Code :-

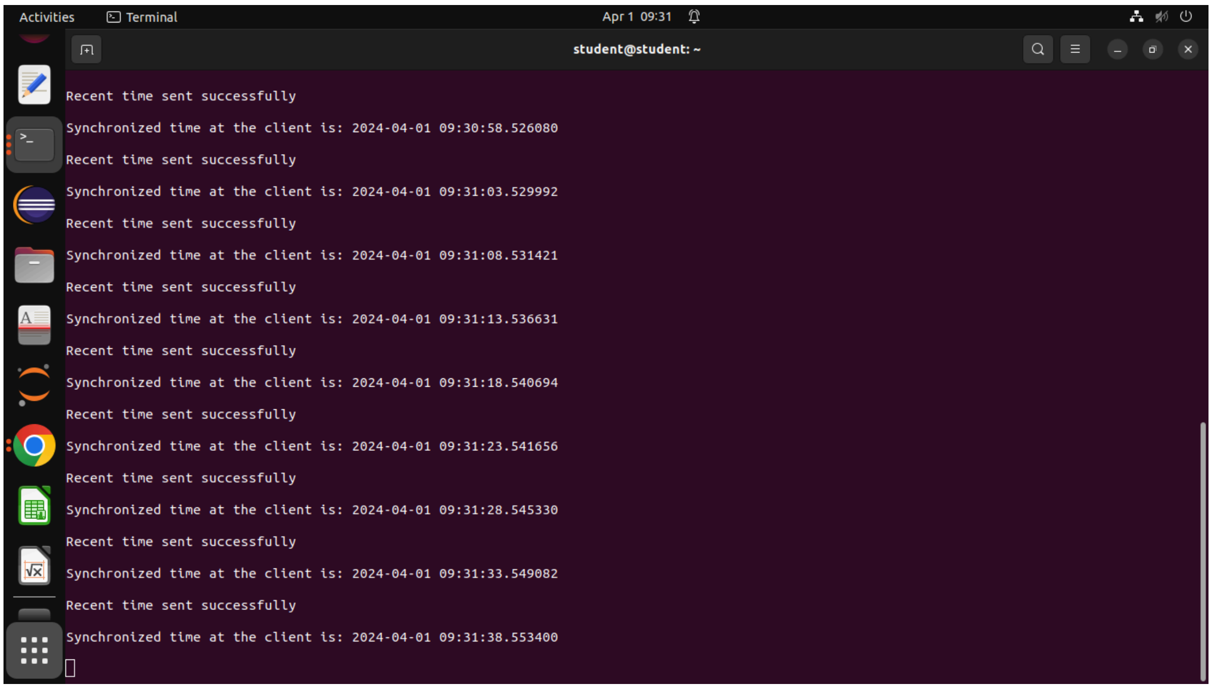
Berkely_server.py

```
# Python3 program imitating a clock server

from functools import reduce
from dateutil import parser
import threading
import datetime
import socket
import time


# datastructure used to store client address and clock data
client_data = {}


''' nested thread function used to receive
        clock time from a connected client '''

def startReceivingClockTime(connector, address):

        while True:
                # receive clock time
                clock_time_string = connector.recv(1024).decode()
                clock_time = parser.parse(clock_time_string)
                clock_time_diff = datetime.datetime.now() - \

clock_time

                client_data[address] = {
                                        "clock_time"     : clock_time,
                                        "time_difference" : clock_time_diff,
                                        "connector"      : connector
                                        }

                print("Client Data updated with: "+ str(address),
                                                                                                end =
"\n\n")
                time.sleep(5)



''' master thread function used to open portal for
        accepting clients over given port '''

def startConnecting(master_server):
        # fetch clock time at slaves / clients
        while True:
                # accepting a client / slave clock client
                master_slave_connector, addr = master_server.accept()
                slave_address = str(addr[0]) + ":" + str(addr[1])

                print(slave_address + " got connected successfully")

                current_thread = threading.Thread(
                                                target = startReceivingClockTime,
                                                args = (master_slave_connector,
                                                                slave_address, ))
                current_thread.start()



# subroutine function used to fetch average clock difference

def getAverageClockDiff():

        current_client_data = client_data.copy()

        time_difference_list = list(client['time_difference']
                                                        for client_addr, client
                                                                in client_data.items())


        sum_of_clock_difference = sum(time_difference_list, \
                                                        datetime.timedelta(0, 0))

        average_clock_difference = sum_of_clock_difference \
                                                                / len(client_data)

        return average_clock_difference


''' master sync thread function used to generate
        cycles of clock synchronization in the network '''

def synchronizeAllClocks():

        while True:

                print("New synchronization cycle started.")
                print("Number of clients to be synchronized: " + \
                                                                str(len(client_data)))
        if len(client_data) > 0:

            average_clock_difference = getAverageClockDiff()

            for client_addr, client in client_data.items():
                try:
                    synchronized_time = \
                        datetime.datetime.now() + \
                                    average_clock_difference

                    client['connector'].send(str(
                            synchronized_time).encode())

                except Exception as e:
                    print("Something went wrong while " + \
                        "sending synchronized time " + \
                        "through " + str(client_addr))

        else :
            print("No client data." + \
                        " Synchronization not applicable.")

        print("\n\n")

        time.sleep(5)


# function used to initiate the Clock Server / Master Node

def initiateClockServer(port = 8080):

    master_server = socket.socket()
    master_server.setsockopt(socket.SOL_SOCKET,
                                socket.SO_REUSEADDR, 1)

    print("Socket at master node created successfully\n")

    master_server.bind(('', port))

    # Start listening to requests
    master_server.listen(10)
    print("Clock server started...\n")

    # start making connections
    print("Starting to make connections...\n")
    master_thread = threading.Thread(
                        target = startConnecting,
                        args = (master_server, ))
    master_thread.start()

    # start synchronization
    print("Starting synchronization parallelly...\n")
    sync_thread = threading.Thread(
                        target = synchronizeAllClocks,
                        args = ())
    sync_thread.start()



# Driver function
if __name__ == '__main__':

    # Trigger the Clock Server
    initiateClockServer(port = 8080)
```

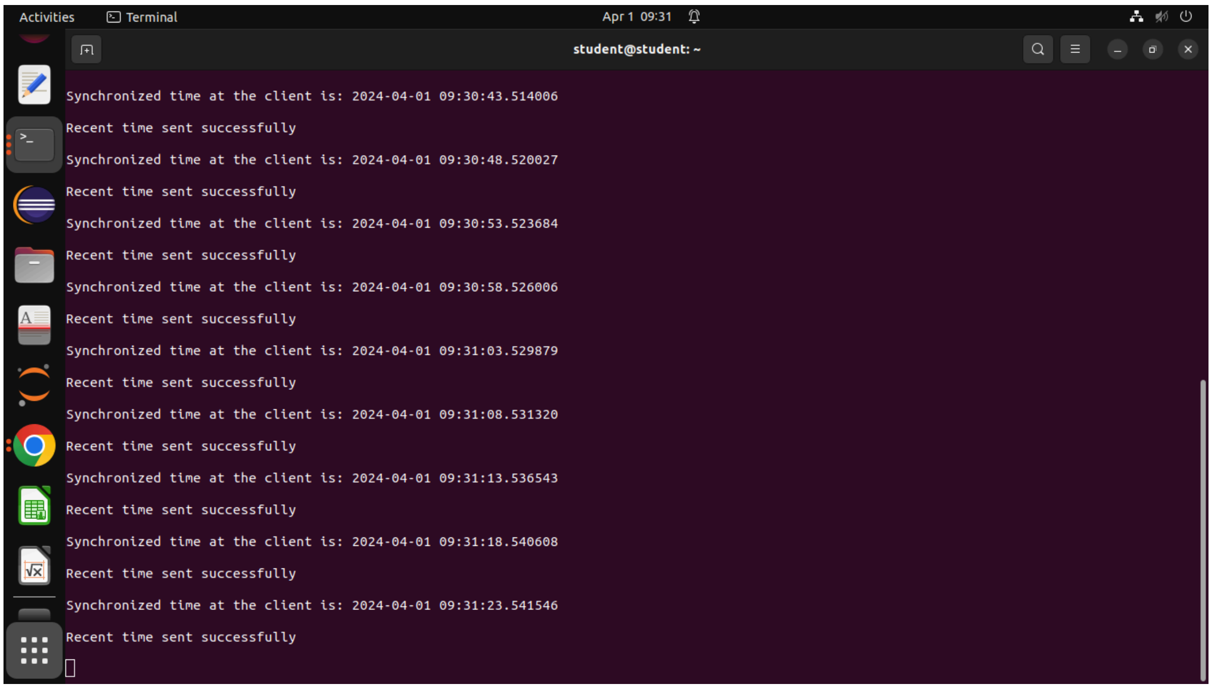
Berkely_client.py

```
# Python3 program imitating a client process

from timeit import default_timer as timer
from dateutil import parser
import threading
import datetime
import socket
import time


# client thread function used to send time at client side
def startSendingTime(slave_client):

    while True:
        # provide server with clock time at the client
        slave_client.send(str(
                    datetime.datetime.now()).encode())

        print("Recent time sent successfully",
                                        end = "\n\n")
        time.sleep(5)


# client thread function used to receive synchronized time
def startReceivingTime(slave_client):

    while True:
```

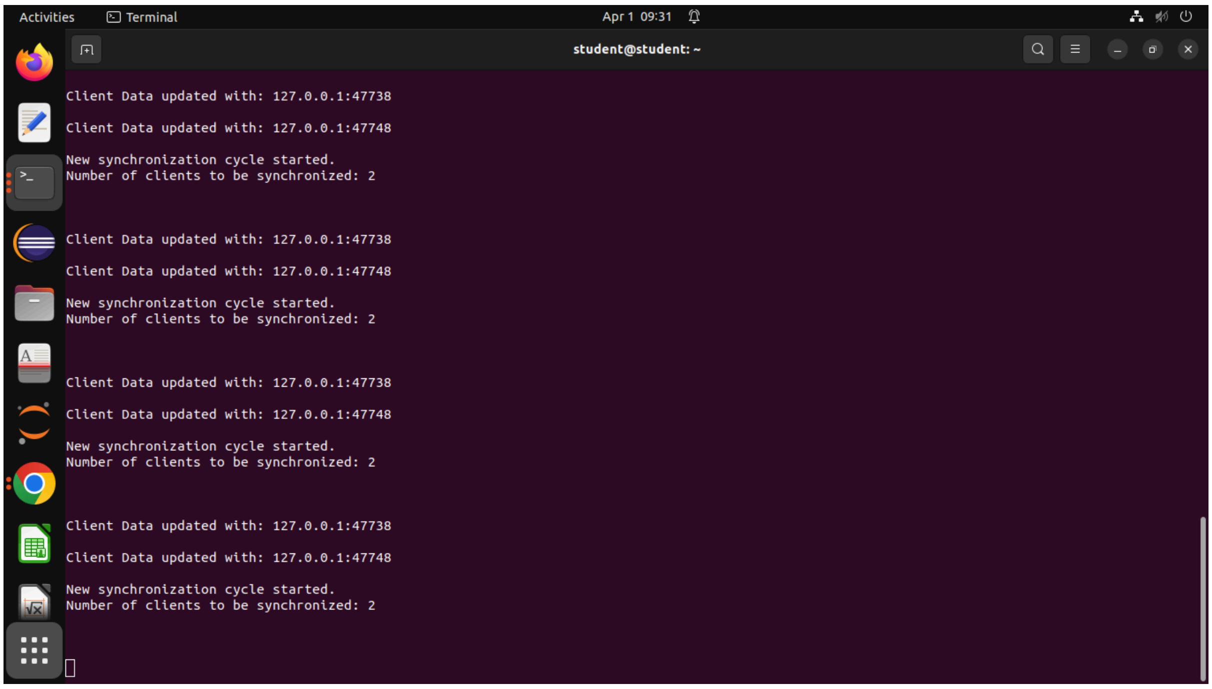
```
                # receive data from the server
                Synchronized_time = parser.parse(
                                                slave_client.recv(1024).decode())

                print("Synchronized time at the client is: " + \
                                                                    str(Synchronized_time),
                                                                    end = "\n\n")


# function used to Synchronize client process time
def initiateSlaveClient(port = 8080):

        slave_client = socket.socket()

        # connect to the clock server on local computer
        slave_client.connect(('127.0.0.1', port))

        # start sending time to server
        print("Starting to receive time from server\n")
        send_time_thread = threading.Thread(
                                        target = startSendingTime,
                                        args = (slave_client, ))
        send_time_thread.start()


        # start receiving synchronized from server
        print("Starting to receiving " + \
                                                "synchronized time from server\n")
        receive_time_thread = threading.Thread(
                                        target = startReceivingTime,
                                        args = (slave_client, ))
        receive_time_thread.start()


# Driver function
if __name__ == '__main__':

        # initialize the Slave / Client
        initiateSlaveClient(port = 8080)
```



```
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:30:58.526080
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:03.529992
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:08.531421
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:13.536631
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:18.540694
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:23.541656
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:28.545330
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:33.549082
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:38.553400
```



```
Synchronized time at the client is: 2024-04-01 09:30:43.514006
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:30:48.520027
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:30:53.523684
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:30:58.526006
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:03.529879
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:08.531320
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:13.536543
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:18.540608
Recent time sent successfully
Synchronized time at the client is: 2024-04-01 09:31:23.541546
Recent time sent successfully
```



```
Client Data updated with: 127.0.0.1:47738

Client Data updated with: 127.0.0.1:47748

New synchronization cycle started.
Number of clients to be synchronized: 2


Client Data updated with: 127.0.0.1:47738

Client Data updated with: 127.0.0.1:47748

New synchronization cycle started.
Number of clients to be synchronized: 2


Client Data updated with: 127.0.0.1:47738

Client Data updated with: 127.0.0.1:47748

New synchronization cycle started.
Number of clients to be synchronized: 2


Client Data updated with: 127.0.0.1:47738

Client Data updated with: 127.0.0.1:47748

New synchronization cycle started.
Number of clients to be synchronized: 2
```