Networking with Python

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Socket Programming In Python

- Python translates the UNIX socket interface
  - IPv4: Use a tuple IP-address, port number
- Sockets go through a life cycle:
  - Creation, Connection, Receiving / Sending, Closing
  - Creation, Binding, Listening, Closing

Socket Programming In Python

- Example:
  - A simple writer to another process
  - Data is send as a byte stream
  - Using local-loop to avoid opening the firewall
    - Otherwise: Go to firewall administration and create a new rule to open port 61234 for TCP
    - Afterwards: remove this rule

Socket Programming In Python

- **Server**:
  - Create socket
    - using ipv4 (AF_INET) and TCP

```
import socket

HOST = '127.0.0.1'  #Loopback interface
PORT = 65431  #Silly port

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
```

Socket Programming In Python

- Bind socket to port and listen

```
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.bind((HOST, PORT))
    s.listen()
    conn, addr = s.accept()
```

Socket Programming In Python

- Receive data from client, stop when no data remains

```
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.bind((HOST, PORT))
    s.listen()
    conn, addr = s.accept()
    print('Connection from:', conn)
    while True:
        data = conn.recv(1024)
        if not data:
            break
        #conn.sendall(data)  to return
        print(data.decode('UTF-8'))
```

- Data is send in binary, as UTF-8

Socket Programming In Python

- **Client**:
  - Instead of binding, we directly connect to the socket

```
import socket

HOST = '127.0.0.1'  #Loopback interface
PORT = 65431  #Silly port

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.connect((HOST, PORT))
```

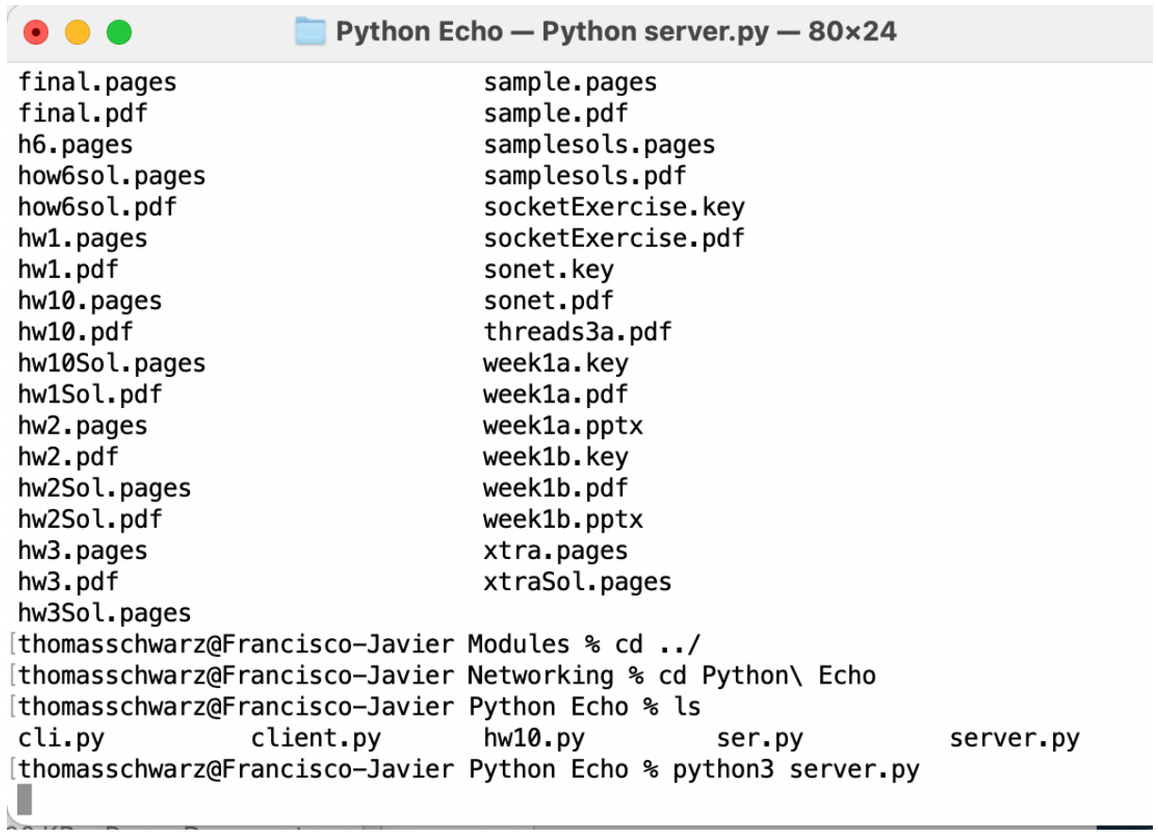
Socket Programming In Python

- **Client**:
  - Now we can write to the server

```
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.connect((HOST, PORT))
    myinput = b'?:'
    while myinput:
        s.send(myinput)
        myinput = bytes(input('?:'), 'utf-8')
    s.close() #not necessary
```

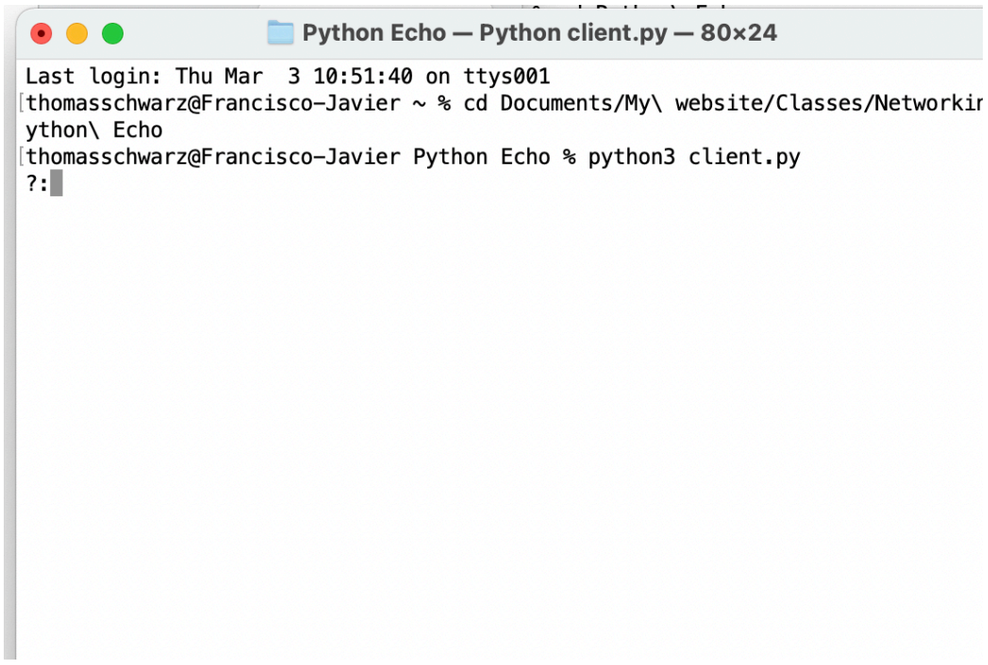
Running in the Command Window

- Open a command window
- Navigate to your server program
- Invoke python3 server.py



Running in the Command Window

- Create another command window / terminal
- Navigate to your client program
- Type: python3 client.py
- Should respond with the prompt



Repetition

- Python allows us quickly create sockets

```
import socket

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
```

TCP Sockets in Python

- Setting up for listening:
  - Bind the socket to a host and port
    - If you do not want to fight firewalls, use the loopback address
    - Parameter is a tuple of Host and Port: Extra pair of ( )
  - Set the socket to listen for incoming packets
  - Accept segments

```
HOST = '127.0.0.1'  #Loopback interface
PORT = 65431  #Silly port
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.bind((HOST, PORT))
    s.listen()
    conn, addr = s.accept()
    print('Connection from:', conn, 'Address', addr)
```

TCP Sockets in Python

- Setting up for sending
  - Use connect and send / sendall

```
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.connect((HOST, PORT))
    myinput = b'?:'
    while myinput:
        s.send(myinput)
        myinput = bytes(input('?:'), 'utf-8')
```

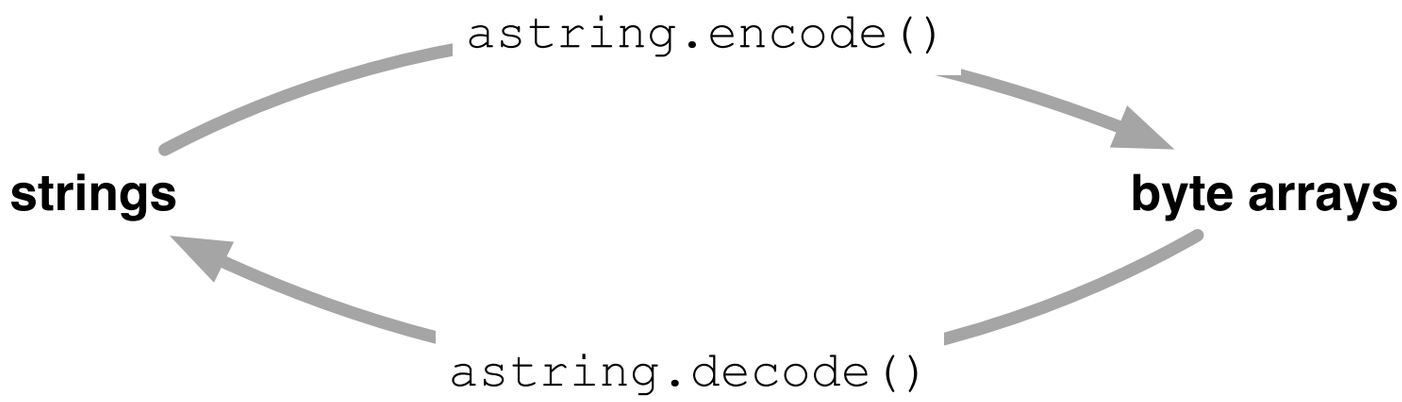
TCP Sockets in Python

- Receiving communication:
  - Use a connection and receive
    - conn.recv blocks unless there is data
    - Parameter is the maximum number of bytes to receive at once

```
conn, addr = s.accept()
while True:
        data = conn.recv(1024)
        if not data:
            break
```

Bytes vs. Strings

- The type of the message is an array of bytes
- To move between bytes and strings use encode and decode



Bytes vs. Strings

- encode and decode have two optional parameters:
  - encoding
    - One of the many character encodings known to Python
    - Default is ‘UTF-8’
  - errors
    - What to do if there is a bad character:
      - ’strict’, ‘ignore’, ‘replace’

Bytes vs. Strings

- Examples:
  - ```
    >>> astring='hello world'
    >>> astring.encode('utf-8')
    b'hello world'
    ```
  - ```
    >>> bytestring = b'hello world'
    >>> bytestring
    b'hello world'
    >>> bytestring.decode('utf-8')
    'hello world'
    ```

String Parsing Primer

- Whether we have a default string or a string of bytes:
  - For parsing:
    - Use split in order to create an array of components in a composite string
  - The default is splitting at white space
  - Example:
    - ```
      >>> bs = b'12 13 14'
      >>> bs.split()
      [b'12', b'13', b'14']
      ```
      ```

String Parsing Primer

- Whether we have a normal string or a string of bytes
  - For conversion:
    - String to Integer: use int( )
    - String to Float: use float( )

```
>>> bytestring = b'3.145 2.76'
>>> for number in bytestring.split():
    print(float(number))


3.145
2.76
```

String Parsing Primer

- To convert a number to a byte string
  - Convert to a string
  - Then convert the string using bytes( )
    - But need to specify encoding
- Example:
  - ```
    >>> bytes(str(3.145), encoding='utf-8')
    b'3.145'
    ```
    ```