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Lab Report

Department of Information and Communication Technology

Report No: 03

Report Name: Python for Networking.

Course Title: Network Planning and designing Lab.

Course Code: ICT-3208

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Objectives : The main objectives of this lab how to Install python and use third- party libraries , Interact with network interfaces using python and getting information from internet using Python.

Third-party libraries: Although the Python's standard library provides a great set of awesome functionalities, there will be times that you will eventually run into the need of making use of third party libraries. Can you imagine building a webserver from scratch? Or making a port to a database driver? Or, maybe, coming up with an image manipulation tool? Third party libraries are welcome in a way that they prevent you from reinventing the something that exit. They save you time to focus on finishing and delivering your application.

Networking Glossary: Before we begin discussing networking with any depth, we must define some common terms that you will see throughout this guide, and in other guides and documentation regarding networking.

Connection: In networking, a connection refers to pieces of related information that are transferred through a network. This generally infers that a connection is built before the data transfer (by following the procedures laid out in a protocol) and then is deconstructed at the end of the data transfer.

Packet: A packet is, generally speaking, the most basic unit that is transfered over a network. When communicating over a network, packets are the envelopes that carry your data (in pieces) from one end point to the other. Packets have a header portion that contains information about the packet including the source and destination, timestamps, network hops, etc. The main portion of a packet contains the actual data being transfered. It is sometimes called the body or the payload.

Network Interface: A network interface can refer to any kind of software interface to networking hardware. For instance, if you have two network cards in your computer, you can control and configure each network interface associated with them individually.A network interface may be associated with a physical device, or it may be a representation of a virtual interface. The "loopback" device, which is a virtual interface to the local machine, is an example of this is used as an interface to connect applications and processes on a single computer to other applications and processes. You can see this referenced as the "lo" interface in many tools. Many times, administrators configure one interface to service traffic to the internet and another interface for a LAN or private network.

Protocols: Networking works by piggybacking a number of different protocols on top of each other. In this way, one piece of data can be transmitted using multiple protocols encapsulated within one another. We will talk about some of the more common protocols that you may come across and attempt to explain the difference, as well as give context as to what part of the process they are involved with. We will start with protocols implemented on the lower networking layers and work our way up to protocols with higher abstraction.

Methodology :

Installing Python Third-party includes:

Python Third-party includes a setup.py file, it is usually distributed as a tarball (.tar.gz or .tar.bz2 file). The instructions for installing these generally look like:

Download the file from

website. Extract the tarball.

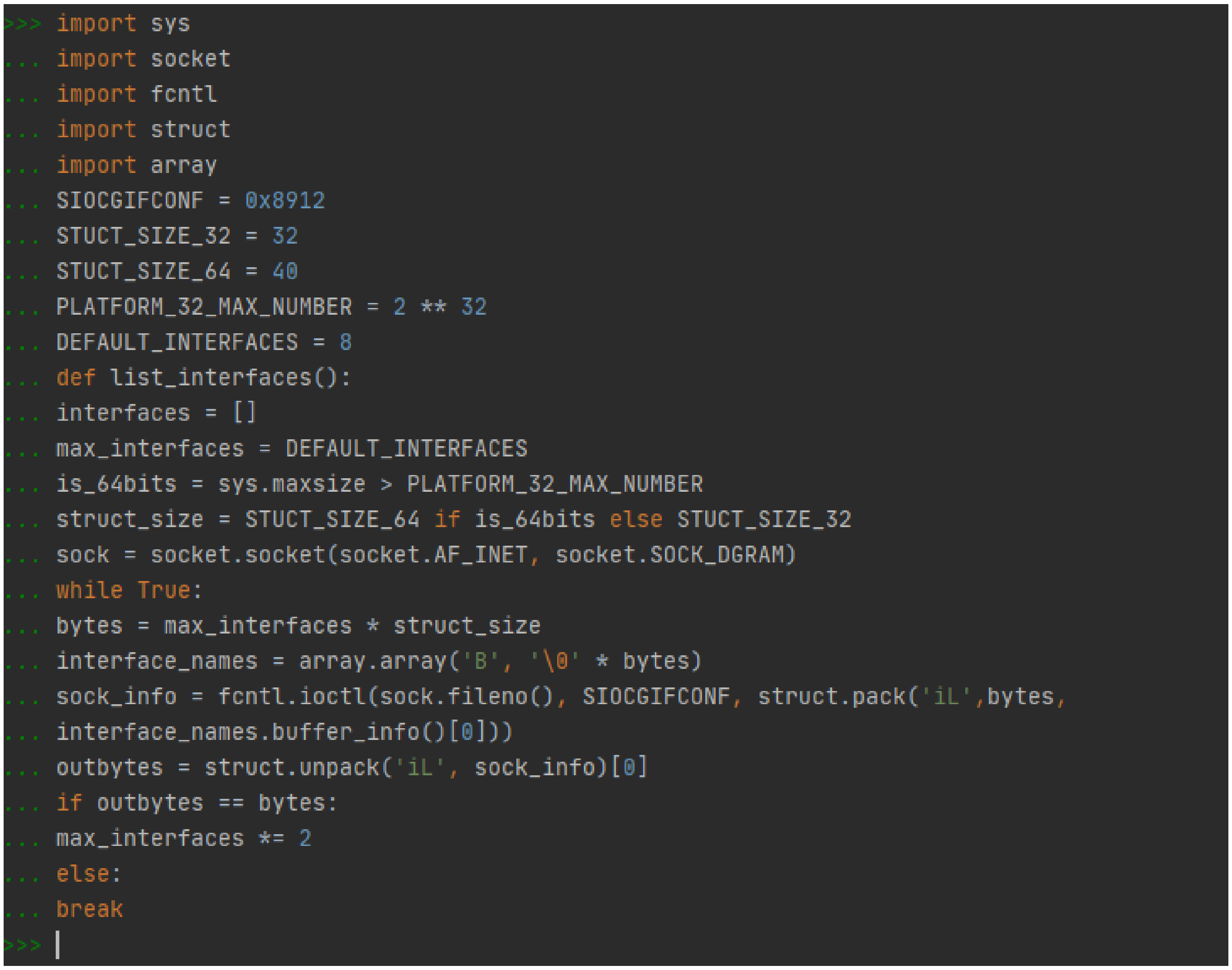
Change into the new directory that has been newly

extracted. Run sudo python setup.py build

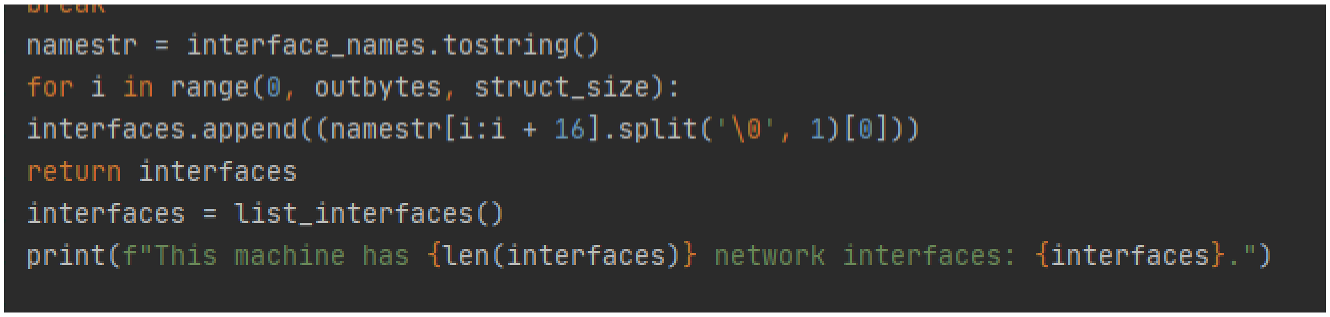
Run sudo python setup.py install.

Exercise 4.1: Enumerating interfaces on your machine

Code :



```
>>> import sys
... import socket
... import fcntl
... import struct
... import array
... SIOCGIFCONF = 0x8912
... STUCT_SIZE_32 = 32
... STUCT_SIZE_64 = 40
... PLATFORM_32_MAX_NUMBER = 2 ** 32
... DEFAULT_INTERFACES = 8
... def list_interfaces():
... interfaces = []
... max_interfaces = DEFAULT_INTERFACES
... is_64bits = sys.maxsize > PLATFORM_32_MAX_NUMBER
... struct_size = STUCT_SIZE_64 if is_64bits else STUCT_SIZE_32
... sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
... while True:
... bytes = max_interfaces * struct_size
... interface_names = array.array('B', '\0' * bytes)
... sock_info = fcntl.ioctl(sock.fileno(), SIOCGIFCONF, struct.pack('iL',bytes,
... interface_names.buffer_info()[0]))
... outbytes = struct.unpack('iL', sock_info)[0]
... if outbytes == bytes:
... max_interfaces *= 2
... else:
... break
>>> 
```

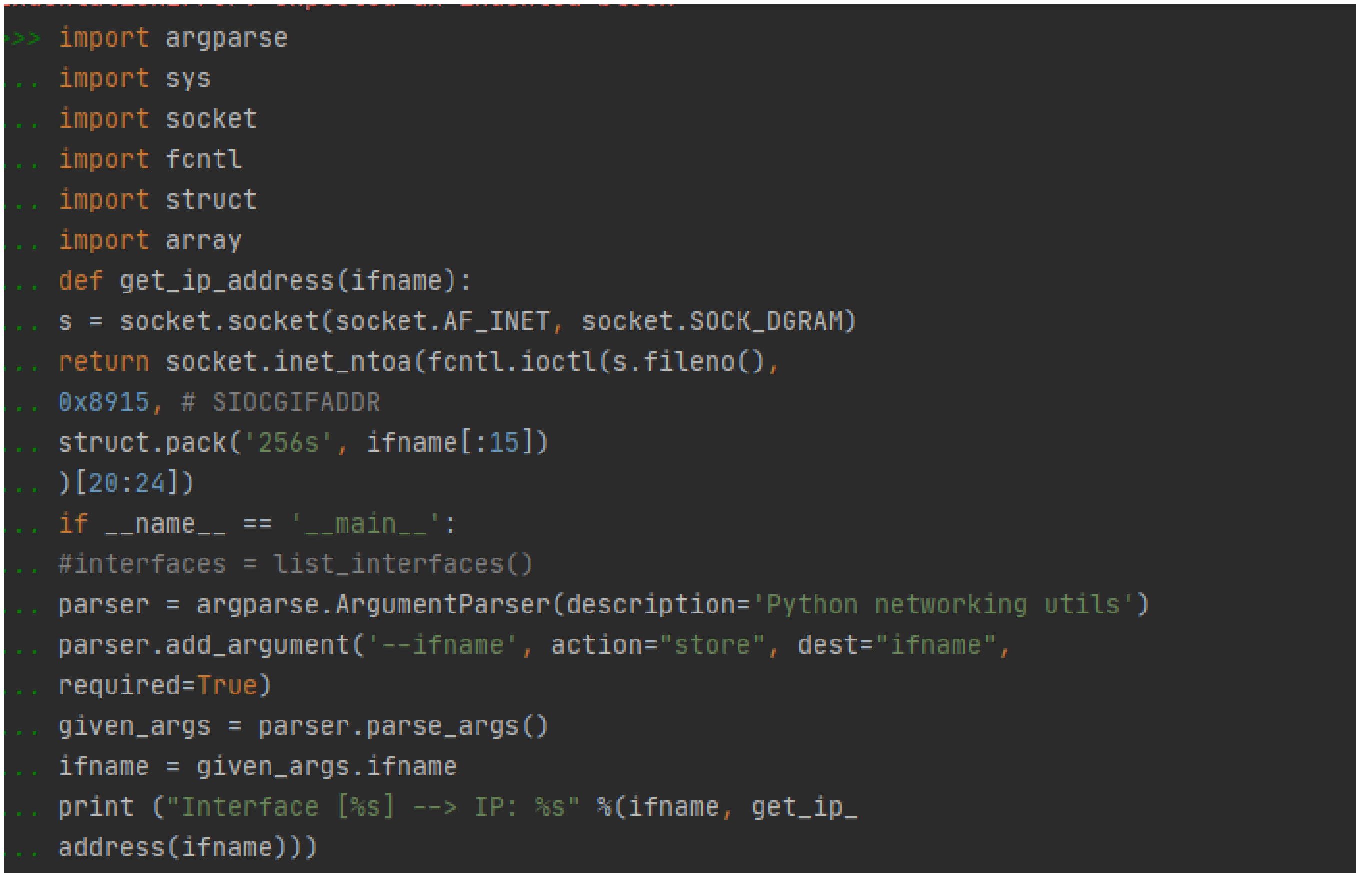


```
namestr = interface_names.tostring()
for i in range(0, outbytes, struct_size):
interfaces.append((namestr[i:i + 16].split('\0', 1)[0]))
return interfaces
interfaces = list_interfaces()
print(f"This machine has {len(interfaces)} network interfaces: {interfaces}.")
```

Output:

```
This machine has 2 network interfaces: ['lo', 'eth0'].
```

Exercise 4.2: Finding the IP address for a specific interface on your machine

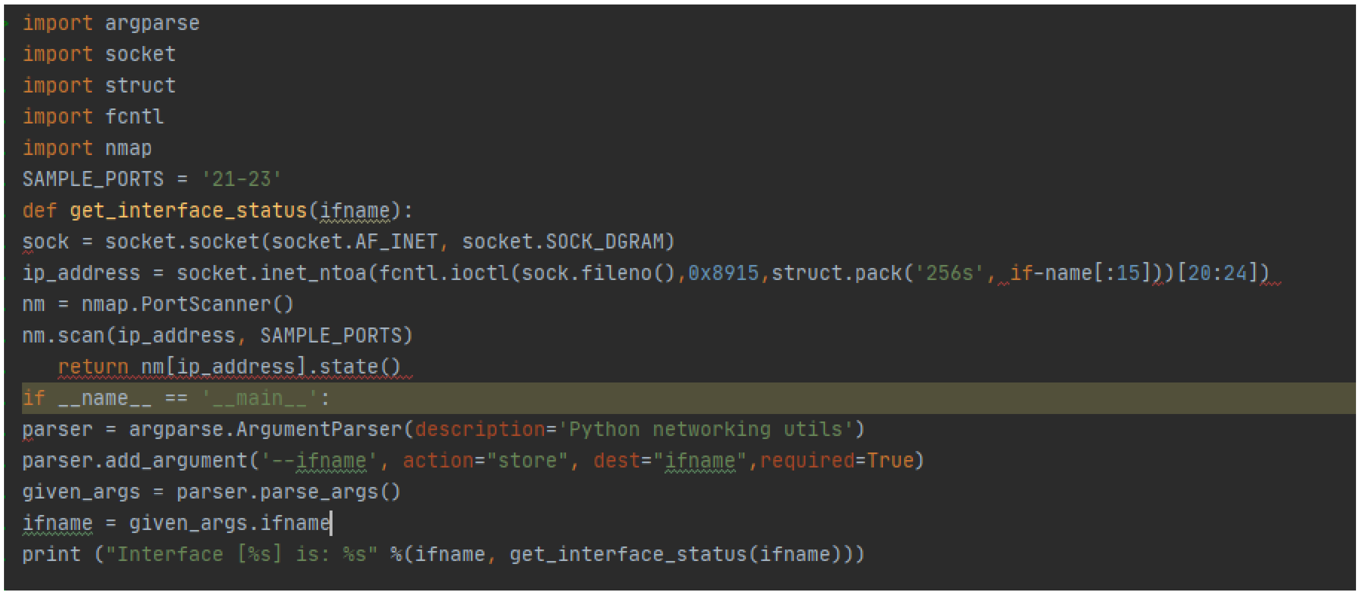


```
>> import argparse
.. import sys
.. import socket
.. import fcntl
.. import struct
.. import array
.. def get_ip_address(ifname):
.. s = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
.. return socket.inet_ntoa(fcntl.ioctl(s.fileno(),
.. 0x8915, # SIOCGIFADDR
.. struct.pack('256s', ifname[:15])
.. )[20:24])
.. if __name__ == '__main__':
.. #interfaces = list_interfaces()
.. parser = argparse.ArgumentParser(description='Python networking utils')
.. parser.add_argument('--ifname', action="store", dest="ifname",
.. required=True)
.. given_args = parser.parse_args()
.. ifname = given_args.ifname
.. print ("Interface [%s] --> IP: %s" %(ifname, get_ip_
.. address(ifname)))
```

Output:

Interface [eth0] --> IP: 10.0.2.15

Exercise 4.3: Finding whether an interface is up on your machine

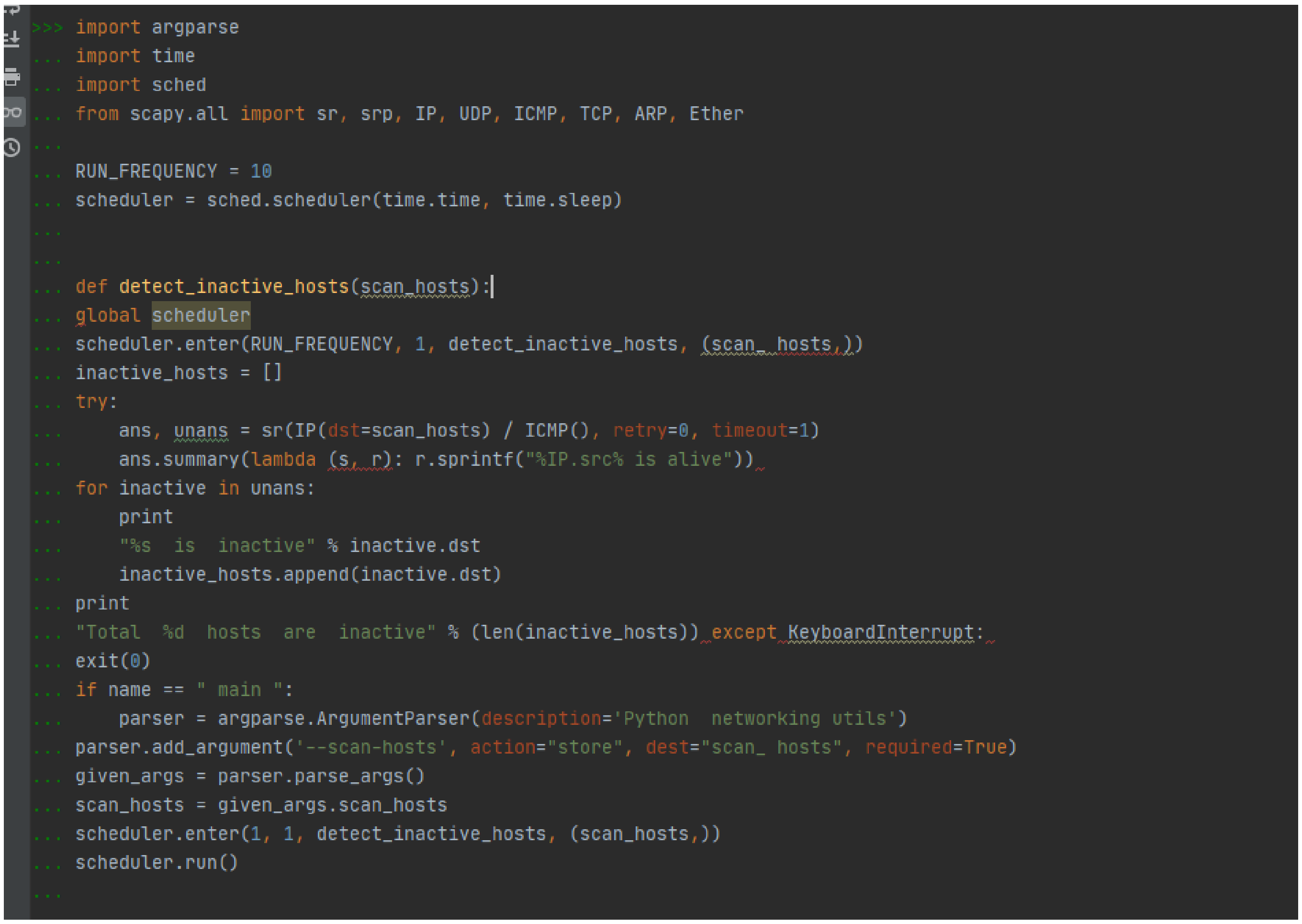


```
import argparse
import socket
import struct
import fcntl
import nmap
SAMPLE_PORTS = '21-23'
def get_interface_status(ifname):
sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
ip_address = socket.inet_ntoa(fcntl.ioctl(sock.fileno(),0x8915,struct.pack('256s', if-name[:15]))[20:24])
nm = nmap.PortScanner()
nm.scan(ip_address, SAMPLE_PORTS)
   return nm[ip_address].state()
if __name__ == '__main__':
parser = argparse.ArgumentParser(description='Python networking utils')
parser.add_argument('--ifname', action="store", dest="ifname",required=True)
given_args = parser.parse_args()
ifname = given_args.ifname
print ("Interface [%s] is: %s" %(ifname, get_interface_status(ifname)))
```

Output:

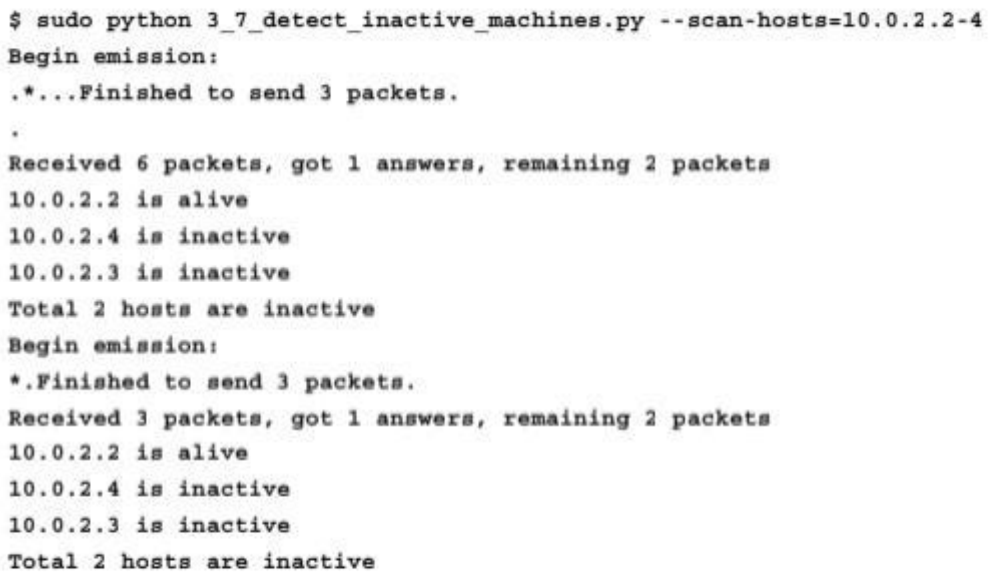
Interface [eth0] is: up

Exercise 4.4: Detecting inactive machines on your network Code:



```
>>> import argparse
... import time
... import sched
... from scapy.all import sr, srp, IP, UDP, ICMP, TCP, ARP, Ether
...
... RUN_FREQUENCY = 10
... scheduler = sched.scheduler(time.time, time.sleep)
...
...
... def detect_inactive_hosts(scan_hosts):
... global scheduler
... scheduler.enter(RUN_FREQUENCY, 1, detect_inactive_hosts, (scan_ hosts,))
... inactive_hosts = []
... try:
...     ans, unans = sr(IP(dst=scan_hosts) / ICMP(), retry=0, timeout=1)
...     ans.summary(lambda (s, r): r.sprintf("%IP.src% is alive"))
... for inactive in unans:
...     print
...     "%s  is  inactive" % inactive.dst
...     inactive_hosts.append(inactive.dst)
... print
... "Total  %d  hosts  are  inactive" % (len(inactive_hosts)) except KeyboardInterrupt:
... exit(0)
... if name == " main ":
...     parser = argparse.ArgumentParser(description='Python  networking utils')
... parser.add_argument('--scan-hosts', action="store", dest="scan_ hosts", required=True)
... given_args = parser.parse_args()
... scan_hosts = given_args.scan_hosts
... scheduler.enter(1, 1, detect_inactive_hosts, (scan_hosts,))
... scheduler.run()
...
```

Output :

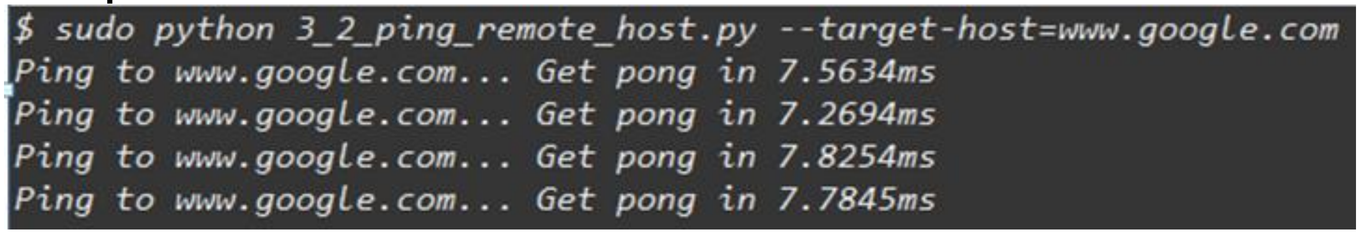


```
$ sudo python 3_7_detect_inactive_machines.py --scan-hosts=10.0.2.2-4
Begin emission:
.*...Finished to send 3 packets.
.
Received 6 packets, got 1 answers, remaining 2 packets
10.0.2.2 is alive
10.0.2.4 is inactive
10.0.2.3 is inactive
Total 2 hosts are inactive
Begin emission:
*.Finished to send 3 packets.
Received 3 packets, got 1 answers, remaining 2 packets
10.0.2.2 is alive
10.0.2.4 is inactive
10.0.2.3 is inactive
Total 2 hosts are inactive
```

Exercise 4.5: Pinging hosts on the network with ICMP Code :

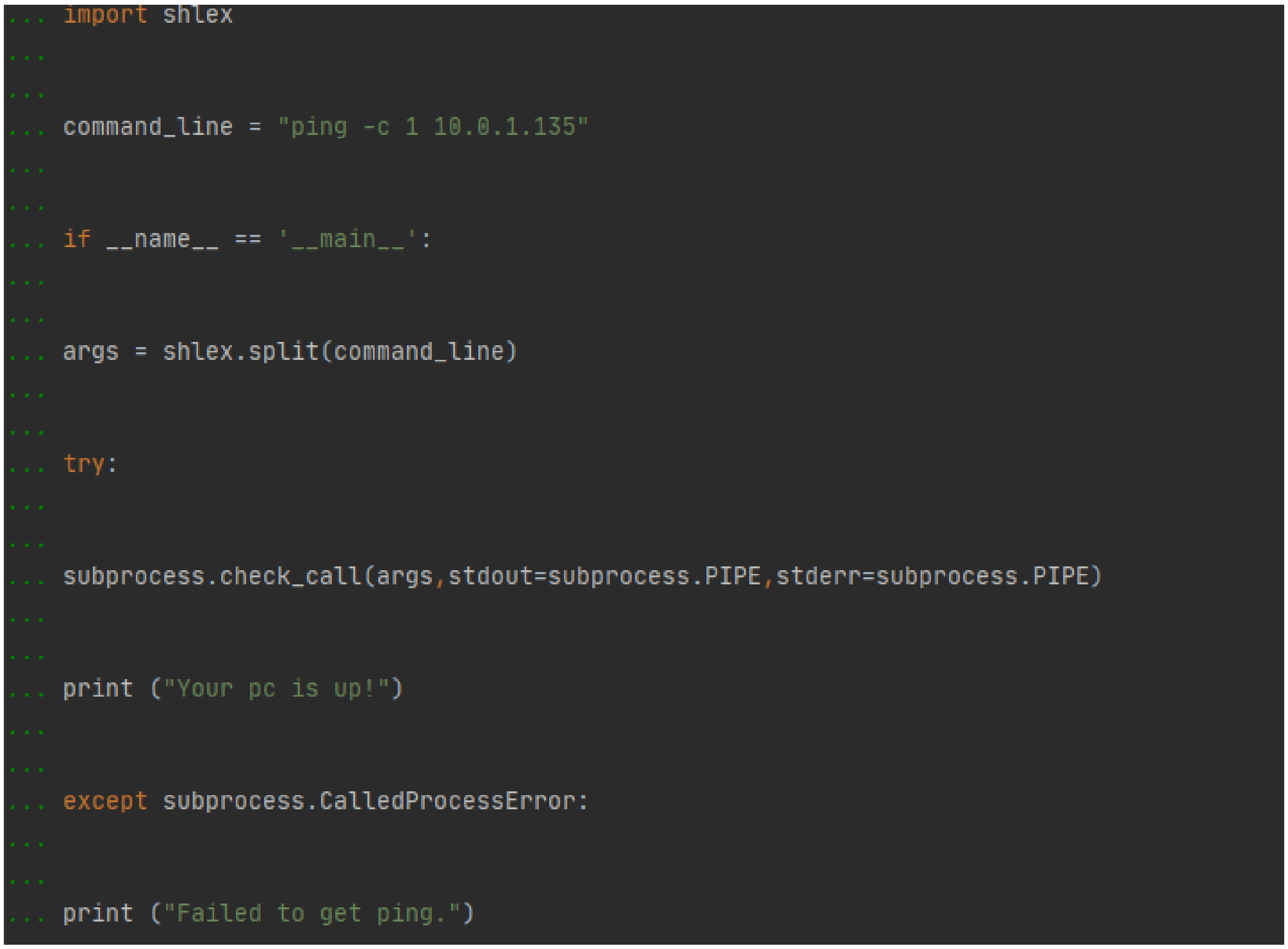
```
import os
import argparse
import socket
import struct
import select
import time
ICMP_ECHO_REQUEST = 8
DEFAULT_TIMEOUT = 2
DEFAULT_COUNT = 4
class Pinger(object):
    def __init__(self, target_host, count=DEFAULT_COUNT,timeout=DEFAULT_TIMEOUT):
        self.target_host = target_host
        self.count = count
        self.timeout = timeout
    def do_checksum(self, source_string):
        sum = 0
        max_count = (len(source_string)/2)*2
        count = 0
        while count < max_count:
            val = ord(source_string[count + 1])*256
            +ord(source_string[count]) sum = sum + val
            sum = sum & 0xffffffff
            count = count + 2
        if max_count<len(source_string):
            sum = sum + ord(source_string[len(source_string) - 1])
            sum = sum & 0xffffffff
        sum = (sum >> 16) + (sum & 0xffff)
        sum = sum + (sum >> 16)
        answer = ~sum
        answer = answer & 0xffff
        answer = answer >> 8 | (answer << 8 & 0xff00)
        return answer
    def receive_pong(self, sock, ID, timeout):
        time_remaining = timeout
        while True:
            start_time = time.time()
            readable = select.select([sock], [], [], time_remaining)
            time_spent = (time.time() - start_time)
            if readable[0] == []:
                return
            time_received = time.time()
            recv_packet, addr = sock.recvfrom(1024)
            icmp_header = recv_packet[20:28]
            type, code, checksum, packet_ID, sequence = struct.un-
pack("bbHHh", icmp_header)
            if packet_ID == ID:
                bytes_In_double = struct.calcsize("d")
                time_sent = struct.unpack("d", recv_packet[28:28 +bytes_In_dou-
ble])[0]
                return time_received - time_sent
            time_remaining = time_remaining - time_spent
            if time_remaining <= 0:
                return
    def send_ping(self, sock, ID):
        target_addr = socket.gethostbyname(self.target_host)
        my_checksum = 0
        header = struct.pack("bbHHh", ICMP_ECHO_REQUEST, 0, my_checksum,ID, 1)
        bytes_In_double = struct.calcsize("d")
        data = (192 - bytes_In_double) * "Q"
        data = struct.pack("d", time.time()) + data
        my_checksum = self.do_checksum(header + data)
        header = struct.pack("bbHHh", ICMP_ECHO_RE-
QUEST, 0, socket.htons(my_checksum), ID, 1)
        packet = header + data
        sock.sendto(packet, (target_addr, 1))
    def ping_once(self):
        icmp = socket.getprotobyname("icmp")
        try:
            sock = socket.socket(socket.AF_INET, socket.SOCK_RAW, icmp)
        except socket.error, (errno, msg):
            if errno == 1:
                msg += "ICMP messages can only be sent from root user processes"
                raise socket.error(msg)
        except Exception, e:
            print "Exception: %s" %(e)
        my_ID = os.getpid() & 0xFFFF
        self.send_ping(sock, my_ID)
        delay = self.receive_pong(sock, my_ID, self.timeout)
        sock.close()
        return delay
    def ping(self):
        for i in xrange(self.count):
            print "Ping to %s..." % self.target_host, try:
                delay = self.ping_once()
            except socket.gaierror, e:
                print "Ping failed. (socket error: '%s')" % e[1] break
            if delay == None:
                print "Ping failed. (timeout within %ssec.)" % self.timeout else:
                delay = delay * 1000
                print "Get pong in %0.4fms" % delay if
__name__ == '__main__':
    parser = argparse.ArgumentParser(description='Python ping')
    parser.add_argument('--target-host', action="store",dest="target_host", re-
quired=True)
    given_args = parser.parse_args()
    target_host = given_args.target_host
    pinger = Pinger(target_host=target_host)
    pinger.ping()
```

Output:



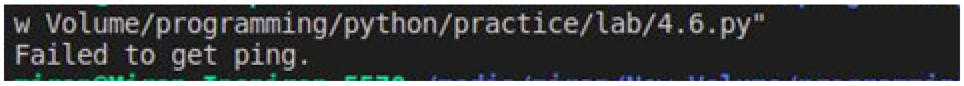
```
$ sudo python 3_2_ping_remote_host.py --target-host=www.google.com
Ping to www.google.com... Get pong in 7.5634ms
Ping to www.google.com... Get pong in 7.2694ms
Ping to www.google.com... Get pong in 7.8254ms
Ping to www.google.com... Get pong in 7.7845ms
```

Exercise 4.6: Pinging hosts on the network with ICMP using pc resources



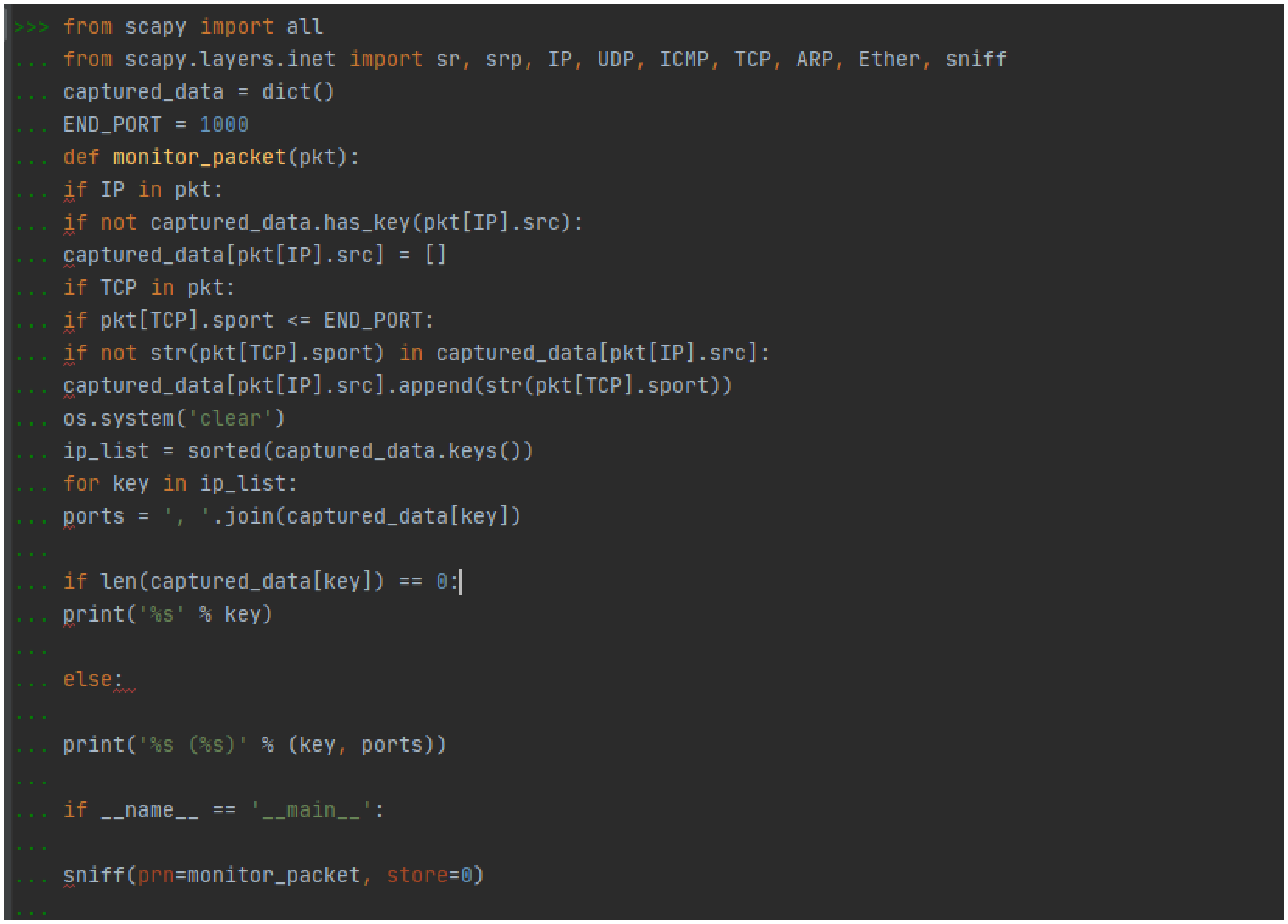
```
... import shlex
...
...
... command_line = "ping -c 1 10.0.1.135"
...
...
... if __name__ == '__main__':
...
...
... args = shlex.split(command_line)
...
...
... try:
...
...
... subprocess.check_call(args,stdout=subprocess.PIPE,stderr=subprocess.PIPE)
...
...
... print ("Your pc is up!")
...
...
... except subprocess.CalledProcessError:
...
...
... print ("Failed to get ping.")
```

Output:



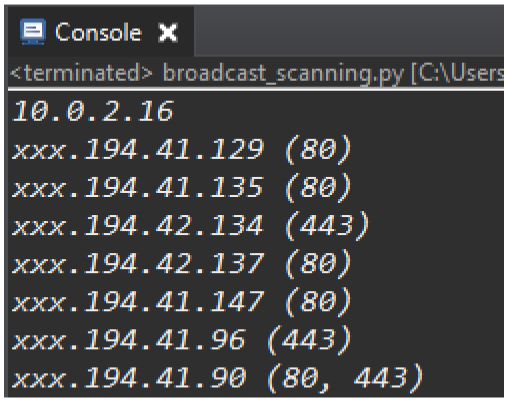
```
w Volume/programming/python/practice/lab/4.6.py"
Failed to get ping.
```

Exercise 4.7: Scanning the broadcast of packets code :



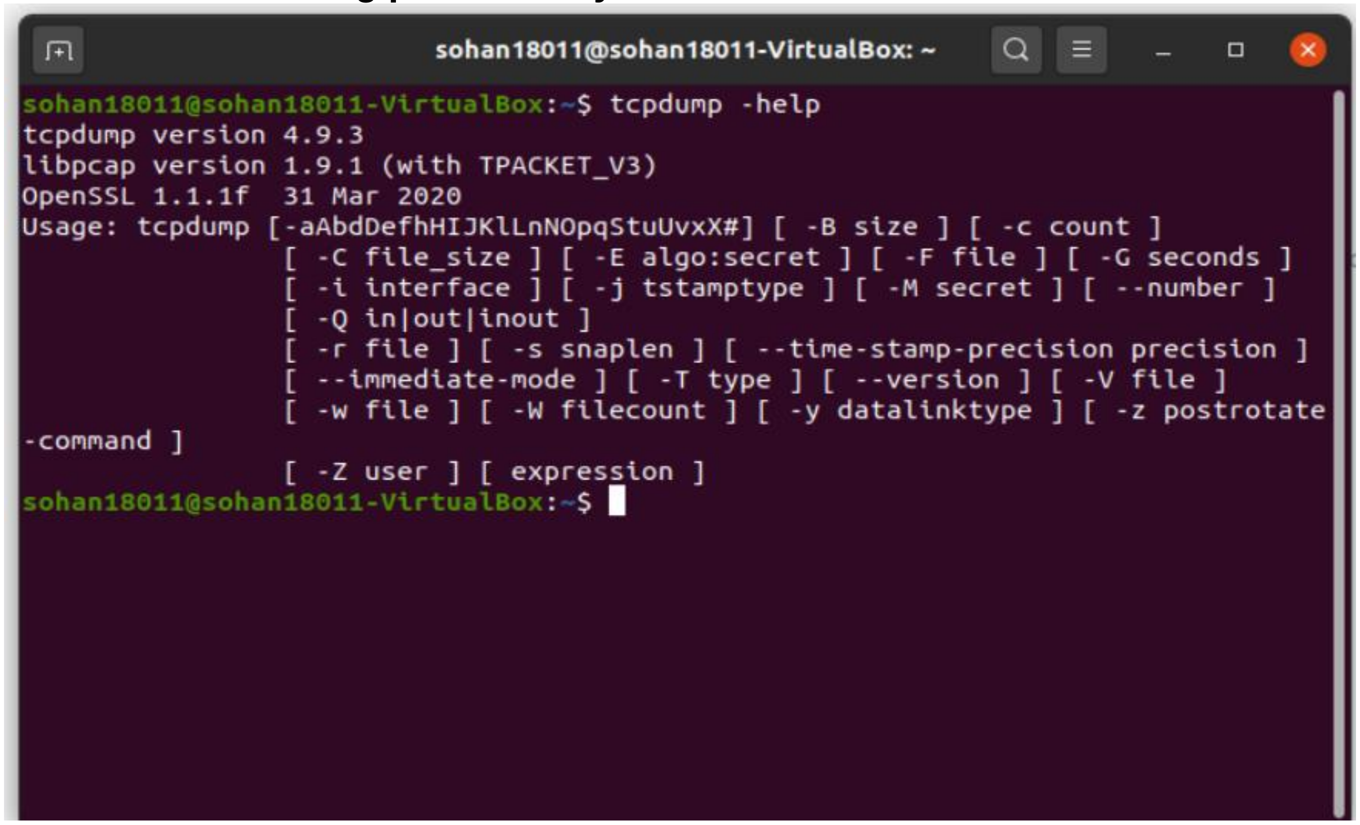
```
>>> from scapy import all
... from scapy.layers.inet import sr, srp, IP, UDP, ICMP, TCP, ARP, Ether, sniff
... captured_data = dict()
... END_PORT = 1000
... def monitor_packet(pkt):
... if IP in pkt:
... if not captured_data.has_key(pkt[IP].src):
... captured_data[pkt[IP].src] = []
... if TCP in pkt:
... if pkt[TCP].sport <= END_PORT:
... if not str(pkt[TCP].sport) in captured_data[pkt[IP].src]:
... captured_data[pkt[IP].src].append(str(pkt[TCP].sport))
... os.system('clear')
... ip_list = sorted(captured_data.keys())
... for key in ip_list:
... ports = ', '.join(captured_data[key])
...
... if len(captured_data[key]) == 0:
... print('%s' % key)
...
... else:
...
... print('%s (%s)' % (key, ports))
...
... if __name__ == '__main__':
...
... sniff(prn=monitor_packet, store=0)
...
```

Output:



```
<terminated> broadcast_scanning.py [C:\Users
10.0.2.16
xxx.194.41.129 (80)
xxx.194.41.135 (80)
xxx.194.42.134 (443)
xxx.194.42.137 (80)
xxx.194.41.147 (80)
xxx.194.41.96 (443)
xxx.194.41.90 (80, 443)
```

Exercise 4.8: Sniffing packets on your network



sohan18011@sohan18011-VirtualBox: ~

```
sohan18011@sohan18011-VirtualBox:~$ tcpdump -help
tcpdump version 4.9.3
libpcap version 1.9.1 (with TPACKET_V3)
OpenSSL 1.1.1f  31 Mar 2020
Usage: tcpdump [-aAbdDefhHIJKlLnNOpqStuUvxX#] [ -B size ] [ -c count ]
                [ -C file_size ] [ -E algo:secret ] [ -F file ] [ -G seconds ]
                [ -i interface ] [ -j tstamptype ] [ -M secret ] [ --number ]
                [ -Q in|out|inout ]
                [ -r file ] [ -s snaplen ] [ --time-stamp-precision precision ]
                [ --immediate-mode ] [ -T type ] [ --version ] [ -V file ]
                [ -w file ] [ -W filecount ] [ -y datalinktype ] [ -z postrotate
-command ]
                [ -Z user ] [ expression ]
sohan18011@sohan18011-VirtualBox:~$ 
```

Conclusion:

There are two levels of network service access in Python. These are:

- Low-Level Access
- High-Level Access

In the first case, programmers can use and access the basic socket support for the operating system using Python's libraries, and programmers can implement both connection-less and connection-oriented protocols for programming.

Application-level network protocols can also be accessed using high-level access provided by Python libraries. These protocols are HTTP, FTP, etc. A socket is the end-point in a flow of communication between two programs or communication channels operating over a network. They are created using a set of programming requests called socket API (Application Programming Interface). Python's socket library offers classes for handling common transports as a generic interface.

Sockets use protocols for determining the connection type for port-to-port communication between client and server machines. The protocols are used for:

- Domain Name Servers (DNS)
- IP addressing
- E-mail
- FTP (File Transfer Protocol) etc...

Python has a socket method that let programmers' set-up different types of socket virtually. After you defined the socket, you can use several methods to manage the connections. Some of the important server socket methods are:

- **listen():** is used to establish and start TCP listener.
- **bind():** is used to bind-address (host-name, port number) to the socket.
- **accept():** is used to TCP client connection until the connection arrives.
- **connect():** is used to initiate TCP server connection.
- **send():** is used to send TCP messages.
- **recv():** is used to receive TCP messages.
- **sendto():** is used to send UDP messages
- **close():** is used to close a socket.

Sending messages back and forth using different basic protocols is simple and straightforward. It shows that programming takes a significant role n client-server architecture where the client makes data request to a server, and the server replies to those machines.