

Assignment 1

Input-

Factorial.java

```
import java.math.BigInteger;
import java.rmi.Remote;
import java.rmi.RemoteException;

public interface Factorial extends Remote {
    BigInteger fact(int num) throws RemoteException;
}
```

FactorialImpl.java

```
import java.math.BigInteger;
import java.rmi.server.UnicastRemoteObject;
import java.rmi.RemoteException;

public class FactorialImpl extends UnicastRemoteObject implements Factorial {

    public FactorialImpl() throws RemoteException {
        super();
    }

    public BigInteger fact(int num) throws RemoteException {
        BigInteger factorial = BigInteger.ONE;
        for (int i = 1; i <= num; i++) {
            factorial = factorial.multiply(BigInteger.valueOf(i));
        }
        return factorial;
    }
}
```

FactorialClient.java

```
import java.rmi.Naming;
import java.rmi.RemoteException;
import java.rmi.NotBoundException;
import java.net.MalformedURLException;

public class FactorialClient {

    public static void main(String[] args) {
        try {
            Factorial f = (Factorial)
Naming.lookup("rmi://localhost/FactorialService");
            int num = 30; // You can take input from args if needed
            System.out.println("Factorial of " + num + " is: " + f.fact(num));
        } catch (MalformedURLException e) {
            System.out.println("MalformedURLException: " + e);
        } catch (RemoteException e) {
            System.out.println("RemoteException: " + e);
        } catch (NotBoundException e) {
            System.out.println("NotBoundException: " + e);
        } catch (ArithmeticException e) {
            System.out.println("ArithmeticException: " + e);
        }
    }
}
```

FactorialServer.java

```
import java.rmi.Naming;

public class FactorialServer {

    public FactorialServer() {
        try {
            Factorial f = new FactorialImpl();
            Naming.rebind("rmi://localhost/FactorialService", f);
            System.out.println("FactorialService is ready.");
        } catch (Exception e) {
            System.out.println("Server Exception: " + e);
        }
    }

    public static void main(String[] args) {
        new FactorialServer();
    }
}
```

Output-

Terminal-1

```
mac@LAPTOP-C6S5TUPQ:~/LAB 1/fac$ javac *.java
mac@LAPTOP-C6S5TUPQ:~/LAB 1/fac$ rmiregistry
WARNING: A terminally deprecated method in java.lang.System has been called
WARNING: System::setSecurityManager has been called by sun.rmi.registry.RegistryImpl
WARNING: Please consider reporting this to the maintainers of sun.rmi.registry.RegistryImpl
WARNING: System::setSecurityManager will be removed in a future release
█
```

Terminal-2

```
mac@LAPTOP-C6S5TUPQ:~/LAB 1/fac$ java FactorialServer
FactorialService is ready.
█
```

Terminal-3

```
mac@LAPTOP-C6S5TUPQ:~/LAB 1/fac$ java FactorialClient
Factorial of 30 is: 2652528598121910586363084800000000
mac@LAPTOP-C6S5TUPQ:~/LAB 1/fac$ █
```



Assignment 2

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Input-

Reverse.idl

```
module ReverseModule {  
    interface Reverse {  
        string reverse_string(in string str);  
    };  
};
```

ReverseImpl.java

```
// ReverseImpl.java  
  
import ReverseModule.ReversePOA;  
  
class ReverseImpl extends ReversePOA {  
    ReverseImpl() {  
        super();  
        System.out.println("Reverse Object Created");  
    }  
  
    public String reverse_string(String name) {  
        StringBuffer str = new StringBuffer(name);  
        str.reverse();  
        return "Server Send " + str;  
    }  
}
```

ReverseClient.java

```
// ReverseClient.java

import ReverseModule.*;
import org.omg.CosNaming.*;
import org.omg.CosNaming.NamingContextPackage.*;
import org.omg.CORBA.*;
import java.io.*;

class ReverseClient {
    public static void main(String args[]) {
        try {
            ORB orb = ORB.init(args, null);
            org.omg.CORBA.Object objRef =
orb.resolve_initial_references("NameService");
            NamingContextExt ncRef = NamingContextExtHelper.narrow(objRef);

            Reverse ReverseImpl =
ReverseHelper.narrow(ncRef.resolve_str("Reverse"));

            System.out.println("Enter String=");
            BufferedReader br = new BufferedReader(new
InputStreamReader(System.in));
            String str = br.readLine();

            String tempStr = ReverseImpl.reverse_string(str);
            System.out.println(tempStr);
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}
```

ReverseServer.java

```
// ReverseServer.java

import ReverseModule.Reverse;
import ReverseModule.ReverseHelper;
import org.omg.CosNaming.*;
import org.omg.CosNaming.NamingContextPackage.*;
import org.omg.CORBA.*;
import org.omg.PortableServer.*;

class ReverseServer {
    public static void main(String[] args) {
        try {
            ORB orb = ORB.init(args, null);
            POA rootPOA =
POAHelper.narrow(orb.resolve_initial_references("RootPOA"));
            rootPOA.the_POAManager().activate();

            ReverseImpl rvr = new ReverseImpl();
            org.omg.CORBA.Object ref = rootPOA.servant_to_reference(rvr);
            Reverse h_ref = ReverseHelper.narrow(ref);

            org.omg.CORBA.Object objRef =
orb.resolve_initial_references("NameService");
            NamingContextExt ncRef = NamingContextExtHelper.narrow(objRef);

            String name = "Reverse";
            NameComponent path[] = ncRef.to_name(name);
            ncRef.rebind(path, h_ref);

            System.out.println("Reverse Server reading and waiting....");
            orb.run();
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}
```

Output-

Terminal-1

```
mac@LAPTOP-C6S5TUPQ:~/LAB 2$ idlj -fall Reverse.idl
mac@LAPTOP-C6S5TUPQ:~/LAB 2$ javac ReverseModule/*.java ReverseImpl.java ReverseServer.java ReverseClient.java
```

Terminal-2

```
mac@LAPTOP-C6S5TUPQ:~/LAB 2$ java ReverseServer -ORBInitialPort 1050 -ORBInitialHost localhost
Reverse Object Created
Reverse Server reading and waiting....

```

Terminal-3

```
mac@LAPTOP-C6S5TUPQ:~/LAB 2$ java ReverseClient -ORBInitialPort 1050 -ORBInitialHost localhost
Enter String=
Hello
Server Send olleH
```


Assignment 3Input-

Sum_mpi.c

```
#include <stdio.h>
#include <stdlib.h>
#include <mpi.h>

int main(int argc, char* argv[]) {
    int rank, size, N;
    int *data = NULL, *sub_data;
    int local_sum = 0, total_sum = 0;

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (rank == 0) {
        printf("Enter number of elements (N): ");
        scanf("%d", &N);
        if (N % size != 0) {
            printf("N must be divisible by number of processes.\n");
            MPI_Abort(MPI_COMM_WORLD, 1);
        }
        data = (int*)malloc(N * sizeof(int));
        printf("Enter %d elements:\n", N);
        for (int i = 0; i < N; i++)
            scanf("%d", &data[i]);
    }

    MPI_Bcast(&N, 1, MPI_INT, 0, MPI_COMM_WORLD);
    int chunk_size = N / size;
    sub_data = (int*)malloc(chunk_size * sizeof(int));

    MPI_Scatter(data, chunk_size, MPI_INT, sub_data, chunk_size, MPI_INT, 0,
MPI_COMM_WORLD);

    for (int i = 0; i < chunk_size; i++)
        local_sum += sub_data[i];

    printf("Local sum at rank %d = %d\n", rank, local_sum);

    MPI_Reduce(&local_sum, &total_sum, 1, MPI_INT, MPI_SUM, 0,
MPI_COMM_WORLD);

    if (rank == 0)
        printf("Final sum = %d\n", total_sum);
}
```

```
    if (data) free(data);  
    free(sub_data);  
    MPI_Finalize();  
    return 0;  
}
```

Output-

Terminal-1

```
mac@LAPTOP-C6S5TUPQ:~$ sudo apt update  
sudo apt install build-essential gcc g++ gfortran -y  
Hit:1 http://archive.ubuntu.com/ubuntu jammy InRelease  
Hit:2 http://security.ubuntu.com/ubuntu jammy-security InRelease  
Hit:3 http://archive.ubuntu.com/ubuntu jammy-updates InRelease  
Hit:4 http://archive.ubuntu.com/ubuntu jammy-backports InRelease  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
161 packages can be upgraded. Run 'apt list --upgradable' to see them.  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
build-essential is already the newest version (12.9ubuntu3).  
g++ is already the newest version (4:11.2.0-1ubuntu1).  
gcc is already the newest version (4:11.2.0-1ubuntu1).  
gfortran is already the newest version (4:11.2.0-1ubuntu1).  
0 upgraded, 0 newly installed, 0 to remove and 161 not upgraded.
```

```
mac@L ~$ cd ~/openmpi-install  
Follow link (ctrl + click)  
wget https://download.open-mpi.org/release/open-mpi/v4.1/openmpi-4.1.4.tar.bz2
```

```
mac@LAPTOP-C6S5TUPQ:~$ ./configure --prefix=$HOME/opt/openmpi  
make -j4 # use all your cores  
make install
```

```
mac@LAPTOP-C6S5TUPQ:~$ tar -xjf openmpi-4.1.4.tar.bz2  
cd openmpi-4.1.4
```

```
mac@LAPTOP-C6S5TUPQ:~/openmpi-install/openmpi-4.1.4$
echo "export PATH=\$PATH:\$HOME/opt/openmpi/bin" >> ~/.bashrc
echo "export LD_LIBRARY_PATH=\$LD_LIBRARY_PATH:\$HOME/opt/openmpi/lib" >> ~/.bashrc
source ~/.bashrc
mac@LAPTOP-C6S5TUPQ:~/openmpi-install/openmpi-4.1.4$
mpicc --version
which mpirun
gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0
Copyright (C) 2021 Free Software Foundation, Inc.
This is free software; see the source for copying conditions. There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

/home/mac/opt/openmpi/bin/mpirun
mac@LAPTOP-C6S5TUPQ:~/openmpi-install/openmpi-4.1.4$ cd ~
nano sum_mpi.c
mac@LAPTOP-C6S5TUPQ:~/mpi-sum$ nano sum_mpi.c
mac@LAPTOP-C6S5TUPQ:~/mpi-sum$ mpicc sum_mpi.c -o sum_mpi
mac@LAPTOP-C6S5TUPQ:~/mpi-sum$ mpirun -np 4 ./sum_mpi
20
Enter number of elements (N): Enter 20 elements:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Local sum at rank 0 = 15
Local sum at rank 1 = 40
Local sum at rank 2 = 65
Final sum = 210
Local sum at rank 3 = 90
mac@LAPTOP-C6S5TUPQ:~/mpi-sum$
```



Assignment 4Input-

master.py

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

client_data = {}

# Function to receive clock time from a 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(f"Client Data updated with: {address}\n")
        time.sleep(5)

# Function to accept client connections
def startConnecting(master_server):
    while True:
        # Accept a new client
        master_slave_connector, addr = master_server.accept()
        slave_address = f"{addr[0]}:{addr[1]}"
        print(f"{slave_address} got connected successfully")
        current_thread = threading.Thread(
            target = startReceivingClockTime,
            args = (master_slave_connector, slave_address, )
        )
        current_thread.start()

# Function to get the average clock difference
def getAverageClockDiff():
    current_client_data = client_data.copy()
    time_difference_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

# Function to synchronize all clocks
def synchronizeAllClocks():
    while True:
        print("New synchronization cycle started.")
        print(f"Number of clients to be synchronized: {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(f"Something went wrong while sending synchronized
time through {client_addr}")
            else:
                print("No client data. Synchronization not applicable.")
                print("\n\n")
                time.sleep(5)

# Function 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)
    master_server.listen(10)
    print("Clock server started...\n")
    print("Starting to make connections...\n")

    # Start connection handling in a new thread
    master_thread = threading.Thread(target=startConnecting,
args=(master_server,))
    master_thread.start()

    # Start synchronization in another thread
    print("Starting synchronization parallelly...\n")
    sync_thread = threading.Thread(target=synchronizeAllClocks)
    sync_thread.start()

# Driver function
if __name__ == '__main__':
    initiateClockServer(port=8080)

```

server.py

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

# Function to send current client time to server
def startSendingTime(slave_client):
    while True:
        slave_client.send(str(datetime.datetime.now()).encode())
        print("Recent time sent successfully\n")
        time.sleep(5)

# Function to receive synchronized time from server
def startReceivingTime(slave_client):
    while True:
        data = slave_client.recv(1024).decode()
        synchronized_time = parser.parse(data)
        print("Synchronized time at the client is: " + str(synchronized_time)
+ "\n")
        time.sleep(5)

# Main function to run the client
def initiateSlaveClient(port=8080):
    slave_client = socket.socket()
    slave_client.connect(('127.0.0.1', port))

    print("Connected to Clock Server\n")

    # Start sending time to server
    send_time_thread = threading.Thread(target=startSendingTime,
args=(slave_client,))
    send_time_thread.start()

    # Start receiving synchronized time
    receive_time_thread = threading.Thread(target=startReceivingTime,
args=(slave_client,))
    receive_time_thread.start()

# Run the client
if __name__ == '__main__':
    initiateSlaveClient(port=8080)
```

Output-

Terminal-1

```
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 master.py
Socket at master node created successfully
```

```
Clock server started...
```

```
Starting to make connections...
```

```
Starting synchronization parallelly...
```

```
New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.
```

```
New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.
```

```
127.0.0.1:49362 got connected successfully
Client Data updated with: 127.0.0.1:49362
```

```
New synchronization cycle started.
Number of clients to be synchronized: 1
```

```
Client Data updated with: 127.0.0.1:49362
```

```
New synchronization cycle started.
Number of clients to be synchronized: 1
```

```
Client Data updated with: 127.0.0.1:49362
```

```
127.0.0.1:50816 got connected successfully
Client Data updated with: 127.0.0.1:50816
```

```
Client Data updated with: 127.0.0.1:49362
```

```
Client Data updated with: 127.0.0.1:37086
```

```
Client Data updated with: 127.0.0.1:50816
```

```
New synchronization cycle started.
Number of clients to be synchronized: 3
```

```
Client Data updated with: 127.0.0.1:49362
```


Terminal-2

```
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 slave.py
Connected to Clock Server

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:02.421001

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:07.426226

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:12.431624

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:22.442730

Recent time sent successfully

mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 slave.py
Connected to Clock Server

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:12.431689

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:22.442774

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:27.447941

Recent time sent successfully

Synchronized time at the client is: 2025-04-14 23:19:32.453209

Recent time sent successfully
```

Or

Input-

master1.py

```
# master.py
import socket
import time

def get_slave_time(host, port):
    s = socket.socket()
```

```

s.connect((host, port))
s.send("TIME_REQUEST".encode())
slave_time = float(s.recv(1024).decode())
s.close()
return slave_time

def send_adjustment(host, port, adjustment):
    s = socket.socket()
    s.connect((host, port))
    s.send("TIME_REQUEST".encode())
    s.recv(1024) # receive time
    s.send(str(adjustment).encode())
    s.close()

def main():
    slave_ports = [8001, 8002, 8003]
    times = []
    host = 'localhost'
    master_time = time.time()

    print(f"[MASTER] Local time: {master_time}")

    for port in slave_ports:
        t = get_slave_time(host, port)
        times.append(t)
        print(f"[MASTER] Received from slave {port}: {t}")

    times.append(master_time)
    avg = sum(times) / len(times)

    # Ignore outliers (difference > 2 sec)
    filtered = [t for t in times if abs(t - avg) <= 2]
    avg_filtered = sum(filtered) / len(filtered)

    print(f"[MASTER] Average time (ignoring outliers): {avg_filtered}")

    adjustments = [avg_filtered - t for t in times]

    # Send adjustments
    for i, port in enumerate(slave_ports):
        send_adjustment(host, port, adjustments[i])
    print("[MASTER] Synchronization complete.")

if __name__ == "__main__":
    main()

```

slave1.py

```
import socket
import time
import threading

def handle_time_request(port, offset):
    with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
        s.bind(('localhost', port))
        s.listen(1)
        print(f"[SLAVE {port}] Waiting for master's time request...")
        conn, _ = s.accept()
        with conn:
            conn.recv(1024) # Just to simulate "time_request"
            current_time = time.time() + offset
            print(f"[SLAVE {port}] Sending local time: {current_time}")
            conn.sendall(str(current_time).encode())

def handle_adjustment(port, offset):
    with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
        s.bind(('localhost', port))
        s.listen(1)
        print(f"[SLAVE {port}] Waiting for time adjustment from master...")
        conn, _ = s.accept()
        with conn:
            adjustment = float(conn.recv(1024).decode())
            print(f"[SLAVE {port}] Received adjustment: {adjustment}")
            print(f"[SLAVE {port}] New time would be: {time.time() + offset + adjustment}")

if __name__ == "__main__":
    port = int(input("Enter slave port (e.g. 8001): "))
    offset = float(input("Enter time offset (e.g. 3 or -2): "))

    # Use threads to keep both sockets alive
    t1 = threading.Thread(target=handle_time_request, args=(port, offset))
    t2 = threading.Thread(target=handle_adjustment, args=(port, offset))

    t1.start()
    t1.join()

    time.sleep(1) # Give master time to compute adjustments

    t2.start()
    t2.join()
```

Output-

Terminal-1

```
mac@LAPTOP-C6S5TUPQ:~$ cd LAB\ 4/berkeley-sync/  
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 slave1.py  
Enter slave port (e.g. 8001): 8001  
Enter time offset (e.g. 3 or -2): 3  
[SLAVE 8001] Waiting for master's time request...
```

Terminal-2

```
mac@LAPTOP-C6S5TUPQ:~$ cd LAB\ 4/berkeley-sync/  
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 slave1.py  
Enter slave port (e.g. 8001): 8002  
Enter time offset (e.g. 3 or -2): -2  
[SLAVE 8002] Waiting for master's time request...
```

Terminal-3

```
mac@LAPTOP-C6S5TUPQ:~$ cd LAB\ 4/berkeley-sync/  
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 slave1.py  
Enter slave port (e.g. 8001): 8003  
Enter time offset (e.g. 3 or -2): 5  
[SLAVE 8003] Waiting for master's time request...
```

Terminal-4

```
mac@LAPTOP-C6S5TUPQ:~/LAB 4/berkeley-sync$ python3 master1.py  
[MASTER] Local time: 1744654472.9744303  
[MASTER] Received from slave 8001: 1744654475.9749715  
[MASTER] Received from slave 8002: 1744654470.9754887  
[MASTER] Received from slave 8003: 1744654477.9758437  
[MASTER] Average time (ignoring outliers): 1744654474.474701
```

Assignment 5Input-**Bully.java**

```
import java.util.*;

public class Bully {
    int coordinator;
    int max_processes;
    boolean processes[];

    public Bully(int max) {
        max_processes = max;
        processes = new boolean[max_processes];
        coordinator = max;

        System.out.println("Creating processes..");
        for(int i = 0; i < max; i++) {
            processes[i] = true;
            System.out.println("P" + (i+1) + " created");
        }
        System.out.println("Process P" + coordinator + " is the coordinator");
    }

    void displayProcesses() {
        for(int i = 0; i < max_processes; i++) {
            if(processes[i]) {
                System.out.println("P" + (i+1) + " is up");
            } else {
                System.out.println("P" + (i+1) + " is down");
            }
        }
        System.out.println("Process P" + coordinator + " is the coordinator");
    }

    void upProcess(int process_id) {
        if(!processes[process_id - 1]) {
            processes[process_id - 1] = true;
            System.out.println("Process " + process_id + " is now up.");
        } else {
            System.out.println("Process " + process_id + " is already up.");
        }
    }

    void downProcess(int process_id) {
        if(!processes[process_id - 1]) {
            System.out.println("Process " + process_id + " is already down.");
        }
    }
}
```

```

    } else {
        processes[process_id - 1] = false;
        System.out.println("Process " + process_id + " is down.");
    }
}

void runElection(int process_id) {
    coordinator = process_id;
    boolean keepGoing = true;

    for(int i = process_id; i < max_processes && keepGoing; i++) {
        System.out.println("Election message sent from process " +
process_id + " to process " + (i+1));

        if(processes[i]) {
            keepGoing = false;
            runElection(i + 1);
        }
    }
}

public static void main(String args[]) {
    Bully bully = null;
    int max_processes = 0, process_id = 0;
    int choice = 0;
    Scanner sc = new Scanner(System.in);

    while(true) {
        System.out.println("Bully Algorithm");
        System.out.println("1. Create processes");
        System.out.println("2. Display processes");
        System.out.println("3. Up a process");
        System.out.println("4. Down a process");
        System.out.println("5. Run election algorithm");
        System.out.println("6. Exit Program");
        System.out.print("Enter your choice:- ");
        choice = sc.nextInt();

        switch(choice) {
            case 1:
                System.out.print("Enter the number of processes:- ");
                max_processes = sc.nextInt();
                bully = new Bully(max_processes);
                break;
            case 2:
                bully.displayProcesses();
                break;
            case 3:
                System.out.print("Enter the process number to up:- ");
                process_id = sc.nextInt();

```

```

        bully.upProcess(process_id);
        break;
    case 4:
        System.out.print("Enter the process number to down:- ");
        process_id = sc.nextInt();
        bully.downProcess(process_id);
        break;
    case 5:
        System.out.print("Enter the process number which will
perform election:- ");
        process_id = sc.nextInt();
        bully.runElection(process_id);
        bully.displayProcesses();
        break;
    case 6:
        System.exit(0);
        break;
    default:
        System.out.println("Error in choice. Please try again.");
        break;
    }
}
}
}
}

```

Ring.java

```

import java.util.*;

public class Ring {
    int max_processes;
    int coordinator;
    boolean processes[];
    ArrayList<Integer> pid;

    public Ring(int max) {
        coordinator = max;
        max_processes = max;
        pid = new ArrayList<Integer>();
        processes = new boolean[max];

        for(int i = 0; i < max; i++) {
            processes[i] = true;
            System.out.println("P" + (i+1) + " created.");
        }
        System.out.println("P" + (coordinator) + " is the coordinator");
    }
}

```

```

void displayProcesses() {
    for(int i = 0; i < max_processes; i++) {
        if(processes[i])
            System.out.println("P" + (i+1) + " is up.");
        else
            System.out.println("P" + (i+1) + " is down.");
    }
    System.out.println("P" + (coordinator) + " is the coordinator");
}

void upProcess(int process_id) {
    if(!processes[process_id-1]) {
        processes[process_id-1] = true;
        System.out.println("Process P" + (process_id) + " is up.");
    } else {
        System.out.println("Process P" + (process_id) + " is already
up.");
    }
}

void downProcess(int process_id) {
    if(!processes[process_id-1]) {
        System.out.println("Process P" + (process_id) + " is already
down.");
    } else {
        processes[process_id-1] = false;
        System.out.println("Process P" + (process_id) + " is down.");
    }
}

void displayArrayList(ArrayList<Integer> pid) {
    System.out.print("[ ");
    for(Integer x : pid) {
        System.out.print(x + " ");
    }
    System.out.print(" ]\n");
}

void initElection(int process_id) {
    if(processes[process_id-1]) {
        pid.add(process_id);

        int temp = process_id;

        System.out.print("Process P" + process_id + " sending the
following list:- ");
        displayArrayList(pid);

        while(temp != process_id - 1) {

```



```

        if(processes[temp]) {
            pid.add(temp+1);
            System.out.print("Process P" + (temp + 1) + " sending the
following list:- ");
            displayArrayList(pid);
        }
        temp = (temp + 1) % max_processes;
    }
    coordinator = Collections.max(pid);
    System.out.println("Process P" + process_id + " has declared P" +
coordinator + " as the coordinator");
    pid.clear();
}
}

public static void main(String args[]) {
    Ring ring = null;
    int max_processes = 0, process_id = 0;
    int choice = 0;
    Scanner sc = new Scanner(System.in);

    while(true) {
        System.out.println("Ring Algorithm");
        System.out.println("1. Create processes");
        System.out.println("2. Display processes");
        System.out.println("3. Up a process");
        System.out.println("4. Down a process");
        System.out.println("5. Run election algorithm");
        System.out.println("6. Exit Program");
        System.out.print("Enter your choice:- ");
        choice = sc.nextInt();

        switch(choice) {
            case 1:
                System.out.print("Enter the total number of processes:-
");
                max_processes = sc.nextInt();
                ring = new Ring(max_processes);
                break;
            case 2:
                ring.displayProcesses();
                break;
            case 3:
                System.out.print("Enter the process to up:- ");
                process_id = sc.nextInt();
                ring.upProcess(process_id);
                break;
            case 4:
                System.out.print("Enter the process to down:- ");
                process_id = sc.nextInt();

```

```

        ring.downProcess(process_id);
        break;
    case 5:
        System.out.print("Enter the process which will initiate
election:- ");
        process_id = sc.nextInt();
        ring.initElection(process_id);
        break;
    case 6:
        System.exit(0);
        break;
    default:
        System.out.println("Error in choice. Please try again.");
        break;
    }
}
}
}
}

```

Output-

Terminal-1

1.

```

mac@LAPTOP-C6S5TUPQ:~/LAB 5/Bully$ javac Bully.java
mac@LAPTOP-C6S5TUPQ:~/LAB 5/Bully$ java Bully
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 1
Enter the number of processes:- 7
Creating processes..
P1 created
P2 created
P3 created
P4 created
P5 created
P6 created
P7 created
Process P7 is the coordinator
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 2
P1 is up
P2 is up
P3 is up
P4 is up
P5 is up
P6 is up
P7 is up
Process P7 is the coordinator

```

2.

```

Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 3
Enter the process number to up:- 5
Process 5 is already up.
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 4
Enter the process number to down:- 4
Process 4 is down.
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 5
Enter the process number which will perform election:- 2
Election message sent from process 2 to process 3
Election message sent from process 3 to process 4
Election message sent from process 3 to process 5
Election message sent from process 5 to process 6
Election message sent from process 6 to process 7
P1 is up
P2 is up

```

3.

```
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 3
Enter the process number to up:- 5
Process 5 is already up.
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 4
Enter the process number to down:- 4
Process 4 is down.
```

4.

```
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 5
Enter the process number which will perform election:- 2
Election message sent from process 2 to process 3
Election message sent from process 3 to process 4
Election message sent from process 3 to process 5
Election message sent from process 5 to process 6
Election message sent from process 6 to process 7
P1 is up
P2 is up
P3 is up
P4 is down
P5 is up
P6 is up
P7 is up
Process P7 is the coordinator
Bully Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 6
```

Terminal-2

1.

```
mac@LAPTOP-C6S5TUPQ:~/LAB 5/Ring$ javac Ring.java
mac@LAPTOP-C6S5TUPQ:~/LAB 5/Ring$ java Ring
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 1
Enter the total number of processes:- 5
P1 created.
P2 created.
P3 created.
P4 created.
P5 created.
P5 is the coordinator
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 2
P1 is up.
P2 is up.
P3 is up.
P4 is up.
P5 is up.
P5 is the coordinator
```

2.

```
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 3
Enter the process to up:- 5
Process P5 is already up.
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 4
Enter the process to down:- 5
Process P5 is down.
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
```

3.

```
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 5
Enter the process which will initiate election:- 2
Process P2 sending the following list:- [ 2 ]
Process P3 sending the following list:- [ 2 3 ]
Process P4 sending the following list:- [ 2 3 4 ]
Process P1 sending the following list:- [ 2 3 4 1 ]
Process P2 has declared P4 as the coordinator
Ring Algorithm
1. Create processes
2. Display processes
3. Up a process
4. Down a process
5. Run election algorithm
6. Exit Program
Enter your choice:- 6
```

Assignment 6

Name- Mayank A. Jaiswal

Class- BE-A

Roll No.- B511042

Input-

Tring.java

```
import java.util.*;

public class TRing{

    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);

        System.out.print("Enter Number Of Nodes You Want In The Ring : ");
        int n = sc.nextInt();

        System.out.println("Ring Formed Is As Below: ");
        for(int i=0; i<n; i++){
            System.out.print(i + " ");
        }

        System.out.println("\n0");

        int choice = 0;

        do{
            System.out.print("Enter Sender : ");
            int sender = sc.nextInt();

            System.out.print("Enter Receiver : ");
            int receiver = sc.nextInt();

            System.out.print("Enter Data To Send : ");
            int data = sc.nextInt();

            int token = 0;

            System.out.print("Token Passing : ");

            for(int i=token; i<sender; i++){
                System.out.print(" " + i + "->");
            }

            System.out.println(" " + sender);
            System.out.println("Sender:" + sender + " Sending Data: " + data);

            for(int i=sender; i!=receiver; i = (i+1)%n){
                System.out.println("Data: " + data + " Forwarded By: " + i);
            }
        } while(choice != 1);
    }
}
```

```

    }

    System.out.println("Receiver: " + receiver + " Received The Data: " + data);

    token = sender;

    System.out.print("Do You Want To Send Data Again? If YES Enter 1, If NO Enter 0: ");
    choice = sc.nextInt();

    }while(choice == 1);

    }
}

```

Output-

```

mac@LAPTOP-C6S5TUPQ:~/LAB 6$ javac TRing.java
mac@LAPTOP-C6S5TUPQ:~/LAB 6$ java TRing
Enter Number Of Nodes You Want In The Ring : 5
Ring Formed Is As Below:
0 1 2 3 4 0
Enter Sender : 0
Enter Receiver : 4
Enter Data To Send : 75
Token Passing : 0
Sender:0 Sending Data: 75
Data: 75 Forwarded By: 0
Data: 75 Forwarded By: 1
Data: 75 Forwarded By: 2
Data: 75 Forwarded By: 3
Receiver: 4 Received The Data: 75
Do You Want To Send Data Again? If YES Enter 1, If NO Enter 0: 1
Enter Sender : 1
Enter Receiver : 3
Enter Data To Send : 55
Token Passing : 0-> 1
Sender:1 Sending Data: 55
Data: 55 Forwarded By: 1
Data: 55 Forwarded By: 2
Receiver: 3 Received The Data: 55
Do You Want To Send Data Again? If YES Enter 1, If NO Enter 0: 1
Enter Sender : 0
Enter Receiver : 3
Enter Data To Send : 57
Token Passing : 0
Sender:0 Sending Data: 57
Data: 57 Forwarded By: 0
Data: 57 Forwarded By: 1
Data: 57 Forwarded By: 2
Receiver: 3 Received The Data: 57
Do You Want To Send Data Again? If YES Enter 1, If NO Enter 0: 0

```

Assignment 7Input-ServerMyCalculatorWebService.java

```
/*
 * To change this license header, choose License Headers in Project
Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package com.myservice;

import javax.jws.WebService;
import javax.jws.WebMethod;
import javax.jws.WebParam;

/**
 *
 * @author YOGESH
 */
@WebService(serviceName = "MyCalculatorWebService")
public class MyCalculatorWebService {

    /**
     * Web service operation
     */
    @WebMethod(operationName = "addition")
    public double addition(@WebParam(name = "num1") double num1,
@WebParam(name = "num2") double num2) {
        //TODO write your implementation code here:
        return num1 + num2;
    }

    /**
     * Web service operation
     */
    @WebMethod(operationName = "subtraction")
    public double subtraction(@WebParam(name = "num1") double num1,
@WebParam(name = "num2") double num2) {
        //TODO write your implementation code here:
        return num1 - num2;
    }

    /**
     * Web service operation
     */
}
```

```

    @WebMethod(operationName = "multiplication")
    public double multiplication(@WebParam(name = "num1") double num1,
    @WebParam(name = "num2") double num2) {
        //TODO write your implementation code here:
        return num1 * num2;
    }

    /**
     * Web service operation
     */
    @WebMethod(operationName = "division")
    public double division(@WebParam(name = "num1") double num1,
    @WebParam(name = "num2") double num2) {
        //TODO write your implementation code here:
        return num1 / num2;
    }
}

```

Client

```

<!DOCTYPE html>
<!--
To change this license header, choose License Headers in Project Properties.
To change this template file, choose Tools | Templates
and open the template in the editor.
-->
<html>
    <head>
        <title>Calculator Web Service Client</title>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <style>
            input{
                width: 200px;
                height: 30px;
                padding: 5px;
                border: 1px solid black;
                border-radius: 5px;
                color: green;
                font-size: 25px;
            }

            #submitbtn{
                width: 100px;

```



```

        height: 30px;
        padding: 5px;
        border: 1px solid black;
        border-radius: 5px;
        color: red;
        font-size: 20px;
    }

</style>
</head>
<body>
    <form action="CalculatorServlet">
        Enter Number-1: <input type="text" name="number1" value=""/> <br>
        Enter Number-2: <input type="text" name="number2" value=""/> <br>

        <input type="submit" value="Submit" id="submitbtn" />
    </form>
</body>
</html>

```

Outputs-

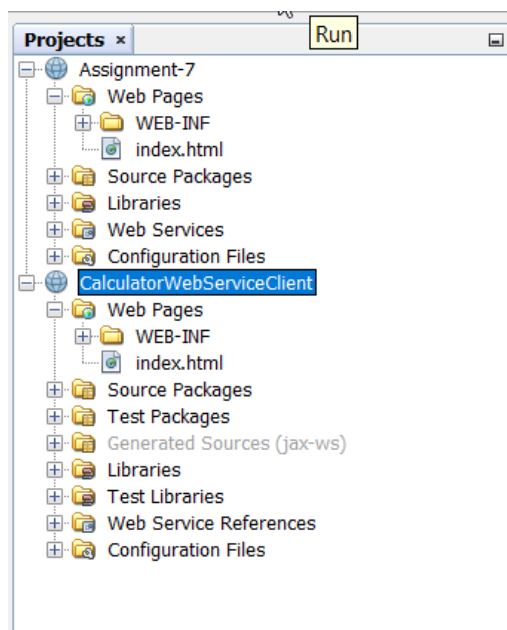


Fig. 7.1 Folder Structure

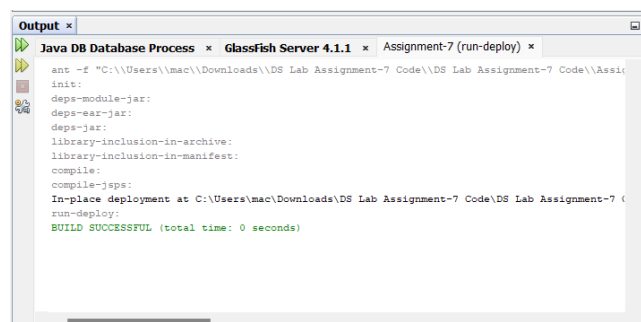
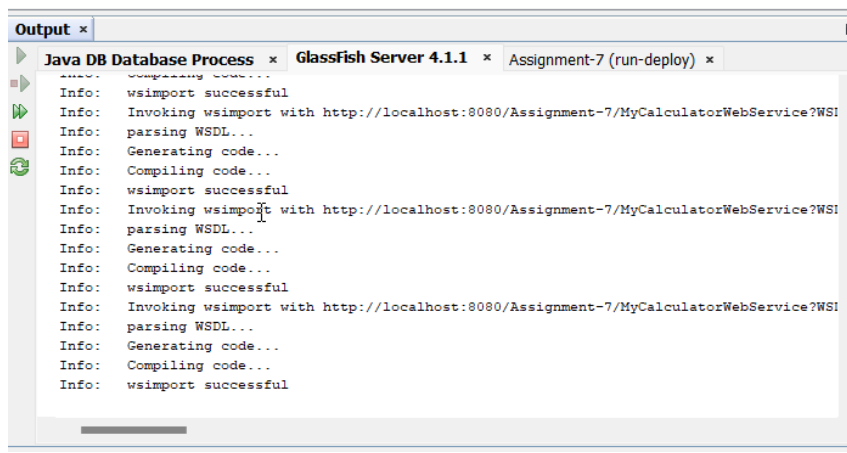


Fig. 7.2 Server Build Successfully



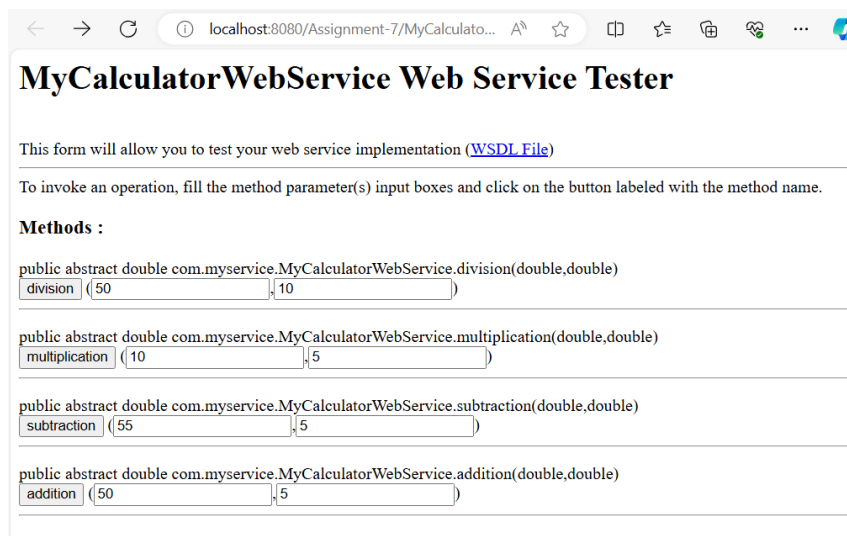
```
Info: Webservice Endpoint deployed CoordinatorPortTypePortImpl
listening at address at http://Windows:8080/___wstx-services/CoordinatorPortTypeImpl.
Info: Webservice Endpoint deployed RegistrationPortTypeImpl
listening at address at http://Windows:8080/___wstx-services/RegistrationPortTypeRPC.
Info: Webservice Endpoint deployed RegistrationRequesterPortTypePortImpl
listening at address at http://Windows:8080/___wstx-services/RegistrationRequesterPortTypeImpl.
Info: Loading application [wstx-services] at [/___wstx-services]
Info: WS-IX Services successfully started.
Info: Loading application [Assgn_7] at [/Assgn_7]
Info: Assgn_7 was successfully deployed in 3,697 milliseconds.
Info: visiting unvisited references
Info: visiting unvisited references
Info: visiting unvisited references
Info: Webservice Endpoint deployed MyCalculatorWebService
listening at address at http://Windows:8080/Assignment-7/MyCalculatorWebService.
Info: Loading application [Assignment-7] at [/Assignment-7]
Info: Assignment-7 was successfully deployed in 476 milliseconds.
```

Fig. 7.3 Server Deployed Successfully



```
Info: wsimport successful
Info: Invoking wsimport with http://localhost:8080/Assignment-7/MyCalculatorWebService?WSI
Info: parsing WSDL...
Info: Generating code...
Info: Compiling code...
Info: wsimport successful
Info: Invoking wsimport with http://localhost:8080/Assignment-7/MyCalculatorWebService?WSI
Info: parsing WSDL...
Info: Generating code...
Info: Compiling code...
Info: wsimport successful
Info: Invoking wsimport with http://localhost:8080/Assignment-7/MyCalculatorWebService?WSI
Info: parsing WSDL...
Info: Generating code...
Info: Compiling code...
Info: wsimport successful
```

Fig. 7.4 Run MyCalculatorWebService.java Code was compiled



MyCalculatorWebService Web Service Tester

This form will allow you to test your web service implementation ([WSDL File](#))

To invoke an operation, fill the method parameter(s) input boxes and click on the button labeled with the method name.

Methods :

public abstract double com.myservice.MyCalculatorWebService.division(double,double)
division (50 , 10)

public abstract double com.myservice.MyCalculatorWebService.multiplication(double,double)
multiplication (10 , 5)

public abstract double com.myservice.MyCalculatorWebService.subtraction(double,double)
subtraction (55 , 5)

public abstract double com.myservice.MyCalculatorWebService.addition(double,double)
addition (50 , 5)

Fig. 7.5 Calculator Service Deployed Successfully

division Method invocation

Method parameter(s)

Type	Value
double	50
double	10

Method returned

double : "5.0"

SOAP Request

Fig. 7.6 Calculator Service Results

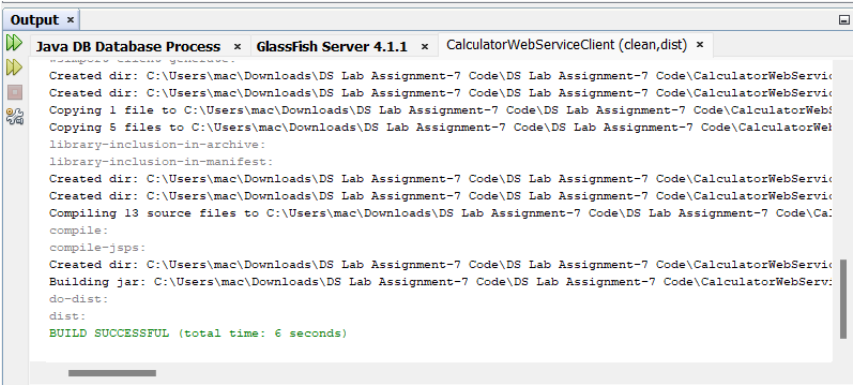


Fig. 7.7 Client Web Service Build Successfully

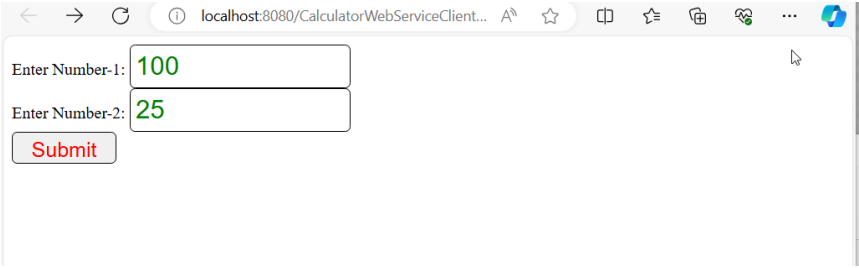


Fig. 7.8 Client Deployed on Local Host

Addition Is: 125.0

Subtraction Is: 75.0

Multiplication Is: 2500.0

Division Is: 4.0

Fig. 7.9 Results