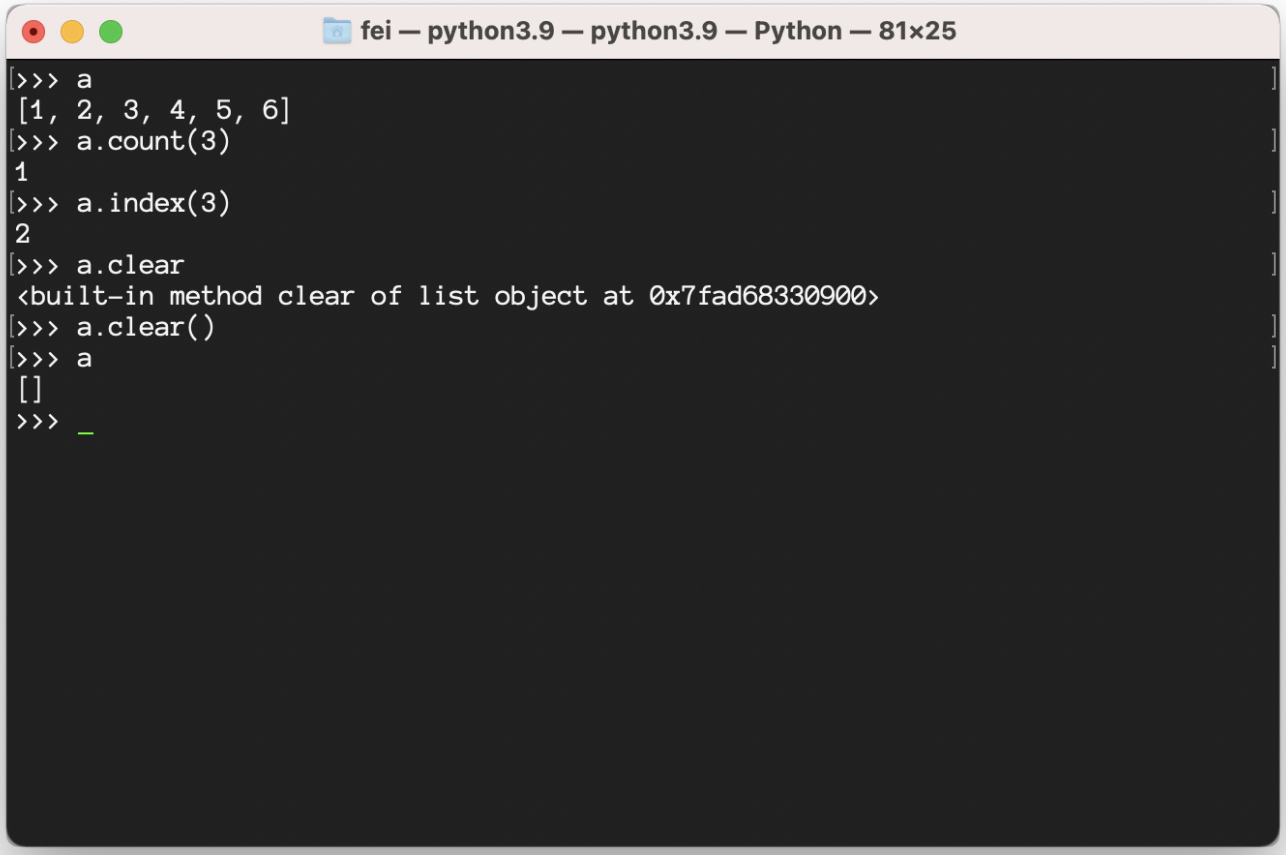
List

- Review
  - `list.append(x)`
  - `list.extend(iterable)`
  - `list.insert(i, x)`
  - `list.pop(i)`



List

- Review
  - `list.append(x)`
  - `list.extend(iterable)`
  - `list.insert(i, x)`
  - `list.pop([x])`
  - `list.count(x)`



List

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  - `list.extend(iterable)`
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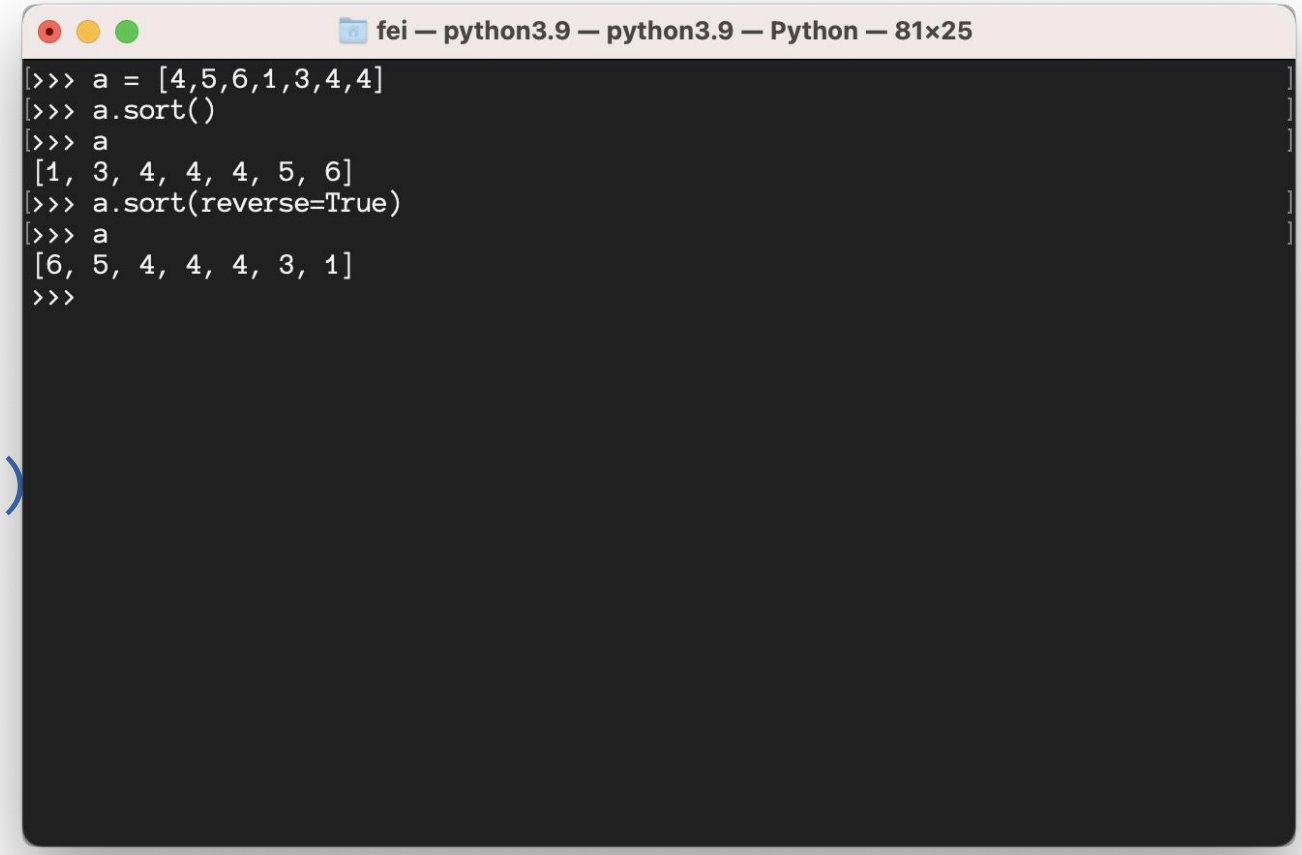
  - `list.count(x)`
  - `list.sort([key, rverse])`



List

- Review
  - `list.append(x)`
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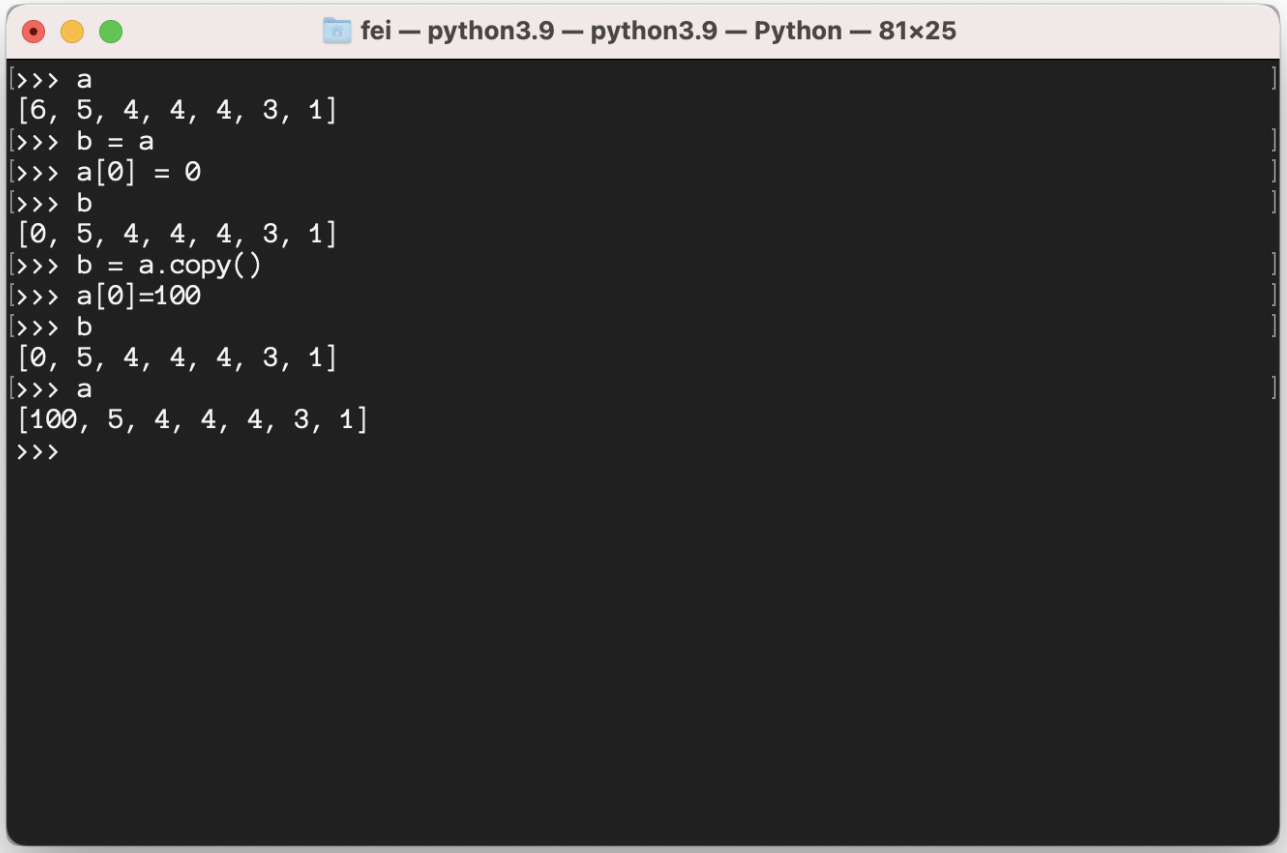
  - `list.insert(i, x)`
  - `list.pop([x])`
  - `list.count(x)`
  - `list.sort([key, rverse])`
  - `list.copy()`



List Comprehensions

```
squares = []
for x in range(10):
    squares.append(x**2)
```

```
squares = list(map(lambda x: x**2, range(10)))
```

```
squares = [x**2 for x in range(10)]
```

List Comprehensions

```
squares = []
for x in range(10):
    squares.append(x**2
```

```
squares = list(map(lambd
```

```
squares = [x**2 for x in
```

Tuple

- Another sequence data type.
- `t = (1, 2, '4', 'string')`
- Sequence data types: indexing,slicing … operations
  - list
  - tuple
  - range
- An immutable list

Set (optional)

- A set is an unordered collection with no duplicate elements.
- `set.add(x)`
- `set.remove(x)`
- `set.difference(s)`
- `set.intersection(s)`
- `set.issubset(s)`

Set (optional)

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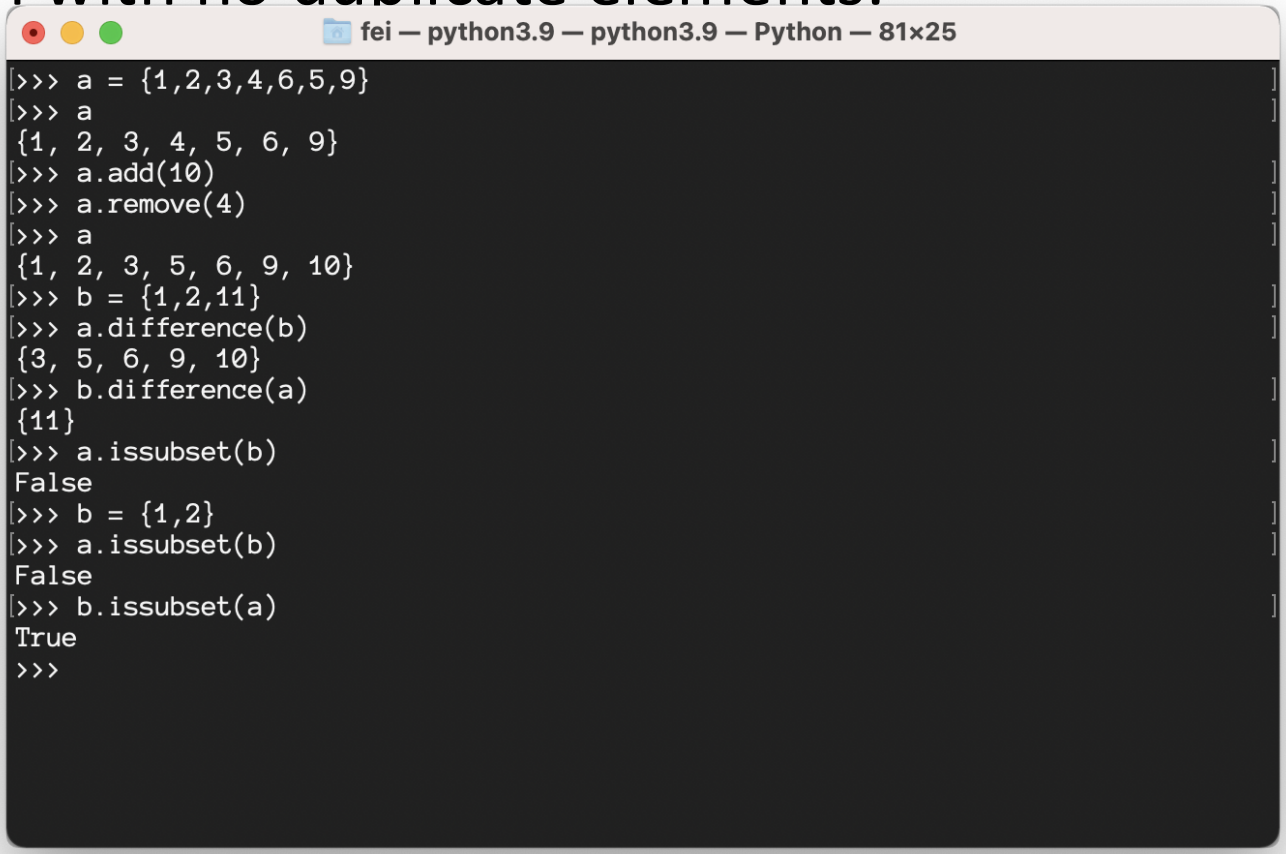

IMPORTANT

Dictionary

- Dictionaries are indexed by *keys*
- Keys can be numbers or strings
- key - value pairs
- First example:

```
tel = {'jack': 4098, 'sape': 4139}
tel['guido'] = 4127
```

IMPORTANT

Dictionary

- Dictionaries are indexed by *keys*
- Keys can be numbers or strings
- key - value pairs
- First example:

```
tel = {'jack': 4098, 'sap
tel['guido'] = 4127
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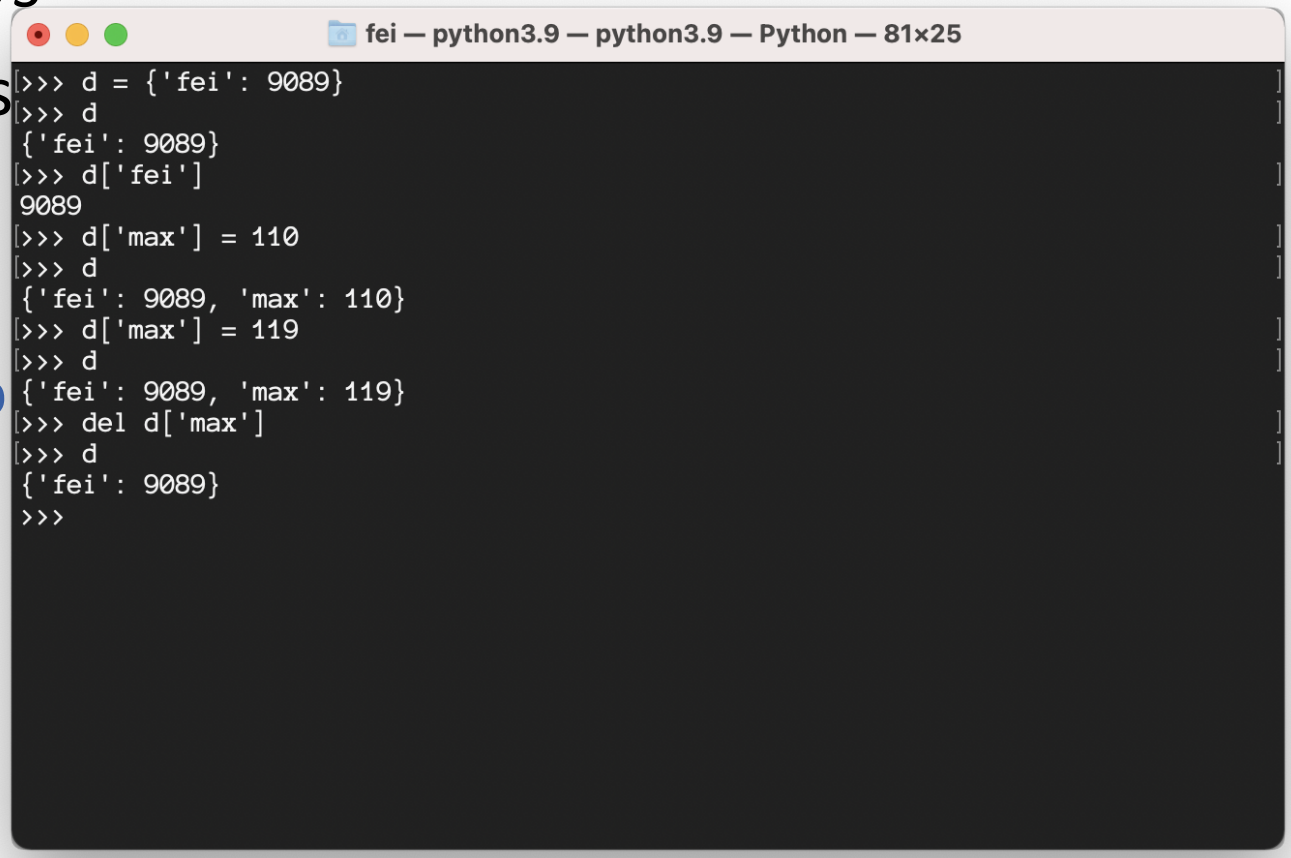


IMPORTANT

Dictionary

- How to know the key exists or not?

IMPORTANT

Dictionary

- How to enumerate the dict?

IMPORTANT

Dictionary

- How to send a dict using socket?
  - dict - > string->binary data
  - binary data -> string -> dict

  - JSON!

IMPORTANT

JSON

- JavaScript Object Notation
- dict <-> JSON formatted string

JSON

IMPORTANT

- JavaScript Object Notation
- dict <-> JSON

struct module

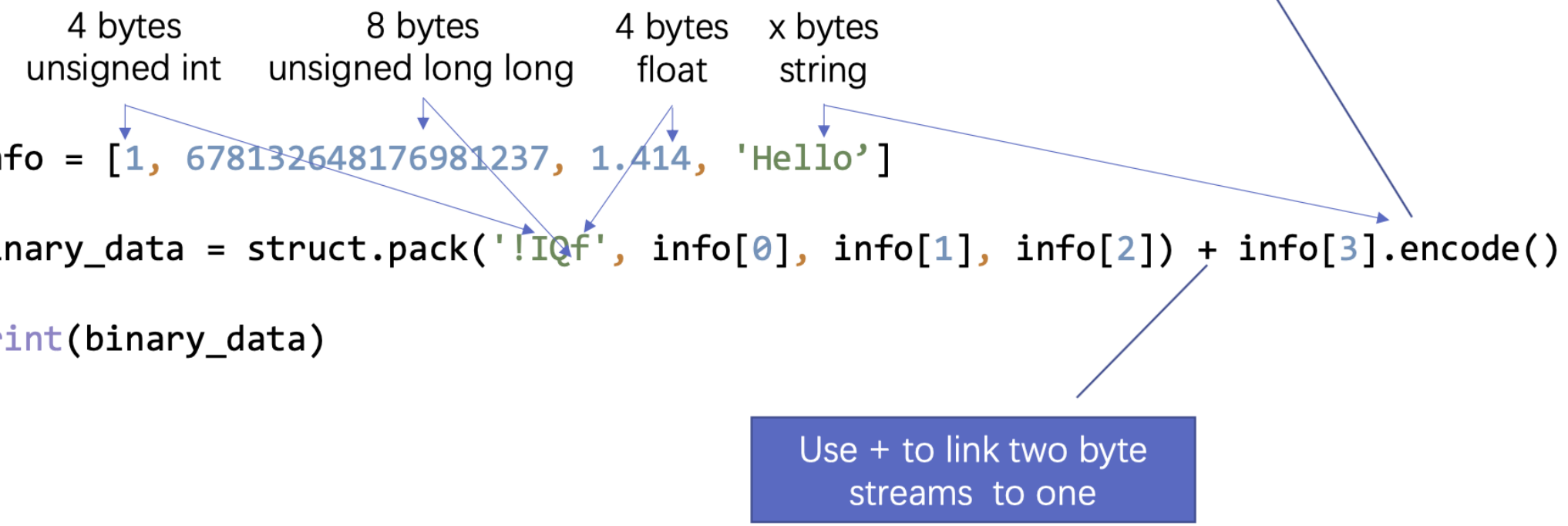
ATTENTION PLEASE!!!

- *struct* module can be used in handling binary data stored in files or from network connections
- *struct* module performs conversions between Python values and C structs represented as Python bytes (we don't use this feature in this project)
- Review:
  - In the last lab, we need to use string.encode() to convert string to bytes
  - How to send ***int or float?***

struct module

As the length of a string is not fixed, we put it to the end. Think: how to add two strings

- Assume:
  - We want to send [1, 67813264817698123 7, 1.414, ‘Hello’] using socket



struct module

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

```
# Get data back:

v_i, v_Q, v_f = struct.unpack('!IQf', binary_data[:16])

v_str = binary_data[16:].decode()

print(v_i, v_Q, v_f, v_str)
```

See “make_packet” and “get_tcp_packet” functions in the server.py to get more ideas about how to deal with number and binary data together!

Format	C Type	Python type	Standard size	Notes
`x`	pad byte	no value		
`c`	`char`	bytes of length 1	1	
`b`	`signed char`	integer	1	(1), (2)
`B`	`unsigned char`	integer	1	(2)
`?`	`_Bool`	bool	1	(1)
`h`	`short`	integer	2	(2)
`H`	`unsigned short`	integer	2	(2)
`i`	`int`	integer	4	(2)
`I`	`unsigned int`	integer	4	(2)
`l`	`long`	integer	4	(2)
`L`	`unsigned long`	integer	4	(2)
`q`	`long long`	integer	8	(2)
`Q`	`unsigned long long`	integer	8	(2)
`n`	`ssize_t`	integer		(3)
`N`	`size_t`	integer		(3)
`e`	(6)	float	2	(4)
`f`	`float`	float	4	(4)
`d`	`double`	float	8	(4)
`s`	`char[]`	bytes		
`p`	`char[]`	bytes		
`P`	`void *`	integer		(5)

File operation

"***open***" method is exploit to operate files:

- `f = open(file='filename.xxx', mode='r')`
  - "open" method open a file and return a stream (a file object)
  - `file` is a path of filename:
    - if the file is in the current working directory, relative path: eg. record.txt, or folder_a/record.txt
    - Otherwise, the full path (absolute path) : eg. (Win)D:\your_dir\record.txt or (Mac)/Users/your_home/record.txt
  - `mode` specifies the mode in which the file is opened.

current working directory: default is the folder that has the current executing .py file. You can also change the CWD.

File open modes

Character	Meaning
‘r’	open for reading (default)
‘w’	open for writing, truncating the file first
‘x’	create a new file and open it for writing
‘a’	open for writing, appending to the end of the file if it exists
‘b’	binary mode, used for media files
't'	text mode (default)
'+'	open a disk file for updating (reading and writing)
'U'	universal newline mode (deprecated)

* We used the red modes normally

Text file write

- The following methods can be used:
  - `f.write(Str)  # Write a str to a file`
  - `f.writelines(StrList)  # Write a list of str to a file`

```
cont = ['Hello, Li Lei.\n', 'Hello, Han Meimei.\n',
        'How are you?\n',
        'Fine, thank you. And you?\n',
        'I am fine too.\n']
f = open('/Users/fei/lesson1.txt', 'w')
# Write all the list once
f.writelines(cont)
# Write line by line
for l in cont:
    f.write(l)

f.close()
```

Text file read

- The following methods can be used:
  - `f.read(n) # read n chars(including \n), n=-1 means read all`
  - `f.readline()  # read one line (including \n)`
  - `f.readlines()  # return a list of all lines`

```
f = open('/Users/fei/lesson1.txt', 'r')
print(f.read())   # Read all contents

f.seek(0)  # Set the file pointer to the beginning
print(f.read(10))  # Read 10 chars

f.close()
```

```
# Use readline
f = open('/Users/fei/lesson1.txt', 'r')

while True:
    line = f.readline()   # Read one line
    if line:  # if the line is not empty, print, otherwise break
        print(line)
    else:
        break

f.close()

# Use readlines
f = open('/Users/fei/lesson1.txt', 'r')

cont = f.readlines()
# Iterate all the lines
for line in cont:
    print(line)

f.close()
```

Text file appending

- Open a file with ‘a’ mode. Then, write something. The new content will append to the end of that file. If there is no that file, it will create a new one. It is very useful to record logs.

```
f = open('/Users/fei/lesson1.txt', 'a')

f.write('Bye.\n')

f.close()
```

Binary file read

- For binary files, still we have those 3 methods to read them:
  - `f.read(n) # read n bytes(including \n), n=-1 means read all`
  - `f.readline()  # read one line (including \n)`
  - `f.readlines()  # return a list of all lines`

```
# Open with text read mode
f = open('/Users/fei/lesson1.txt', 'r')
print(type(f.read()))
f.close()

# Open with binary read mode, what's the difference?
f = open('/Users/fei/lesson1.txt', 'rb')
print(type(f.read()))
f.close()
```

Binary file write

- The following methods can be used:
  - `f.write(bytes)  # Write some bytes to a file`
- Binary file operation is very powerful, but we don’t go deep today.
  - We just open a binary file (jpeg image), read all the data, ant then write the same data to another jpg file.

```
f = open('/Users/fei/a.jpg', 'rb')
# Read all the binary bytes from a.jpg
image_data = f.read()

f.close()

# Write to a new jpg file
f = open('/Users/fei/aa.jpg', 'wb')
f.write(image_data)
f.close()
```

File operation demo

https://box.xjtlu.edu.cn/f/20e8ff4ad71644e1ba29/

Lab practice

- Design a pair of UDP based server and client programs:
  - Client sends a small jpeg image, named xjtlu.jpg to server side;
  - Server receives the image data, and save it as xjtlu1.jpg on server;
  - Server sends back a small jpeg image, named xjtlu1.jpg to client;
  - Client receives the image data, and save it as xjtlu2.jpg on client.
- Design a pair of TCP based server and client program, the requirements are the same as above.
- xjtlu.jpg: https://box.xjtlu.edu.cn/f/2dfde6edfef14cffa5eb/?dl=1
- No special module(lib) is need. (opencv is not needed!)
- Your codes should be executed on different machines (one real PC and one virtual machine, or two virtual machines).
- No submission, no checking!

In class test 1 (5 points)

- A multiplayer “**number guessing**” game using sockets programming.
- Should have one server to manages the game logic .
- Should have some (at least two) players join the game.
- Detailed rules will be released during each lab session.
- The requirements are slightly different for different lab sessions
  - Pls read the requirement carefully.
- You can prepare for the in class test 1.
- You will lose 1 points if you cannot submit during the lab time.
- You will lose 2 points if you cannot submit within 24 hours.

Thanks