PRACTICAL REPORT

On

Big Data Analytics

Modern Networking

Computer Vision

Submitted in fulfilment of the

Requirements for the award of the Degree of

MASTER OF SCIENCE (INFORMATION TECHNOLOGY) – SEM II

By

NAME: DINESHKUMAR SHANKARLAL KUMAWAT

ROLL NO: PSI124002

DEPARTMENT OF INFORMATION TECHNOLOGY

THE SIA COLLEGE OF HIGHER EDUCATION

Affiliated to University of Mumbai

DOMBIVLI

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DOMBIVLI, MAHARASHTRA 421203

Department of Information Technology

CERTIFICATE

Certified that the experimental work as entered in this journal is as per syllabus in M.Sc. Information Technology for _____ as prescribed by University of Mumbai and was done in the Information Technology laboratory of The S.I.A College of Higher Education by the student Mr/ Ms _____ having Seat No. _____ of class M.Sc. Information Technology - PART I during the academic year 2024-2025.

No. of Experiments completed _____ out of _____.

Course Coordinator
Date:

Sign of Incharge
Date:

College Seal

Sign of Examiner
Date:

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Sr No.	Name of Practical	Sign
1	Install, configure and run Hadoop and HDFS and explore HDFS.	
2	Implement word count / frequency programs using MapReduce.	
3	Implement an MapReduce program that processes a weather dataset.	
4	Implement an application that stores big data in Hbase / MongoDB and manipulate it using R / Python	
5	Implement Decision tree classification techniques	
6	Implement SVM classification techniques	
7	REGRESSION MODEL Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).	
8	MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.	
9	CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for classification problem. c. Evaluate the performance of classifier.	
10	CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b. Plot the cluster data using R visualizations.	

Practical: 1

Install, configure and run Hadoop and HDFS and explore HDFS.

Prerequisites:

Update OS

sudo apt update

Install JAVA

sudo apt install openjdk-8-jdk -y

java -version; javac -version

Install OpenSSH

sudo apt install openssh-server openssh-client -y

Add User in Kali Linux and adding user as root

sudo adduser hdoop

su - hdoop

su - root

sudo adduser hdoop sudo

Generating an RSA SSH key pair

ssh-keygen -t rsa -P '' -f ~/.ssh/id_rsa

cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys

chmod 0600 ~/.ssh/authorized_keys

ssh localhost

Edit 6 files

1st File

sudo nano .bashrc

export HADOOP_HOME=/home/hdoop/hadoop-3.4.1

export HADOOP_INSTALL=$HADOOP_HOME

export HADOOP_MAPRED_HOME=$HADOOP_HOME

export HADOOP_COMMON_HOME=$HADOOP_HOME

export HADOOP_HDFS_HOME=$HADOOP_HOME

export YARN_HOME=$HADOOP_HOME

export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/lib/native

export PATH=$PATH:$HADOOP_HOME/sbin:$HADOOP_HOME/bin

export HADOOP_OPTS"-Djava.library.path=$HADOOP_HOME/lib/nativ"

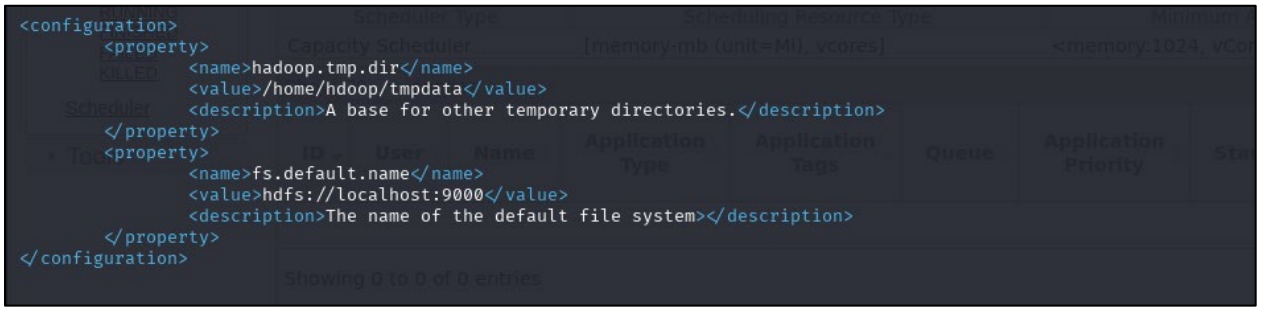
2nd File

sudo nano $HADOOP_HOME/etc/hadoop/hadoop-env.sh

3rd File

sudo nano $HADOOP_HOME/etc/hadoop/core-site.xml

<configuration> <property> <name>hadoop.tmp.dir</name>
<value>/home/hdoop/tmpdata</value> <description>A base for other temporary
directories.</description> </property> <property> <name>fs.default.name</name>
<value>hdfs://localhost:9000</value> <description>The name of the default file
system></description> </property> </configuration>



```
<configuration>
        <property>
                <name>hadoop.tmp.dir</name>
                <value>/home/hdoop/tmpdata</value>
                <description>A base for other temporary directories.</description>
        </property>
        <property>
                <name>fs.default.name</name>
                <value>hdfs://localhost:9000</value>
                <description>The name of the default file system></description>
        </property>
</configuration>
```

4th File

sudo nano $HADOOP_HOME/etc/hadoop/hdfs-site.xml

<configuration> <property> <name>dfs.data.dir</name>
<value>/home/hdoop/dfsdata/namenode</value> </property> <property>
<name>dfs.data.dir</name> <value>/home/hdoop/dfsdata/datanode</value> </property>
<property> <name>dfs.replication</name> <value>1</value> </property> </configuration>

```
<configuration>
        <property>
                <name>dfs.data.dir</name>
                <value>/home/hdoop/dfsdata/namenode</value>
        </property>
        <property>
                <name>dfs.data.dir</name>
                <value>/home/hdoop/dfsdata/datanode</value>
        </property>
        <property>
                <name>dfs.replication</name>
                <value>1</value>
        </property>
</configuration>
```

5th File

sudo nano $HADOOP_HOME/etc/hadoop/mapred-site.xml

<configuration> <property> <name>mapreduce.framework.name</name> <value>yarn</value> </property> </configuration>

```
<configuration>
        <property>
                <name>mapreduce.framework.name</name>
                <value>yarn</value>
        </property>
</configuration>
```

6th File

sudo nano $HADOOP_HOME/etc/hadoop/yarn-site.xml

<configuration> <property> <name>yarn.nodemanager.aux-services</name> <value>mapreduce_shuffle</value> </property> <property> <name>yarn.nodemanager.aux-services.mapreduce.shuffle.class</name> <value>org.apache.hadoop.mapred.ShuffleHandler</value> </property> <property> <name>yarn.resourcemanager.hostname</name> <value>127.0.0.1</value> </property> <property> <name>yarn.acl.enable</name> <value>0</value> </property> <property> <name>yarn.nodemanager.env-whitelist</name> <value>JAVA_HOME,HADOOP_COMMON_HOME,HADOOP_HDFS_HOME,HADOOP_CONF_DIR,CLASSPATH_PERPEND_DISTCACHE,HADOOP_YARN_HOME,HADOOP_MAPRED_HOME</value> </property> </configuration>

```
<configuration>
        <property>
                <name>yarn.nodemanager.aux-services</name>
                <value>mapreduce_shuffle</value>
        </property>
        <property>
                <name>yarn.nodemanager.aux-services.mapreduce.shuffle.class</name>
                <value>org.apache.hadoop.mapred.ShuffleHandler</value>
        </property>
        <property>
                <name>yarn.resourcemanager.hostname</name>
                <value>127.0.0.1</value>
        </property>
        <property>
                <name>yarn.acl.enable</name>
                <value>0</value>
        </property>
        <property>
                <name>yarn.nodemanager.env-whitelist</name>
                <value>JAVA_HOME,HADOOP_COMMON_HOME,HADOOP_HDFS_HOME,HADOOP_CONF_DIR,CLASSPATH_PERPEND_DISTCACHE,HA
        </property>
</configuration>
```

Launching Apache Hadoop

hdfs namenode -format

```
┌──(hdoop㉿cln35h)-[~]
└─$ hdfs namenode -format
WARNING: /home/hdoop/hadoop-3.4.1/logs does not exist. Creating.
2025-03-01 18:53:49,551 INFO namenode.NameNode: STARTUP_MSG:
/************************************************************
STARTUP_MSG: Starting NameNode
STARTUP_MSG:   host = cln35h/127.0.1.1
STARTUP_MSG:   args = [-format]
STARTUP_MSG:   version = 3.4.1
STARTUP_MSG:   classpath = /home/hdoop/hadoop-3.4.1/etc/hadoop:/home/hdoop/hadoop-3.4.1/share/hadoop/common/lib/jsp-
api-2.1.jar:/home/hdoop/hadoop-3.4.1/share/hadoop/common/lib/netty-common-4.1.100.Final.jar:/home/hdoop/hadoop-3.4.1
/share/hadoop/common/lib/netty-transport-sctp-4.1.100.Final.jar:/home/hdoop/hadoop-3.4.1/share/hadoop/common/lib/net
```

```
2025-03-01 18:53:50,110 INFO namenode.FSImage: Allocated new BlockPoolId: BP-287398362-127.0.1.1-1740835430107
2025-03-01 18:53:50,124 INFO common.Storage: Storage directory /home/hdoop/tmpdata/dfs/name has been successfully fo
rmatted.
2025-03-01 18:53:50,155 INFO namenode.FSImageFormatProtobuf: Saving image file /home/hdoop/tmpdata/dfs/name/current/
fsimage.ckpt_0000000000000000000 using no compression
2025-03-01 18:53:50,234 INFO namenode.FSImageFormatProtobuf: Image file /home/hdoop/tmpdata/dfs/name/current/fsimage
.ckpt_0000000000000000000 of size 400 bytes saved in 0 seconds .
2025-03-01 18:53:50,257 INFO namenode.NNStorageRetentionManager: Going to retain 1 images with txid ≥ 0
2025-03-01 18:53:50,261 INFO blockmanagement.DatanodeManager: Slow peers collection thread shutdown
2025-03-01 18:53:50,273 INFO namenode.FSNamesystem: Stopping services started for active state
2025-03-01 18:53:50,273 INFO namenode.FSNamesystem: Stopping services started for standby state
2025-03-01 18:53:50,278 INFO namenode.FSImage: FSImageSaver clean checkpoint: txid=0 when meet shutdown.
2025-03-01 18:53:50,279 INFO namenode.NameNode: SHUTDOWN_MSG:
/************************************************************
SHUTDOWN_MSG: Shutting down NameNode at cln35h/127.0.1.1
************************************************************/
```

Start hdfs

cd hadoop-3.4.1/sbin

./start-dfs.sh

```
┌──(hdoop㉿cln35h)-[~]
└─$ cd hadoop-3.4.1/sbin

┌──(hdoop㉿cln35h)-[~/hadoop-3.4.1/sbin]
└─$ ./start-dfs.sh
```

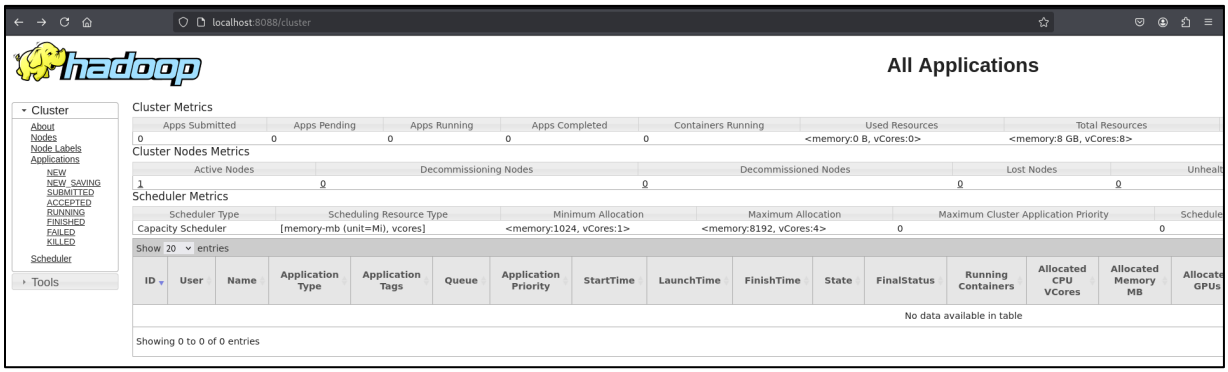
```
┌──(hdoop㉿cln35h)-[~/hadoop-3.4.1/sbin]
└─$ ./start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [cln35h]
cln35h: Warning: Permanently added 'cln35h' (ED25519) to the list of known hosts.
2025-03-01 18:58:39,825 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using
builtin-java classes where applicable
```

./start-yarn.sh

```
┌──(hdoop㉿cln35h)-[~/hadoop-3.4.1/sbin]
└─$ ./start-yarn.sh
Starting resourcemanager
Starting nodemanagers
```

jps

```
┌──(hdoop㉿cln35h)-[~/hadoop-3.4.1/sbin]
└─$ jps
51184 SecondaryNameNode
51825 NodeManager
50820 NameNode
50981 DataNode
52151 Jps
51545 ResourceManager
```



Practical: 2

Implement word count / frequency programs using MapReduce.

Code:

```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -mkdir -p /wordcount/input
```

```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -put /home/hdoop/wordcount/input.txt /wordcount/input
2025-03-11 12:36:12,667 WARN hdfs.DataStreamer: DataStreamer Exception
org.apache.hadoop.ipc.RemoteException(java.io.IOException): File /wordcount/input/input.txt._COPYING_ could only be written to 0 of the 1 minReplication nodes. There are 0 datanode(s) running and 0 n
n.
        at org.apache.hadoop.hdfs.server.blockmanagement.BlockManager.chooseTarget4NewBlock(BlockManager.java:2473)
        at org.apache.hadoop.hdfs.server.namenode.FSDirWriteFileOp.chooseTargetForNewBlock(FSDirWriteFileOp.java:293)
        at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.getAdditionalBlock(FSNamesystem.java:3075)
        at org.apache.hadoop.hdfs.server.namenode.NameNodeRpcServer.addBlock(NameNodeRpcServer.java:932)
        at org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolServerSideTranslatorPB.addBlock(ClientNamenodeProtocolServerSideTranslatorPB.java:603)
        at org.apache.hadoop.hdfs.protocol.proto.ClientNamenodeProtocolProtos$ClientNamenodeProtocol$2.callBlockingMethod(ClientNamenodeProtocolProtos.java)
        at org.apache.hadoop.ipc.ProtobufRpcEngine2$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine2.java:621)
        at org.apache.hadoop.ipc.ProtobufRpcEngine2$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine2.java:589)
        at org.apache.hadoop.ipc.ProtobufRpcEngine2$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine2.java:573)
        at org.apache.hadoop.ipc.RPC$Server.call(RPC.java:1227)
        at org.apache.hadoop.ipc.Server$RpcCall.run(Server.java:1246)
        at org.apache.hadoop.ipc.Server$RpcCall.run(Server.java:1169)
        at java.base/java.security.AccessController.doPrivileged(Native Method)
        at java.base/javax.security.auth.Subject.doAs(Subject.java:423)
        at org.apache.hadoop.security.UserGroupInformation.doAs(UserGroupInformation.java:1953)
        at org.apache.hadoop.ipc.Server$Handler.run(Server.java:3198)

        at org.apache.hadoop.ipc.Client.getRpcResponse(Client.java:1584)
        at org.apache.hadoop.ipc.Client.call(Client.java:1529)
        at org.apache.hadoop.ipc.Client.call(Client.java:1426)
        at org.apache.hadoop.ipc.ProtobufRpcEngine2$Invoker.invoke(ProtobufRpcEngine2.java:258)
        at org.apache.hadoop.ipc.ProtobufRpcEngine2$Invoker.invoke(ProtobufRpcEngine2.java:139)
        at com.sun.proxy.$Proxy12.addBlock(Unknown Source)
        at org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolTranslatorPB.lambda$addBlock$11(ClientNamenodeProtocolTranslatorPB.java:500)
        at org.apache.hadoop.ipc.internal.ShadedProtobufHelper.ipc(ShadedProtobufHelper.java:160)
        at org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolTranslatorPB.addBlock(ClientNamenodeProtocolTranslatorPB.java:500)
        at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at java.base/jdk.internal.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.base/java.lang.reflect.Method.invoke(Method.java:566)
        at org.apache.hadoop.io.retry.RetryInvocationHandler.invokeMethod(RetryInvocationHandler.java:437)
        at org.apache.hadoop.io.retry.RetryInvocationHandler$Call.invokeMethod(RetryInvocationHandler.java:170)
        at org.apache.hadoop.io.retry.RetryInvocationHandler$Call.invoke(RetryInvocationHandler.java:162)
        at org.apache.hadoop.io.retry.RetryInvocationHandler$Call.invokeOnce(RetryInvocationHandler.java:100)
        at org.apache.hadoop.io.retry.RetryInvocationHandler.invoke(RetryInvocationHandler.java:366)
        at com.sun.proxy.$Proxy13.addBlock(Unknown Source)
        at org.apache.hadoop.hdfs.DFSOutputStream.addBlock(DFSOutputStream.java:1143)
        at org.apache.hadoop.hdfs.DataStreamer.locateFollowingBlock(DataStreamer.java:2035)
        at org.apache.hadoop.hdfs.DataStreamer.setupPipelineForCreate(DataStreamer.java:1830)
        at org.apache.hadoop.hdfs.DataStreamer.run(DataStreamer.java:752)
put: File /wordcount/input/input.txt._COPYING_ could only be written to 0 of the 1 minReplication nodes. There are 0 datanode(s) running and 0 node(s) are excluded in this operation.
```

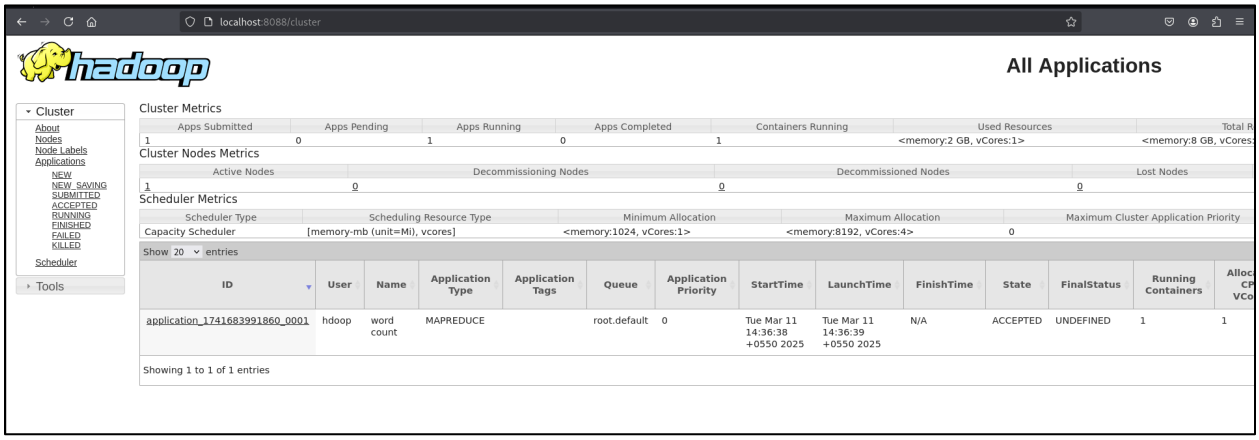
Create WordCount.java

```
import java.io.IOException;
import java.util.StringTokenizer;
import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
```

```
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;

public class WordCount {
   public static class TokenizerMapper extends Mapper<Object, Text, Text, IntWritable> {
      private final static IntWritable one = new IntWritable(1);
      private Text word = new Text();
      public void map(Object key, Text value, Context context) throws IOException,
InterruptedException {
         StringTokenizer itr = new StringTokenizer(value.toString());
         while (itr.hasMoreTokens()) {
            word.set(itr.nextToken());
            context.write(word, one);
         }
      }
   }
   public static class IntSumReducer extends Reducer<Text, IntWritable, Text, IntWritable> {
      public void reduce(Text key, Iterable<IntWritable> values, Context context) throws
IOException, InterruptedException {
         int sum = 0;
         for (IntWritable val : values) {
            sum += val.get();
         }
         context.write(key, new IntWritable(sum));
      }
   }
   public static void main(String[] args) throws Exception {
      Configuration conf = new Configuration();
      Job job = Job.getInstance(conf, "word count");
```

```
        job.setJarByClass(WordCount.class);
        job.setMapperClass(TokenizerMapper.class);
        job.setCombinerClass(IntSumReducer.class);
        job.setReducerClass(IntSumReducer.class);
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(IntWritable.class);
        FileInputFormat.addInputPath(job, new Path(args[0]));
        FileOutputFormat.setOutputPath(job, new Path(args[1]));
        System.exit(job.waitForCompletion(true) ? 0 : 1);
    }
}
```

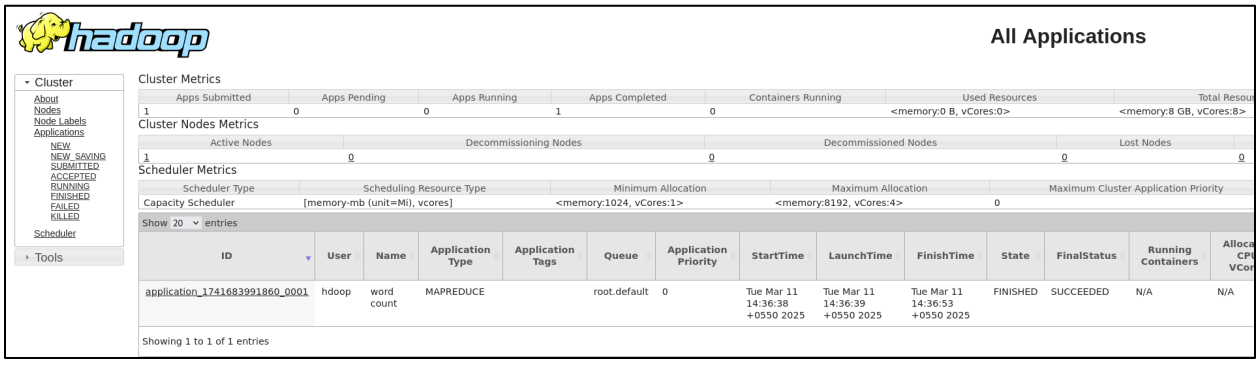
```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ ls
input.txt  output  wordcount_classes  WordCount.jar  WordCount.java

┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hadoop com.sun.tools.javac.Main WordCount.java

┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ jar cf wc.jar WordCount*.class
```



```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hadoop jar wc.jar WordCount /wordcount/input /wordcount/output
2025-03-11 14:36:37,855 INFO client.DefaultNoHARMFailoverProxyProvider: Connecting to ResourceManager at /127.0.0.1:8032
2025-03-11 14:36:38,110 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with ToolRunner to remedy this.
2025-03-11 14:36:38,125 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/hdoop/.staging/job_1741683991860_0001
2025-03-11 14:36:38,355 INFO input.FileInputFormat: Total input files to process : 1
2025-03-11 14:36:38,417 INFO mapreduce.JobSubmitter: number of splits:1
2025-03-11 14:36:38,551 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1741683991860_0001
2025-03-11 14:36:38,551 INFO mapreduce.JobSubmitter: Executing with tokens: []
2025-03-11 14:36:38,694 INFO conf.Configuration: resource-types.xml not found
2025-03-11 14:36:38,695 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
2025-03-11 14:36:39,044 INFO impl.YarnClientImpl: Submitted application application_1741683991860_0001
2025-03-11 14:36:39,071 INFO mapreduce.Job: The url to track the job: http://cln35h:8088/proxy/application_1741683991860_0001/
2025-03-11 14:36:39,072 INFO mapreduce.Job: Running job: job_1741683991860_0001
2025-03-11 14:36:45,164 INFO mapreduce.Job: Job job_1741683991860_0001 running in uber mode : false
2025-03-11 14:36:45,165 INFO mapreduce.Job:  map 0% reduce 0%
2025-03-11 14:36:49,246 INFO mapreduce.Job:  map 100% reduce 0%
2025-03-11 14:36:54,273 INFO mapreduce.Job:  map 100% reduce 100%
2025-03-11 14:36:55,286 INFO mapreduce.Job: Job job_1741683991860_0001 completed successfully
2025-03-11 14:36:55,343 INFO mapreduce.Job: Counters: 54
        File System Counters
                FILE: Number of bytes read=192
                FILE: Number of bytes written=617685
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=219
                HDFS: Number of bytes written=122
                HDFS: Number of read operations=8
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
                HDFS: Number of bytes read erasure-coded=0
        Job Counters
                Launched map tasks=1
                Launched reduce tasks=1
                Data-local map tasks=1
                Total time spent by all maps in occupied slots (ms)=1875
                Total time spent by all reduces in occupied slots (ms)=1787
                Total time spent by all map tasks (ms)=1875
                Total time spent by all reduce tasks (ms)=1787
                Total vcore-milliseconds taken by all map tasks=1875
                Total vcore-milliseconds taken by all reduce tasks=1787
                Total megabyte-milliseconds taken by all map tasks=1920000
                Total megabyte-milliseconds taken by all reduce tasks=1829888
```

```
                Total megabyte-milliseconds taken by all reduce tasks=1829888
        Map-Reduce Framework
                Map input records=4
                Map output records=18
                Map output bytes=179
                Map output materialized bytes=192
                Input split bytes=112
                Combine input records=18
                Combine output records=16
                Reduce input groups=16
                Reduce shuffle bytes=192
                Reduce input records=16
                Reduce output records=16
                Spilled Records=32
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=31
                CPU time spent (ms)=710
                Physical memory (bytes) snapshot=546140160
                Virtual memory (bytes) snapshot=5476126720
                Total committed heap usage (bytes)=321912832
                Peak Map Physical memory (bytes)=321703936
                Peak Map Virtual memory (bytes)=2733084672
                Peak Reduce Physical memory (bytes)=224436224
                Peak Reduce Virtual memory (bytes)=2743042048
        Shuffle Errors
                BAD_ID=0
                CONNECTION=0
                IO_ERROR=0
                WRONG_LENGTH=0
                WRONG_MAP=0
                WRONG_REDUCE=0
        File Input Format Counters
                Bytes Read=107
        File Output Format Counters
                Bytes Written=122
```

```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -ls /wordcount/output
Found 2 items
-rw-r--r--   1 hdoop supergroup          0 2025-03-11 14:36 /wordcount/output/_SUCCESS
-rw-r--r--   1 hdoop supergroup        122 2025-03-11 14:36 /wordcount/output/part-r-00000

┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -cat /wordcount/output/part-r-00000
145     1
Hadoop  2
Hello   1
MapReduce       2
Welcome 1
World   1
big     1
data    1
for     1
great   1
is      1
of      1
processing      1
the     1
to      1
world   1

┌──(hdoop㉿cln35h)-[~/wordcount]
└─$
```



Practical: 3

Implement an MapReduce program that processes a weather dataset.

Code:

Download data from: https://www.ncei.noaa.gov/data/global-historical-climatology-network-daily/access/AGE00147718.csv

STATION	DATE	LATITUDE	LONGITUDE	ELEVATION	NAME	PRCP	PRCP_ATTRIBUTES	TMAX	TMAX_ATTRIBUTES	TMIN	TMIN_ATTRIBUTES	TAVG	TAVG_ATTRIBUTES
AGE00147718	1880-01-01	34.85	5.72	125	BISKRA, AG	0	,,E			64	,,E		
AGE00147718	1880-01-02	34.85	5.72	125	BISKRA, AG	0	,,E			68	,,E		
AGE00147718	1880-01-03	34.85	5.72	125	BISKRA, AG	0	,,E			36	,,E		
AGE00147718	1880-01-04	34.85	5.72	125	BISKRA, AG	0	,,E			72	,,E		
AGE00147718	1880-01-05	34.85	5.72	125	BISKRA, AG	0	,,E			64	,,E		
AGE00147718	1880-01-06	34.85	5.72	125	BISKRA, AG	0	,,E			68	,,E		
AGE00147718	1880-01-07	34.85	5.72	125	BISKRA, AG	0	,,E			60	,,E		
AGE00147718	1880-01-08	34.85	5.72	125	BISKRA, AG	0	,,E			70	,,E		
AGE00147718	1880-01-09	34.85	5.72	125	BISKRA, AG	0	,,E			70	,,E		
AGE00147718	1880-01-10	34.85	5.72	125	BISKRA, AG	0	,,E			2	,,E		
AGE00147718	1880-01-11	34.85	5.72	125	BISKRA, AG	0	,,E			1	,,E		
AGE00147718	1880-01-12	34.85	5.72	125	BISKRA, AG	0	,,E			0	,,E		
AGE00147718	1880-01-13	34.85	5.72	125	BISKRA, AG	0	,,E			38	,,E		
AGE00147718	1880-01-14	34.85	5.72	125	BISKRA, AG	0	,,E			2	,,E		

Create MaxTemperaturePerYear.java

```
import java.io.IOException;
import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
```

```
public class MaxTemperaturePerYear {
   public static class TemperatureMapper extends Mapper<LongWritable, Text, Text,
IntWritable> {
      private Text year = new Text();
      private IntWritable temperature = new IntWritable();
      public void map(LongWritable key, Text value, Context context) throws IOException,
InterruptedException {
         String line = value.toString();
         String[] fields = line.split("\t");  // Split by tab
         if (key.get() == 0 && fields[0].equals("STATION")) return;
         try {
            String date = fields[1]; // Extract DATE
            String tmaxStr = fields[8].trim(); // Extract and trim TMAX
            String extractedYear = extractYear(date);
            if (extractedYear == null) return;
            if (!tmaxStr.isEmpty() && tmaxStr.matches("-?\\d+")) {
               year.set(extractedYear); // Set year
               temperature.set(Integer.parseInt(tmaxStr)); // Convert TMAX to int
               context.write(year, temperature); // Emit (year, temperature)
            }
         } catch (Exception e) {
         }
      }
      private String extractYear(String date) {
         String[] dateParts = date.split("[-/]"); // Support YYYY-MM-DD or MM/DD/YYYY
         if (dateParts.length == 3) {
            if (dateParts[0].length() == 4) { // YYYY-MM-DD
               return dateParts[0];
            } else if (dateParts[2].length() == 4) { // MM/DD/YYYY
               return dateParts[2];
            }
```

```
        }
        return null;        }
    }
    public static class TemperatureReducer extends Reducer<Text, IntWritable, Text,
IntWritable> {
        public void reduce(Text key, Iterable<IntWritable> values, Context context) throws
IOException, InterruptedException {
            int maxTemp = Integer.MIN_VALUE;
            for (IntWritable val : values) {
                maxTemp = Math.max(maxTemp, val.get());
            }
            context.write(key, new IntWritable(maxTemp));
        }
    }
    public static void main(String[] args) throws Exception {
        Configuration conf = new Configuration();
        Job job = Job.getInstance(conf, "Max Temperature Per Year");
        job.setJarByClass(MaxTemperaturePerYear.class);
        job.setMapperClass(TemperatureMapper.class);
        job.setReducerClass(TemperatureReducer.class);
        job.setMapOutputKeyClass(Text.class);
        job.setMapOutputValueClass(IntWritable.class);
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(IntWritable.class);
        FileInputFormat.addInputPath(job, new Path(args[0]));
        FileOutputFormat.setOutputPath(job, new Path(args[1]));
        System.exit(job.waitForCompletion(true) ? 0 : 1);
    }
}
```

Command:

hadoop com.sun.tools.javac.Main MaxTemperaturePerYear.java

jar cf max-temp.jar MaxTemperaturePerYear*.class

```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hadoop com.sun.tools.javac.Main MaxTemperaturePerYear.java
jar cf max-temp.jar MaxTemperaturePerYear*.class
```

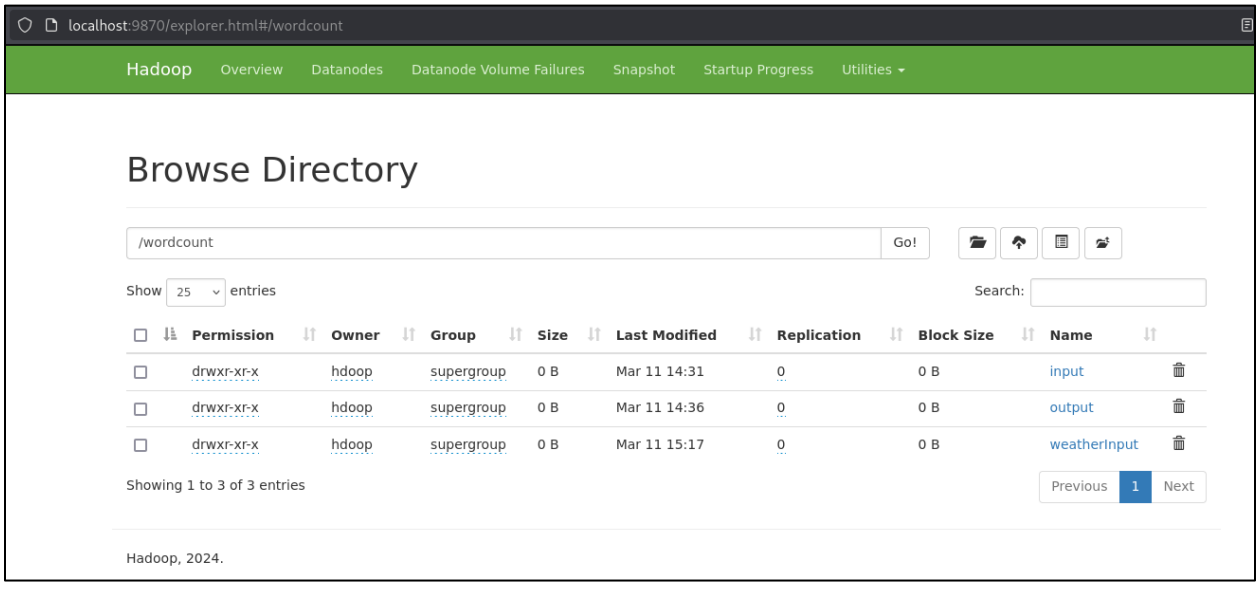
Then create directory in HDFS using command:

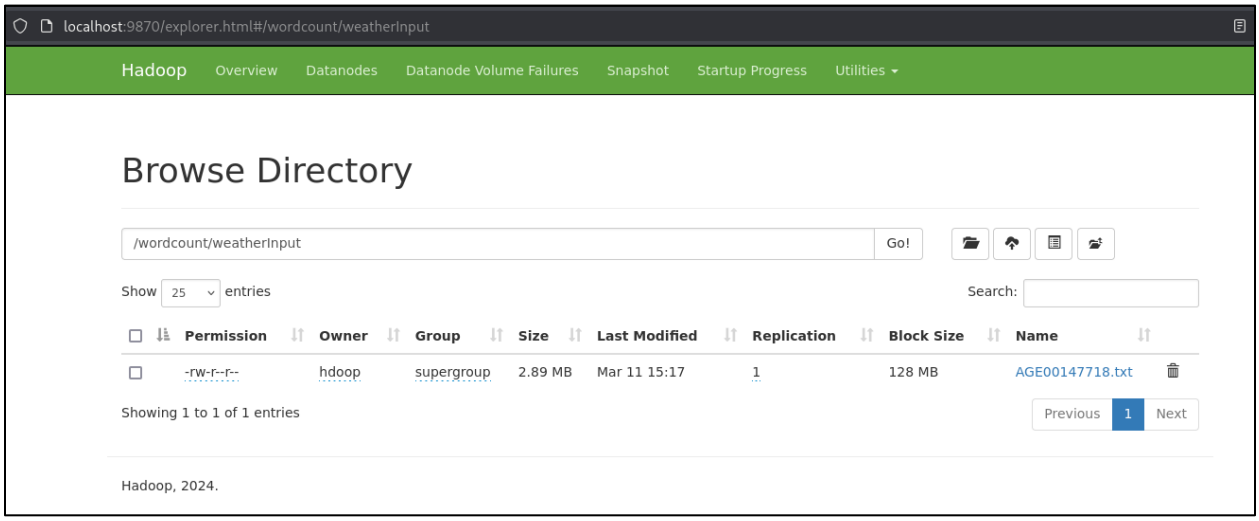
hdfs dfs -mkdir -p /wordcount/weatherInput

Then put dataset file in HDFS:

hdfs dfs -put /home/hdoop/wordcount/AGE00147718.txt /wordcount/weatherInput

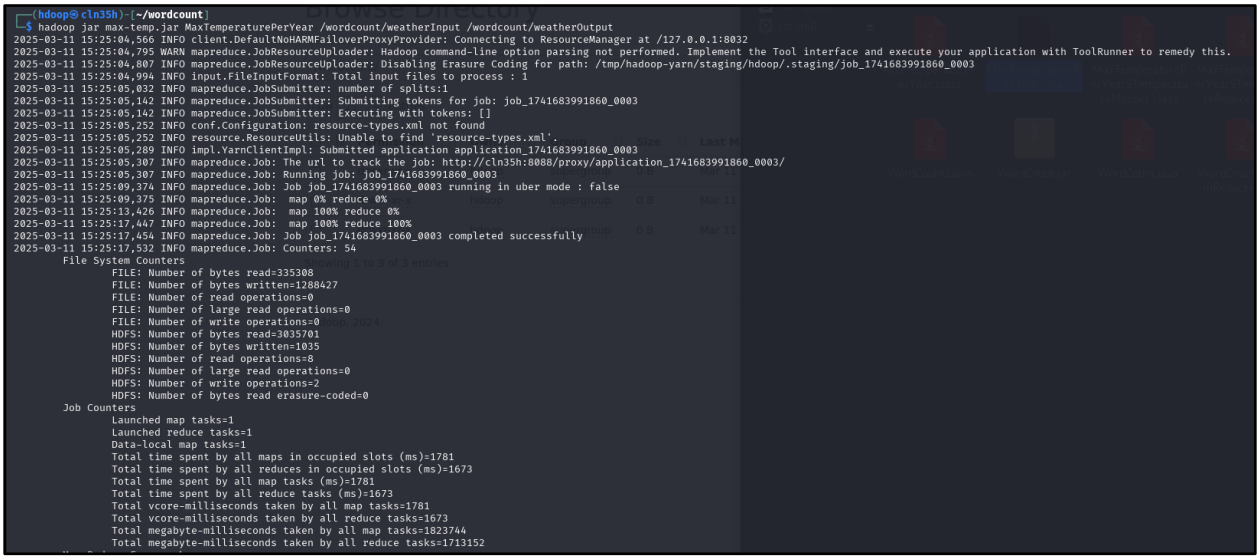
```
┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -mkdir -p /wordcount/weatherInput

┌──(hdoop㉿cln35h)-[~/wordcount]
└─$ hdfs dfs -put /home/hdoop/wordcount/AGE00147718.txt /wordcount/weatherInput
```





Then run command to find highest temperature in that respective year and create output directory Command:

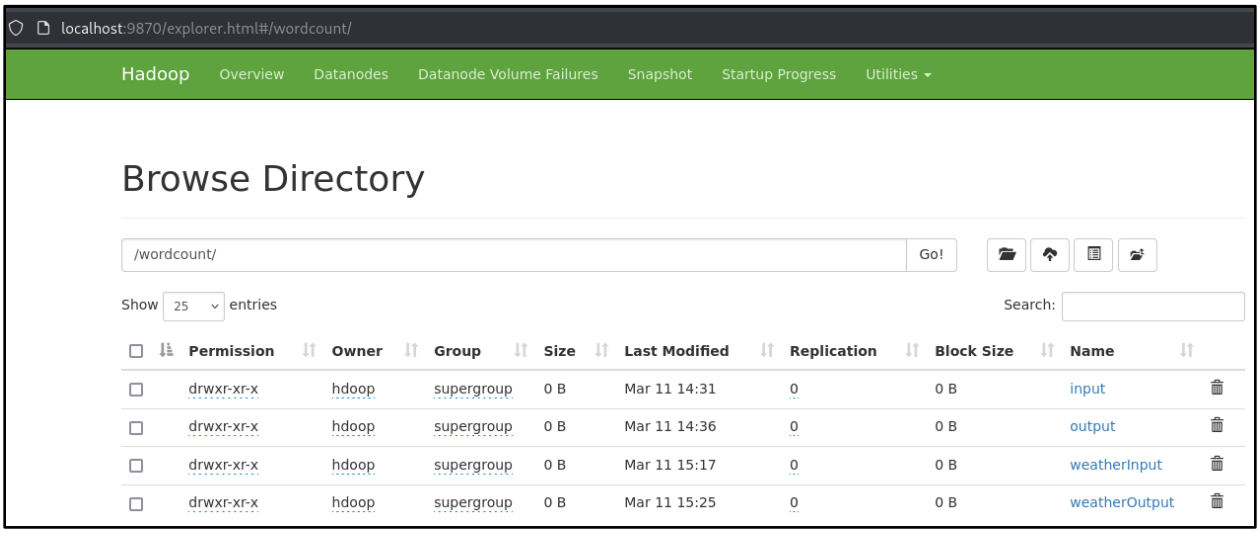
hadoop jar max-temp.jar MaxTemperaturePerYear /wordcount/weatherInput /wordcount/weatherOutput

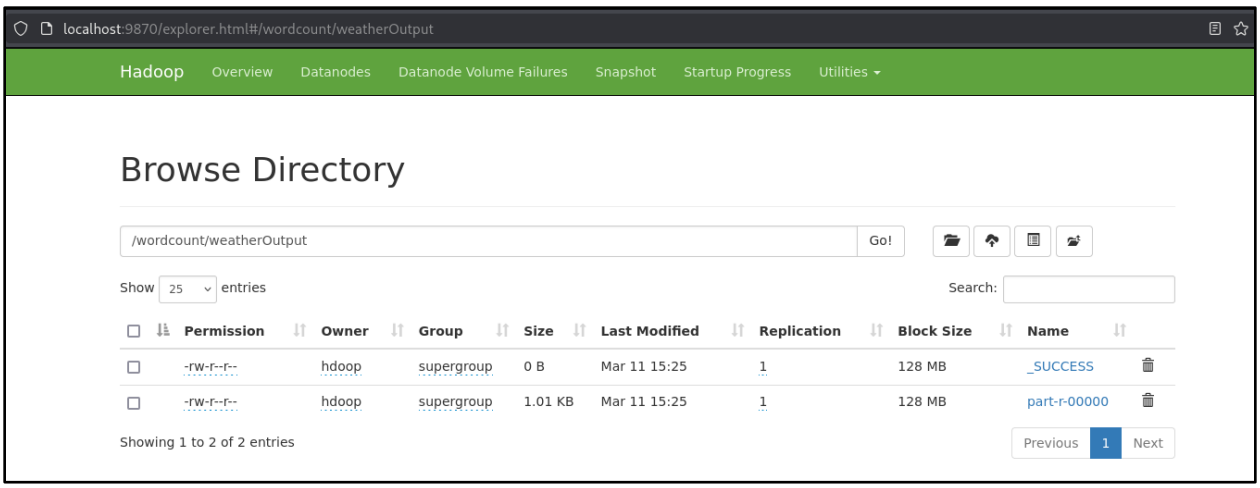


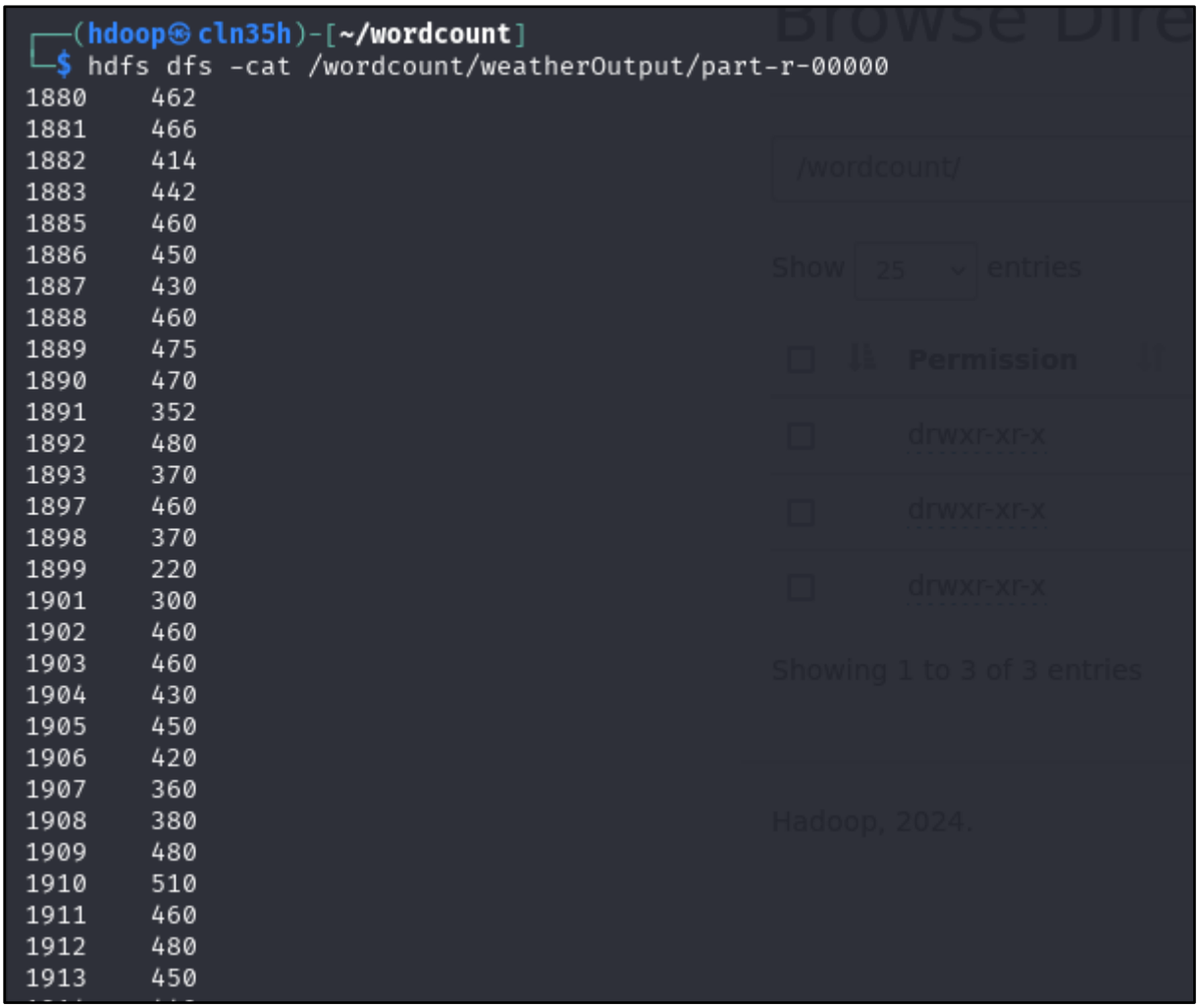
```
Map-Reduce Framework
        Map input records=37138
        Map output records=30482
        Map output bytes=274338
        Map output materialized bytes=335308
        Input split bytes=125
        Combine input records=0
        Combine output records=0
        Reduce input groups=115
        Reduce shuffle bytes=335308
        Reduce input records=30482
        Reduce output records=115
        Spilled Records=60964
        Shuffled Maps =1
        Failed Shuffles=0
        Merged Map outputs=1
        GC time elapsed (ms)=34
        CPU time spent (ms)=1980
        Physical memory (bytes) snapshot=561418240
        Virtual memory (bytes) snapshot=5478084608
        Total committed heap usage (bytes)=370147328
        Peak Map Physical memory (bytes)=342487040
        Peak Map Virtual memory (bytes)=2739007488
        Peak Reduce Physical memory (bytes)=218931200
        Peak Reduce Virtual memory (bytes)=2739077120
Shuffle Errors
        BAD_ID=0
        CONNECTION=0
        IO_ERROR=0
        WRONG_LENGTH=0
        WRONG_MAP=0
        WRONG_REDUCE=0
File Input Format Counters
        Bytes Read=3035576
File Output Format Counters
        Bytes Written=1035
```

Command to display data:

hdfs dfs -cat /wordcount/weatherOutput/part-r-00000




localhost:9870/explorer.html#/wordcount/weatherOutput
Hadoop
Overview
Datanodes
Datanode Volume Failures
Snapshot
Startup Progress
Utilities
Browse Directory
/wordcount/weatherOutput
Go!
Show 25 entries
Search:
Permission
Owner
Group
Size
Last Modified
Replication
Block Size
Name
-rw-r--r--
hdoop
supergroup
0 B
Mar 11 15:25
1
128 MB
_SUCCESS
-rw-r--r--
hdoop
supergroup
1.01 KB
Mar 11 15:25
1
128 MB
part-r-00000
Showing 1 to 2 of 2 entries
Previous
1
Next


(hdoop㉿cln35h)-[~/wordcount]
$ hdfs dfs -cat /wordcount/weatherOutput/part-r-00000
1880 462
1881 466
1882 414
1883 442
1885 460
1886 450
1887 430
1888 460
1889 475
1890 470
1891 352
1892 480
1893 370
1897 460
1898 370
1899 220
1901 300
1902 460
1903 460
1904 430
1905 450
1906 420
1907 360
1908 380
1909 480
1910 510
1911 460
1912 480
1913 450

Practical: 4

Implement an application that stores big data in Hbase / MongoDB and manipulate it using R / Python

Code:

```
from pymongo import MongoClient
from pymongo.server_api import ServerApi
MONGO_URI =
"mongodb+srv://dineshskumawat0:<db_password>@cluster0.v50o3.mongodb.net/?retryWrites=
true&w=majority&appName=Cluster0"
DATABASE_NAME = "sample_mflix"
client = MongoClient(MONGO_URI, server_api=ServerApi('1'))
try:
    client.admin.command('ping')
    print("Connection Established: Successfully connected to MongoDB!")
except Exception as e:
    print(f"Connection Failed: {e}")
    exit()
db = client[DATABASE_NAME]
comments_collection = db["comments"]
movies_collection = db["movies"]
users_collection = db["users"]
def insert_document(collection, document):
    """Insert a document into a collection"""
    result = collection.insert_one(document)
    print(f"Inserted document ID: {result.inserted_id}")
def find_documents(collection, query={}, limit=5):
    """Find documents based on a query"""
    results = collection.find(query).limit(limit)
```

```
    for doc in results:
        print(doc)
def update_document(collection, query, update_values):
    """Update documents based on a query"""
    result = collection.update_many(query, {"$set": update_values})
    print(f"Matched {result.matched_count}, Modified {result.modified_count}")
def delete_document(collection, query):
    """Delete documents based on a query"""
    result = collection.delete_many(query)
    print(f"Deleted {result.deleted_count} documents")
if __name__ == "__main__":
    print("\n--- MongoDB Connection Established ---")
    sample_doc = {"name": "Dinesh Kumawat", "email": "dineshskumawat0@gmail.com"}
    insert_document(users_collection, sample_doc)
    print("\nFinding Users:")
    find_documents(users_collection, {"name": "Dinesh Kumawat"})
    print("\nUpdating User:")
    update_document(users_collection, {"name": "Dinesh Kumawat"}, {"email":
"dineshkumarskumawat@gmail.com"})
    print("\nDeleting User:")
    delete_document(users_collection, {"name": "Dinesh Kumawat"})
```

Output:

```
========== RESTART: C:\Users\Dinesh\Downloads\pyCheckmang.py ==========
Connection Established: Successfully connected to MongoDB!

--- MongoDB Connection Established ---
Inserted document ID: 67d01168ac77201c71ea59ae

Finding Users:
{'_id': ObjectId('67d01168ac77201c71ea59ae'), 'name': 'Dinesh Kumawat', 'email': 'dineshskumawat0@gmail.com'}

Updating User:
Matched 1, Modified 1

Deleting User:
Deleted 1 documents
```

Practical: 5

Implement Decision tree classification techniques

Code:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.datasets import load_iris
from sklearn.metrics import accuracy_score, classification_report
import matplotlib.pyplot as plt

iris = load_iris()
X = iris.data
y = iris.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)
dt_classifier = DecisionTreeClassifier(random_state=42)

dt_classifier.fit(X_train, y_train)

y_pred = dt_classifier.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.2f}")

print("\nClassification Report:\n", classification_report(y_test, y_pred))

plt.figure(figsize=(12, 8))
plot_tree(dt_classifier, filled=True, feature_names=iris.feature_names,
```

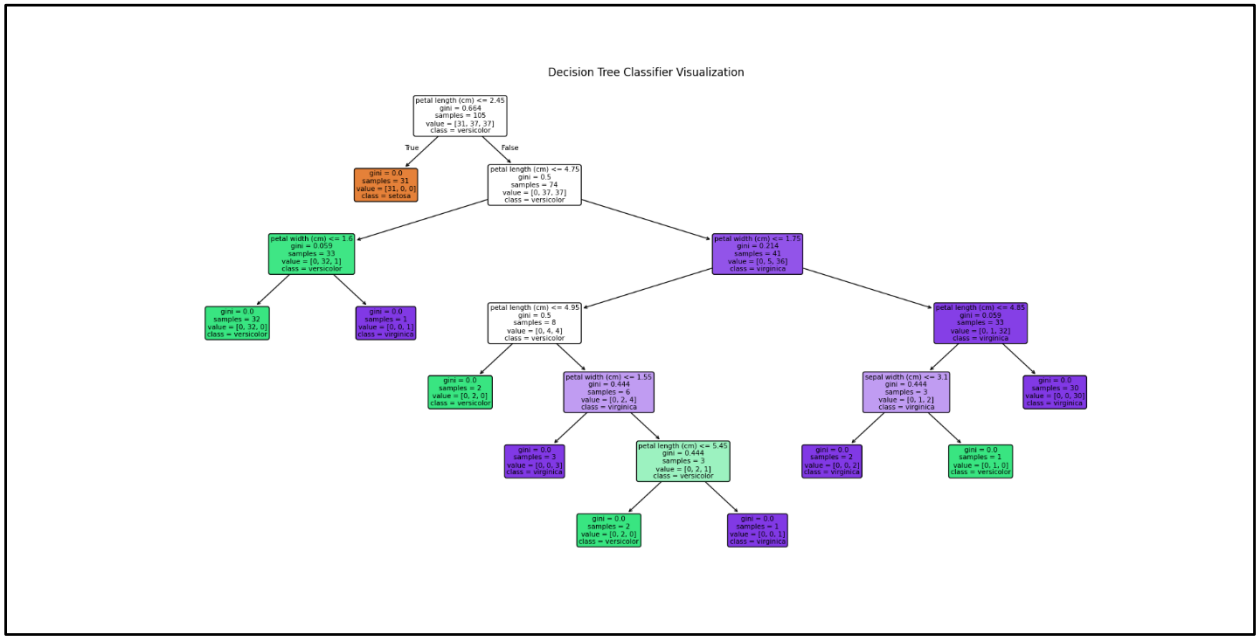
class_names=iris.target_names, rounded=True)

plt.title("Decision Tree Classifier Visualization")

plt.show()

Output:

```
================================== RESTART: C:/Users/Dinesh/Downloads/classy.py ==
Accuracy: 1.00

Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        19
           1       1.00      1.00      1.00        13
           2       1.00      1.00      1.00        13

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45
```



Practical: 6

Implement SVM classification techniques

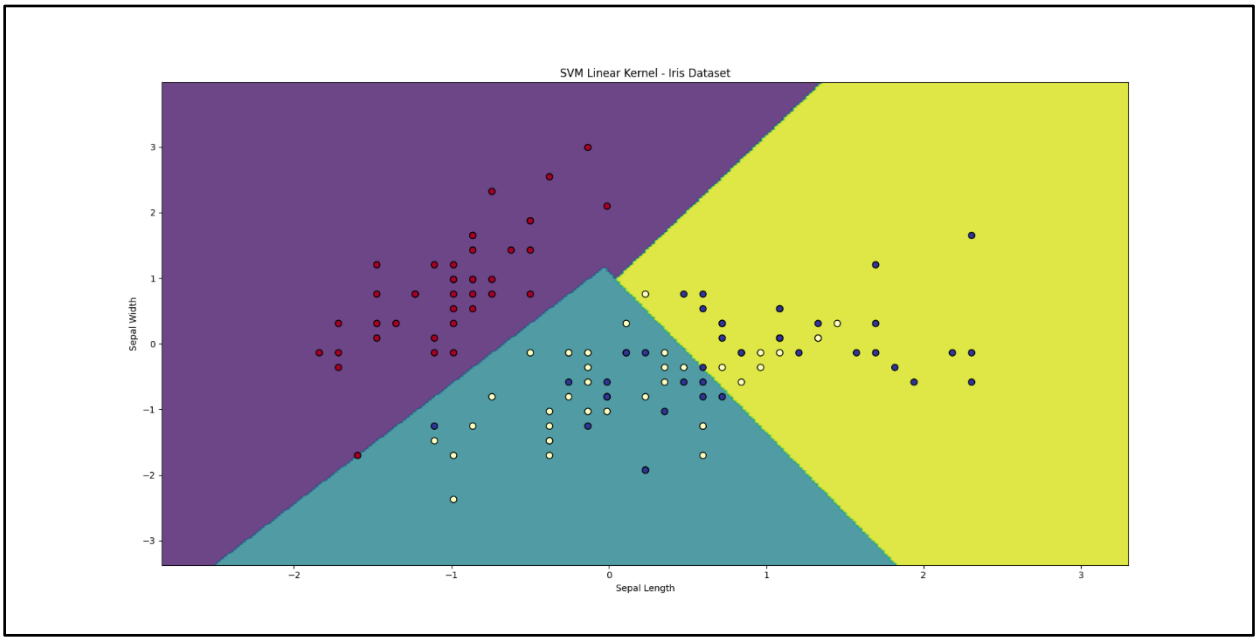
Code:

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn import datasets
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVC
from sklearn.metrics import classification_report, confusion_matrix

iris = datasets.load_iris()
X = iris.data
y = iris.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

model = SVC(kernel='linear')
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

print("Classification Report:")
```

```
print(classification_report(y_test, y_pred))

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

X_train_2d = X_train[:, :2]
X_test_2d = X_test[:, :2]

model_2d = SVC(kernel='linear')
model_2d.fit(X_train_2d, y_train)

plt.figure(figsize=(10,6))
h = .02
x_min, x_max = X_train_2d[:, 0].min() - 1, X_train_2d[:, 0].max() + 1
y_min, y_max = X_train_2d[:, 1].min() - 1, X_train_2d[:, 1].max() + 1

xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))
Z = model_2d.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)

plt.contourf(xx, yy, Z, alpha=0.8)
plt.scatter(X_train_2d[:, 0], X_train_2d[:, 1], c=y_train, edgecolors='k', marker='o', s=50,
cmap=plt.cm.RdYlBu)
plt.title('SVM Linear Kernel - Iris Dataset')
plt.xlabel('Sepal Length')
plt.ylabel('Sepal Width')
plt.show()
```

Output:

```
================================== RESTART: C:/Users/Dinesh/Downloads/svm.py ===
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       1.00      0.89      0.94         9
           2       0.92      1.00      0.96        11

    accuracy                           0.97        30
   macro avg       0.97      0.96      0.97        30
weighted avg       0.97      0.97      0.97        30

Confusion Matrix:
[[10  0  0]
 [ 0  8  1]
 [ 0  0 11]]
```



Practical: 7

REGRESSION MODEL

Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).

Code:

```
library(rio)
library(tidyverse)
library(ggplot2)
library(caret)

raw_data <-
import("https://raw.githubusercontent.com/finnstats/finnstats/a9164a541ee2f4a830bfb66363ac3b7edc8b3449/binary.csv")

str(raw_data)
```

```
> str(raw_data)
'data.frame':   400 obs. of  4 variables:
 $ admit: int  0 1 1 1 0 1 1 0 1 0 ...
 $ gre  : int  380 660 800 640 520 760 560 400 540 700 ...
 $ gpa  : num  3.61 3.67 4 3.19 2.93 3 2.98 3.08 3.39 3.92 ...
 $ rank : int  3 3 1 4 4 2 1 2 3 2 ...
```

```
raw_data$admit <- as.factor(case_when(raw_data$admit == 1 ~ "Success", raw_data$admit == 0 ~ "Fail"))
raw_data$rank <- as.factor(raw_data$rank)

xtabs(~admit + rank, raw_data)
```

```
> xtabs(~admit + rank, raw_data)
         rank
admit      1  2  3  4
  Fail    28 97 93 55
  Success 33 54 28 12
```

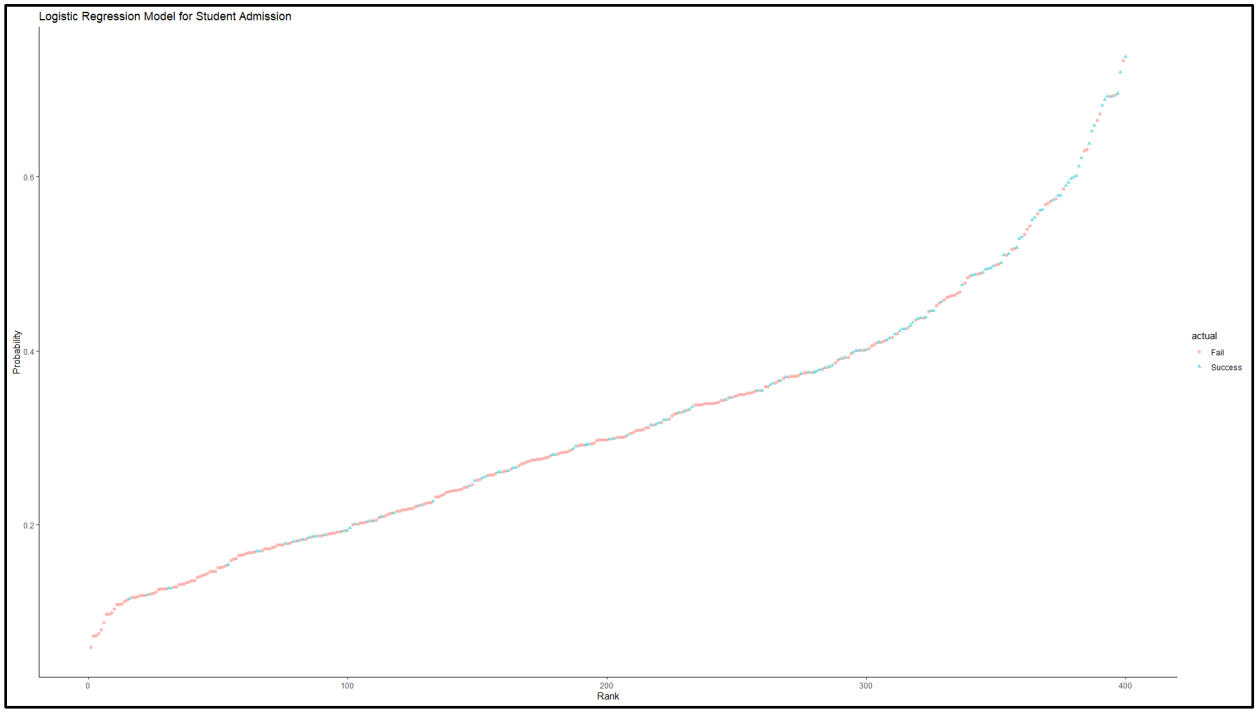
```
model <- glm(admit ~ gre + gpa + rank, data = raw_data, family = "binomial")
summary(model)
```

```
> summary(model)

Call:
glm(formula = admit ~ gre + gpa + rank, family = "binomial",
    data = raw_data)

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.989979   1.139951  -3.500 0.000465 ***
gre          0.002264   0.001094   2.070 0.038465 *
gpa          0.804038   0.331819   2.423 0.015388 *
rank2       -0.675443   0.316490  -2.134 0.032829 *
rank3       -1.340204   0.345306  -3.881 0.000104 ***
rank4       -1.551464   0.417832  -3.713 0.000205 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 499.98  on 399  degrees of freedom
Residual deviance: 458.52  on 394  degrees of freedom
AIC: 470.52

Number of Fisher Scoring iterations: 4
```

```
result <- data.frame(predict_pct = model$fitted.values, actual = raw_data$admit)
result <- result %>% arrange(predict_pct)
result$rank <- 1:nrow(result)
ggplot(result) +
  geom_point(aes(x = rank, y = predict_pct, color = actual, shape = actual), alpha = 0.5) +
  labs(title = "Logistic Regression Model for Student Admission") +
  xlab("Rank") + ylab("Probability") + theme_classic()


result$predict <- if_else(result$predict_pct > 0.5, "Success", "Fail")
confusionMatrix(as.factor(result$predict), result$actual, positive = "Success")
```

```
> confusionMatrix(as.factor(result$predict), result$actual, positive = "Success")
Confusion Matrix and Statistics

          Reference
Prediction Fail Success
   Fail     254      97
   Success   19      30

               Accuracy : 0.71
                 95% CI : (0.6628, 0.754)
    No Information Rate : 0.6825
    P-Value [Acc > NIR] : 0.1293

                  Kappa : 0.1994

 Mcnemar's Test P-Value : 8.724e-13

            Sensitivity : 0.2362
            Specificity : 0.9304
         Pos Pred Value : 0.6122
         Neg Pred Value : 0.7236
             Prevalence : 0.3175
         Detection Rate : 0.0750
   Detection Prevalence : 0.1225
      Balanced Accuracy : 0.5833

       'Positive' Class : Success
```

Output:



Practical: 8

MULTIPLE REGRESSION MODEL

Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.

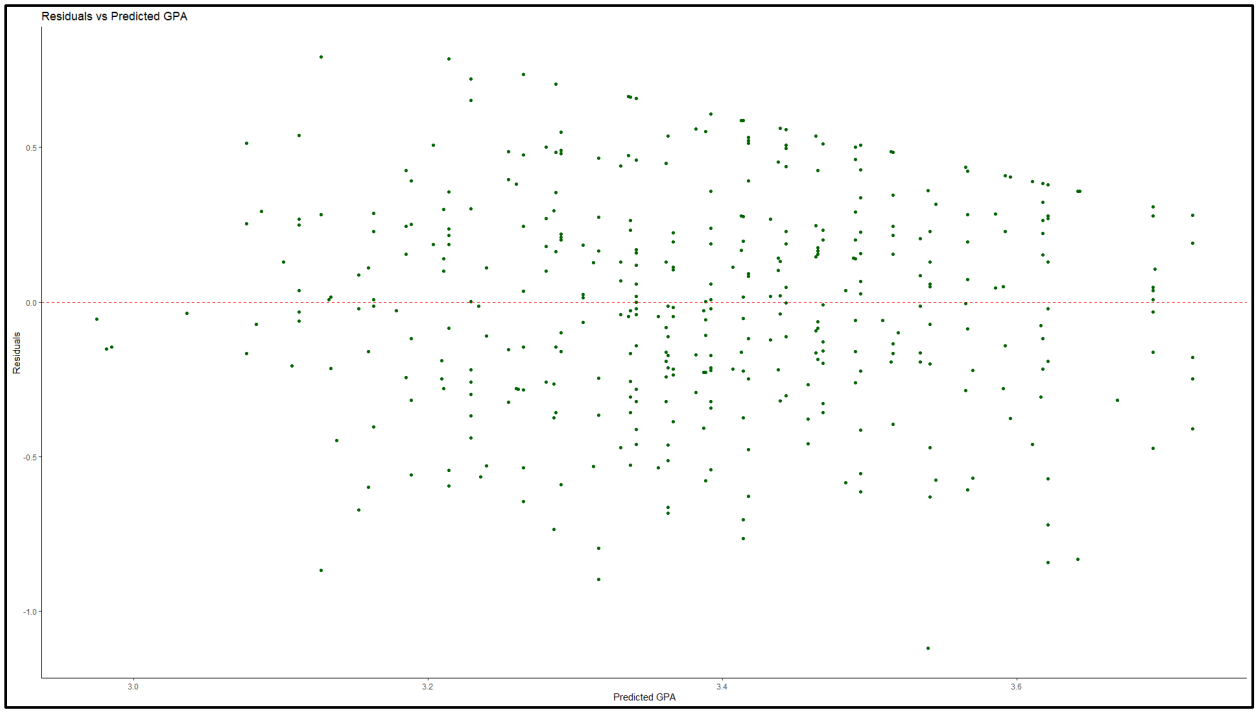
Code:

```
library(rio)
library(tidyverse)
library(ggplot2)
library(caret)
raw_data <-
import("https://raw.githubusercontent.com/finnstats/finnstats/a9164a541ee2f4a830bfb66363ac3b7edc8b3449/binary.csv")
str(raw_data)
raw_data$rank <- as.factor(raw_data$rank)
model_multiple <- lm(gpa ~ gre + rank, data = raw_data)
summary(model_multiple)
```

```
> summary(model_multiple)

Call:
lm(formula = gpa ~ gre + rank, data = raw_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.11990 -0.22477  0.00711  0.24871  0.79272

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.6745588  0.1037273  25.785  < 2e-16 ***
gre          0.0012726  0.0001529   8.322 1.42e-15 ***
rank2       -0.0713822  0.0531462  -1.343    0.180
rank3        0.0267699  0.0552419   0.485    0.628
rank4       -0.0817493  0.0622583  -1.313    0.190
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.35 on 395 degrees of freedom
Multiple R-squared:  0.1629,    Adjusted R-squared:  0.1544
F-statistic: 19.22 on 4 and 395 DF,  p-value: 1.864e-14
```

```
raw_data$predicted_gpa <- predict(model_multiple, newdata = raw_data)
ggplot(raw_data, aes(x = gpa, y = predicted_gpa)) +
  geom_point(color = "blue") +
  geom_smooth(method = "lm", color = "red") +
  labs(title = "Actual vs Predicted GPA (Multiple Linear Regression)", x = "Actual GPA", y =
"Predicted GPA") +
  theme_classic()

raw_data$residuals <- residuals(model_multiple)
ggplot(raw_data, aes(x = predicted_gpa, y = residuals)) +   geom_point(color = "darkgreen") +
  geom_hline(yintercept = 0, linetype = "dashed", color = "red") +
  labs(title = "Residuals vs Predicted GPA", x = "Predicted GPA", y = "Residuals") +
  theme_classic()
```

Output:



Practical: 9

CLASSIFICATION MODEL

a. Install relevant package for classification.

b. Choose classifier for classification problem.

c. Evaluate the performance of classifier.

Code:

```
library(caret)
library(randomForest)


raw_data$admit <- as.factor(raw_data$admit)


set.seed(123)  # For reproducibility
trainIndex <- createDataPartition(raw_data$admit, p = 0.8, list = FALSE)
trainData <- raw_data[trainIndex, ]
testData <- raw_data[-trainIndex, ]


rf_model <- randomForest(admit ~ gre + gpa + rank, data = trainData)
print(rf_model)
```

```
> print(rf_model)

Call:
 randomForest(formula = admit ~ gre + gpa + rank, data = trainData)
               Type of random forest: classification
                     Number of trees: 500
No. of variables tried at each split: 1

        OOB estimate of  error rate: 28.97%
Confusion matrix:
    0  1 class.error
0 204 15  0.06849315
1  78 24  0.76470588
```

predictions <- predict(rf_model, newdata = testData)

confusion_matrix <- confusionMatrix(predictions, testData$admit)

print(confusion_matrix)

```
> print(confusion_matrix)
Confusion Matrix and Statistics

          Reference
Prediction  0  1
         0 53 20
         1  1  5

               Accuracy : 0.7342
                 95% CI : (0.6228, 0.8273)
    No Information Rate : 0.6835
    P-Value [Acc > NIR] : 0.1998

                  Kappa : 0.228

 Mcnemar's Test P-Value : 8.568e-05

            Sensitivity : 0.9815
            Specificity : 0.2000
         Pos Pred Value : 0.7260
         Neg Pred Value : 0.8333
             Prevalence : 0.6835
         Detection Rate : 0.6709
   Detection Prevalence : 0.9241
      Balanced Accuracy : 0.5907

       'Positive' Class : 0
```

Practical: 10

CLUSTERING MODEL

a. Clustering algorithms for unsupervised classification.

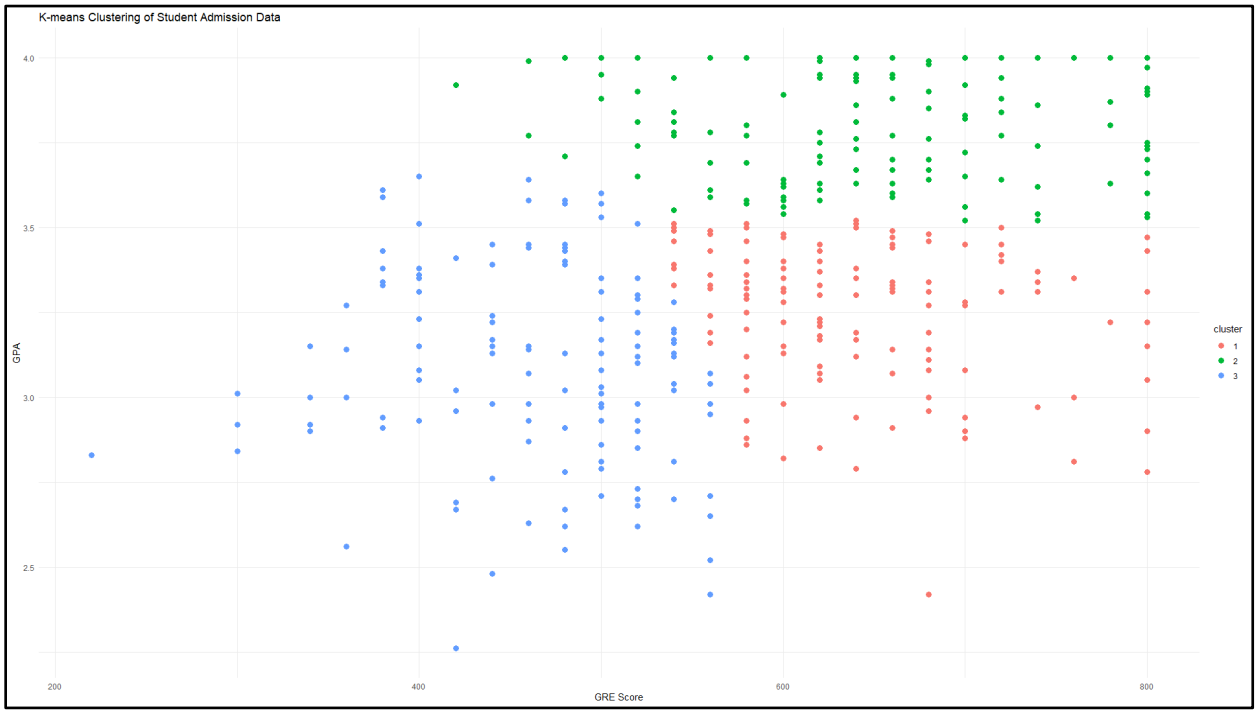
b. Plot the cluster data using R visualizations

Code:

```
library(ggplot2)
library(cluster)
library(factoextra)

clustering_data <- raw_data[, c("gre", "gpa")]

clustering_data_scaled <- scale(clustering_data)

fviz_nbclust(clustering_data_scaled, kmeans, method = "wss")

kmeans_result <- kmeans(clustering_data_scaled, centers = 3, nstart = 25)

print(kmeans_result)
raw_data$cluster <- as.factor(kmeans_result$cluster)

ggplot(raw_data, aes(x = gre, y = gpa, color = cluster)) +
  geom_point(size = 3) +
  labs(title = "K-means Clustering of Student Admission Data",
       x = "GRE Score", y = "GPA") +
  theme_minimal()
```

```
> print(kmeans_result)
K-means clustering with 3 clusters of sizes 133, 139, 128

Cluster means:
         gre        gpa
1  0.4592579 -0.3634607
2  0.5511497  1.0707978
3 -1.0757118 -0.7851612

Clustering vector:
  1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25  26  27  28  29  30  31  32
  3   2   2   1   3   1   3   3   1   2   2   3   2   1   2   3   2   3   2   2   3   2   1   1   1   2   2   2   1   3   2   1
 33  34  35  36  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57  58  59  60  61  62  63  64
  1   2   3   3   1   3   3   3   3   1   1   3   1   3   1   3   3   3   2   3   1   1   1   2   1   3   3   1   1   1   2   2
 65  66  67  68  69  70  71  72  73  74  75  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90  91  92  93  94  95  96
  2   2   2   1   2   2   2   3   3   2   1   2   1   2   3   2   1   1   3   3   3   3   1   1   1   2   2   2   2   1   1   1
 97  98  99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128
  1   3   1   3   3   2   3   2   2   1   2   3   3   3   1   3   3   1   2   2   3   2   2   3   2   3   3   3   2   1   2   2
129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160
  3   3   1   1   1   3   3   3   1   2   1   2   2   2   2   1   1   3   3   3   3   1   2   3   2   1   2   1   3   3   1   2
161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192
  1   1   2   3   1   2   3   2   2   2   3   3   1   1   3   1   3   1   1   3   2   2   2   2   3   2   2   1   3   3   1   2
193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224
  2   3   1   2   1   3   2   2   1   1   2   2   2   2   2   2   3   1   1   1   3   1   2   1   3   3   3   2   3   2   3   1
225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256
  1   1   2   3   3   1   1   1   3   3   2   1   1   2   3   1   3   2   1   1   3   2   1   3   2   2   1   1   2   2   2   1
257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288
  3   2   3   2   1   3   3   2   2   3   1   2   1   3   2   1   2   1   3   1   2   2   1   1   2   3   1   3   3   1   1   2
289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320
  1   3   1   1   2   2   3   3   1   3   1   1   1   2   3   2   3   1   3   1   3   3   2   2   2   2   1   3   3   2   2   3
321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352
  3   3   3   3   3   2   1   1   1   3   2   2   3   1   3   2   3   1   3   1   3   3   2   1   3   3   1   2   3   1   2   1
353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384
  1   2   2   1   1   1   2   2   2   1   1   3   1   3   3   2   2   2   2   2   1   1   2   1   2   2   1   3   2   1   1   2
385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400
  3   3   2   1   1   1   1   2   1   2   2   2   3   3   2   2

Within cluster sum of squares by cluster:
[1]  89.25814 112.07561 122.41728
 (between_SS / total_SS =  59.4 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweenss"    "size"         "iter"
[9] "ifault"
```

Output:



PRACTICAL REPORT

On

Modern Networking

Submitted in fulfilment of the

Requirements for the award of the Degree of

MASTER OF SCIENCE (INFORMATION TECHNOLOGY) – SEM II

By

NAME: DINESHKUMAR SHANKARLAL KUMAWAT

ROLL NO: PSI124002

DEPARTMENT OF INFORMATION TECHNOLOGY

THE SIA COLLEGE OF HIGHER EDUCATION

Affiliated to University of Mumbai

DOMBIVLI

MAHARASHTRA - 421203

2024-2025

THE SIA COLLEGE OF HIGHER EDUCATION

(Affiliated to University of Mumbai)

Re-Accredited B+ by NAAC

DOMBIVLI, MAHARASHTRA 421203

Department of Information Technology

CERTIFICATE

Certified that the experimental work as entered in this journal is as per syllabus in M.Sc. Information Technology for _____ as prescribed by University of Mumbai and was done in the Information Technology laboratory of The S.I.A College of Higher Education by the student Mr/ Ms _____ having Seat No. _____ of class M.Sc. Information Technology - PART I during the academic year 2024-2025.

No. of Experiments completed _____ out of _____.

Course Coordinator
Date:

Sign of Incharge
Date:

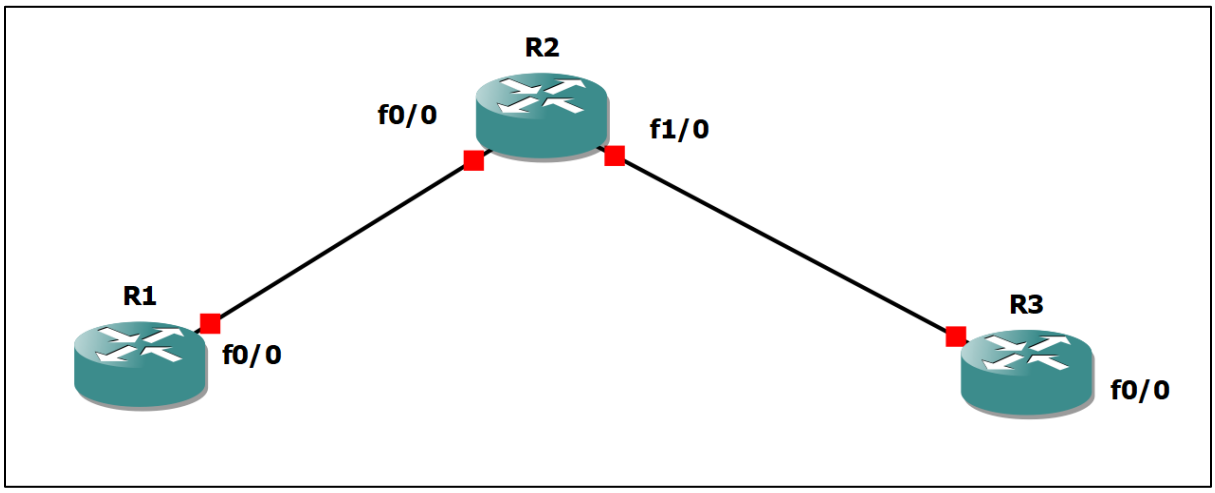
College Seal

Sign of Examiner
Date:

Index

Practical: 1A

Configure IP SLA Tracking and Path Control Topology



Command:

R1

R1#enable
R1#configure terminal
R1(config)#interface FastEthernet0/0
R1(config-if)# ip address 10.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#router rip
R1(config-router)# version 2
R1(config-router)# network 10.0.0.0
R1(config-router)#exit
R1(config)#ip sla 1
R1(config-ip-sla)# icmp-echo 10.0.1.2

```
R1#enable
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface FastEthernet0/0
R1(config-if)# ip address 10.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#router rip
R1(config-router)# version 2
R1(config-router)# network 10.0.0.0
R1(config-router)#exit
R1(config)#ip sla 1
R1(config-ip-sla)# icmp-echo 10.0.1.2
```

R1(config-ip-sla-echo)# timeout 5000
R1(config-ip-sla-echo)# frequency 6
R1(config-ip-sla-echo)#exit
R1(config)#ip sla schedule 1 life forever start-time now
R1(config)#track 1 ip sla 1 reachability
R1(config-track)#ip route 0.0.0.0 0.0.0.0 10.0.0.2 track 1
R1(config)#ip route 0.0.0.0 0.0.0.0 10.0.1.2 10
R1(config)#end

```
R1(config-ip-sla-echo)# timeout 5000
R1(config-ip-sla-echo)# frequency 6
R1(config-ip-sla-echo)#exit
R1(config)#ip sla schedule 1 life forever start-time now
R1(config)#track 1 ip sla 1 reachability
R1(config-track)#ip route 0.0.0.0 0.0.0.0 10.0.0.2 track 1
R1(config)#ip route 0.0.0.0 0.0.0.0 10.0.1.2 10
R1(config)#end
```

R1#show ip route
R1#show ip sla statistics

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is 10.0.0.2 to network 0.0.0.0

     10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
R       10.0.1.0 [120/1] via 10.0.0.2, 00:00:17, FastEthernet0/0
S*   0.0.0.0/0 [1/0] via 10.0.0.2
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 1
Type of operation: icmp-echo
        Latest RTT: 75 milliseconds
Latest operation start time: *20:45:48.811 UTC Fri Jun 20 2025
Latest operation return code: OK
Number of successes: 5
Number of failures: 30
Operation time to live: Forever
```

R1#show track
R1#ping 10.0.1.2

```
R1#show track
Track 1
  IP SLA 1 reachability
  Reachability is Up
    2 changes, last change 00:00:28
  Latest operation return code: OK
  Latest RTT (millisecs) 75
  Tracked by:
    STATIC-IP-ROUTING 0
R1#ping 10.0.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/58/72 ms
```

R2

R2#enable
R2#configure terminal
R2(config)#interface FastEthernet0/0
R2(config-if)# ip address 10.0.0.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config)#interface FastEthernet1/0
R2(config-if)# ip address 10.0.1.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config)#router rip
R2(config-router)# version 2
R2(config-router)# network 10.0.0.0
R2(config-router)# network 10.0.1.0
R2(config-router)#exit

```
R2#enable
R2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface FastEthernet0/0
R2(config-if)# ip address 10.0.0.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#
*Jun 20 20:43:46.351: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 20:43:47.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#exit
R2(config)#interface FastEthernet1/0
R2(config-if)# ip address 10.0.1.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#
*Jun 20 20:44:06.879: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 20 20:44:07.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R2(config-if)#exit
R2(config)#router rip
R2(config-router)# version 2
R2(config-router)# network 10.0.0.0
R2(config-router)# network 10.0.1.0
R2(config-router)#exit
R2(config)#
```

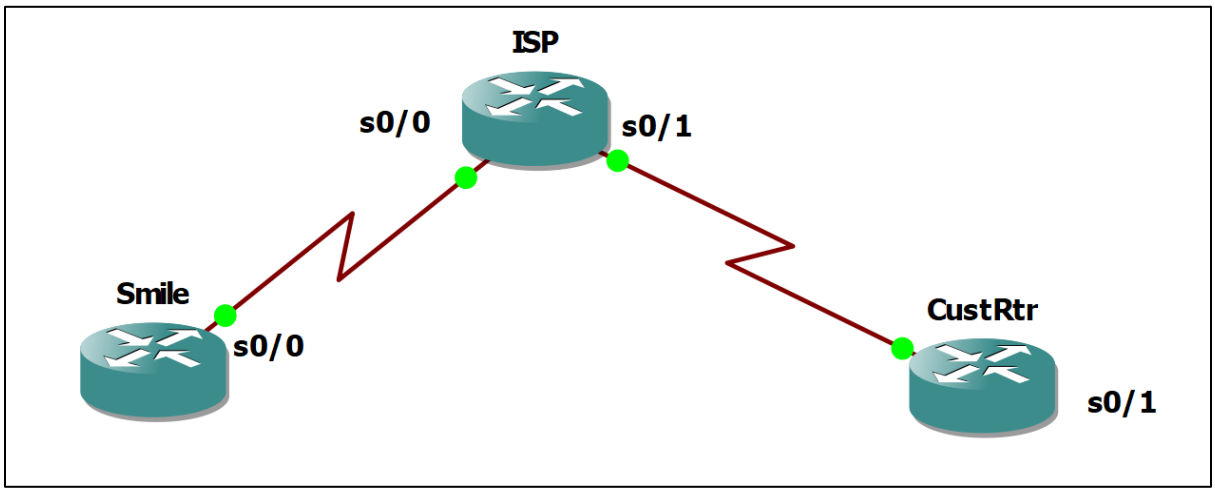
R3

R3#enable
R3#configure terminal
R3(config)#interface FastEthernet0/0
R3(config-if)# ip address 10.0.1.2 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#router rip
R3(config-router)# version 2
R3(config-router)# network 10.0.1.0
R3(config-router)#exit

```
R3#enable
R3#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#interface FastEthernet0/0
R3(config-if)# ip address 10.0.1.2 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
*Jun 20 20:45:02.439: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 20:45:03.439: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#exit
R3(config)#router rip
R3(config-router)# version 2
R3(config-router)# network 10.0.1.0
R3(config-router)#exit
```

Practical: 2

Using the AS_PATH Attribute



Command:

Smile(R1)

```
Smile#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Smile(config)#interface Loopback0
Smile(config-if)# ip address 10.1.1.1 255.255.255.0
Smile(config-if)#exit
Smile(config)#interface Serial0/0
Smile(config-if)# ip address 192.168.1.1 255.255.255.0
Smile(config-if)# no shutdown
Smile(config-if)#exit
Smile(config)#router bgp 100
Smile(config-router)# neighbor 192.168.1.2 remote-as 300
Smile(config-router)# network 10.1.1.0 mask 255.255.255.0
Smile(config-router)#exit
Smile(config)#
```

```
Smile#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Smile(config)#interface Loopback0
Smile(config-if)#
*Mar  1 00:04:51.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
Smile(config-if)# ip address 10.1.1.1 255.255.255.0
Smile(config-if)#exit
Smile(config)#interface Serial0/0
Smile(config-if)# ip address 192.168.1.1 255.255.255.0
Smile(config-if)# no shutdown
Smile(config-if)#exit
*Mar  1 00:05:27.651: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
Smile(config-if)#exit
Smile(config)#
*Mar  1 00:05:28.655: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
Smile(config)#router bgp 100
Smile(config-router)# neighbor 192.168.1.2 remote-as 300
Smile(config-router)# network 10.1.1.0 mask 255.255.255.0
Smile(config-router)#exit
Smile(config)#
*Mar  1 00:05:51.715: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to down
Smile(config)#
```

Smile#show ip route

```
Smile#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 3 subnets
B       10.3.3.0 [20/0] via 192.168.1.2, 00:00:31
B       10.2.2.0 [20/0] via 192.168.1.2, 00:01:20
C       10.1.1.0 is directly connected, Loopback0
C    192.168.1.0/24 is directly connected, Serial0/0
```

Smile#tclsh
Smile(tcl)#foreach address {10.1.1.1 10.2.2.1 10.3.3.1 192.168.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

```
Smile#tclsh
Smile(tcl)#$.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/40/56 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/85/116 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/38/48 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

ISP(R2)

ISP#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#interface Loopback0
ISP(config-if)# ip address 10.2.2.1 255.255.255.0
ISP(config-if)#exit
ISP(config)#interface Serial0/0
ISP(config-if)# ip address 192.168.1.2 255.255.255.0
ISP(config-if)# no shutdown
ISP(config-if)#exit
ISP(config)#interface Serial0/1
ISP(config-if)# ip address 192.168.2.1 255.255.255.0
ISP(config-if)# no shutdown

ISP(config-if)#exit
ISP(config)#router bgp 300
ISP(config-router)# neighbor 192.168.1.1 remote-as 100
ISP(config-router)# neighbor 192.168.2.2 remote-as 65000
ISP(config-router)# network 10.2.2.0 mask 255.255.255.0
ISP(config-router)#exit
ISP(config)#ip as-path access-list 1 deny ^100$
ISP(config)#ip as-path access-list 1 permit .*
ISP(config)#router bgp 300
ISP(config-router)# neighbor 192.168.2.2 filter-list 1 out
ISP(config-router)#exit

```
ISP#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ISP(config)#interface Loopback0
ISP(config-if)#
*Mar  1 00:07:13.063: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP(config-if)#
ISP(config-if)#
ISP(config-if)#
ISP(config-if)# ip address 10.2.2.1 255.255.255.0
ISP(config-if)#exit
ISP(config)#interface Serial0/0
ISP(config-if)# ip address 192.168.1.2 255.255.255.0
ISP(config-if)# no shutdown
ISP(config-if)#
*Mar  1 00:07:45.227: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
ISP(config-if)#exit
*Mar  1 00:07:46.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
ISP(config-if)#exit
ISP(config)#interface Serial0/1
ISP(config-if)# ip address 192.168.2.1 255.255.255.0
ISP(config-if)# no shutdown
ISP(config-if)#exit
*Mar  1 00:08:13.987: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
ISP(config-if)#exit
ISP(config)#
*Mar  1 00:08:14.991: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
ISP(config)#router bgp 300
ISP(config-router)# neighbor 192.168.1.1 remote-as 100
ISP(config-router)# neighbor 192.168.2.2 remote-as 65000
ISP(config-router)# network 10.2.2.0 mask 255.255.255.0
ISP(config-router)#
*Mar  1 00:08:41.707: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to down
ISP(config-router)#exit
ISP(config)#
*Mar  1 00:08:58.307: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Up
ISP(config)#ip as-path access-list 1 deny ^100$
ISP(config)#ip as-path access-list 1 permit .*
ISP(config)#router bgp 300
ISP(config-router)# neighbor 192.168.2.2 filter-list 1 out
ISP(config-router)#exit
```

ISP#clear ip bgp *

```
ISP#clear ip bgp *
ISP#
*Mar  1 00:10:31.591: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Down User reset
*Mar  1 00:10:31.963: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Up
ISP#
```

ISP#tclsh
ISP(tcl)#foreach address {10.1.1.1 10.2.2.1 10.3.3.1 192.168.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

```
ISP#tclsh
ISP(tcl)#$.1 192.168.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/40/64 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/32/36 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/33/48 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/82/112 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/60/64 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/29/32 ms
```

CustRtr(R3)

CustRtr#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
CustRtr(config)#interface Loopback0
CustRtr(config-if)# ip address 10.3.3.1 255.255.255.0
CustRtr(config-if)#exit
CustRtr(config)#interface Serial0/1
CustRtr(config-if)# ip address 192.168.2.2 255.255.255.0
CustRtr(config-if)# no shutdown
CustRtr(config-if)#exit
CustRtr(config)#router bgp 65000
CustRtr(config-router)# neighbor 192.168.2.1 remote-as 300
CustRtr(config-router)# network 10.3.3.0 mask 255.255.255.0
CustRtr(config-router)#exit

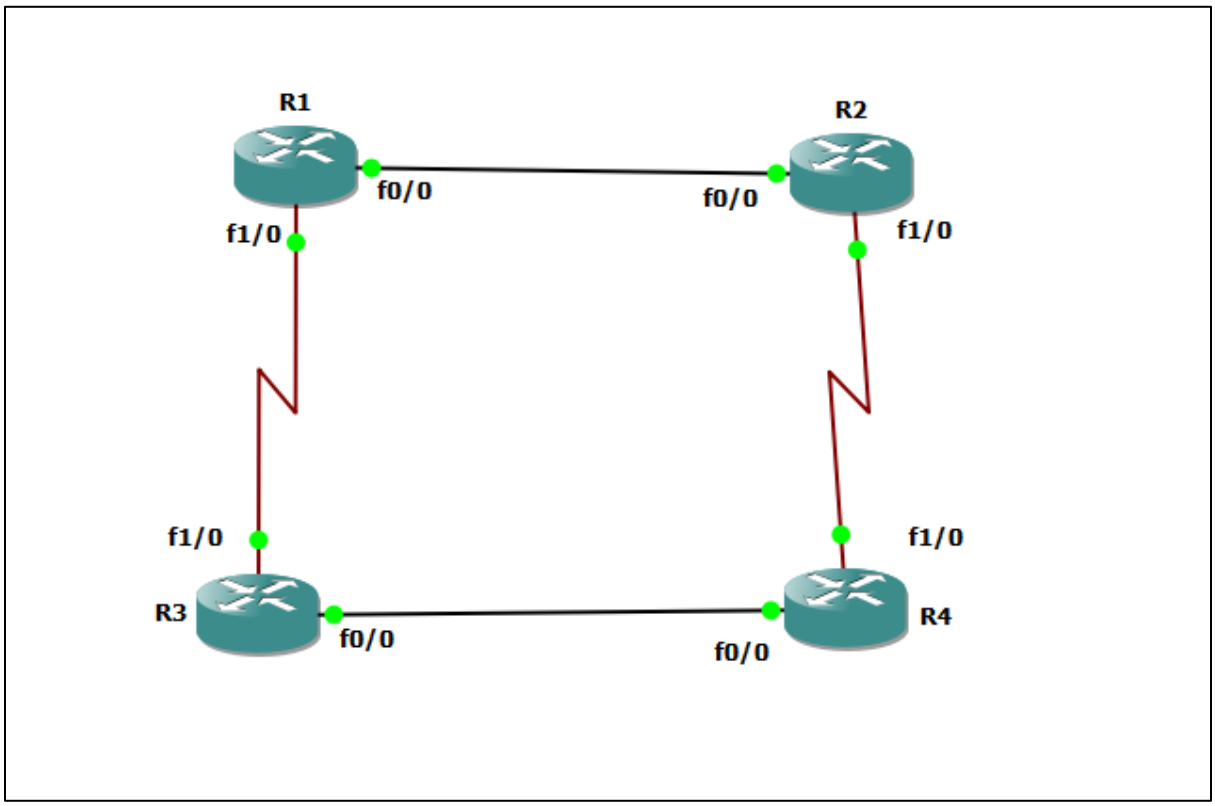
```
CustRtr#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CustRtr(config)#interface Loopback0
CustRtr(config-if)#
*Mar  1 00:12:11.239: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
CustRtr(config-if)# ip address 10.3.3.1 255.255.255.0
CustRtr(config-if)#exit
CustRtr(config)#interface Serial0/1
CustRtr(config-if)# ip address 192.168.2.2 255.255.255.0
CustRtr(config-if)# no shutdown
CustRtr(config-if)#
*Mar  1 00:12:36.479: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
CustRtr(config-if)#
*Mar  1 00:12:37.483: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
CustRtr(config-if)#exit
CustRtr(config)#router bgp 65000
CustRtr(config-router)# neighbor 192.168.2.1 remote-as 300
CustRtr(config-router)# network 10.3.3.0 mask 255.255.255.0
CustRtr(config-router)#exit
```

CustRtr#tclsh
CustRtr(tcl)#foreach address {10.1.1.1 10.2.2.1 10.3.3.1 192.168.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

```
CustRtr#tclsh
CustRtr(tcl)#$.1.1 192.168.1.2 192.168.2.1 192.168.2.2} {ping $address}

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/47/60 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/36/52 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/85/96 ms
```

Practical: 3

Configuring IBGP and EBGP Sessions, Local Preference, and MED



Command:

R1

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface fastEthernet 0/0
R1(config-if)# ip address 12.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#interface fastEthernet 1/0
R1(config-if)# ip address 13.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#exit

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface fastEthernet 0/0
R1(config-if)# ip address 12.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#
*Jun 20 23:33:52.743: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 23:33:53.743: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#exit
R1(config)#interface fastEthernet 1/0
R1(config-if)# ip address 13.0.0.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#
*Jun 20 23:34:12.755: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 20 23:34:13.755: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R1(config-if)#exit
```

BGP CONFIGURATION

R1(config)#router bgp 100
R1(config-router)#neighbor 12.0.0.2 remote-as 200
R1(config-router)# neighbor 13.0.0.3 remote-as 100
R1(config-router)# neighbor 13.0.0.3 update-source fastEthernet 1/0
R1(config-router)# network 12.0.0.0 mask 255.255.255.0
R1(config-router)# network 13.0.0.0 mask 255.255.255.0

Local Preference on R1

R1#conf t
R1(config)#route-map set_localpref permit 10
R1(config-route-map)# set local-preference 200
R1(config-route-map)#exit
R1(config)#router bgp 100
R1(config-router)# neighbor 13.0.0.3 route-map set_localpref in

```
R1(config)#router bgp 100
R1(config-router)#neighbor 12.0.0.2 remote-as 200
R1(config-router)# neighbor 13.0.0.3 remote-as 100
R1(config-router)# neighbor 13.0.0.3 update-source fastEthernet 1/0
R1(config-router)# network 12.0.0.0 mask 255.255.255.0
R1(config-router)# network 13.0.0.0 mask 255.255.255.0
R1(config-router)#
*Jun 20 23:41:54.007: %BGP-5-ADJCHANGE: neighbor 12.0.0.2 Up
R1(config-router)#
*Jun 20 23:42:36.787: %BGP-5-ADJCHANGE: neighbor 13.0.0.3 Up
R1(config-router)#
R1#
*Jun 20 23:43:54.663: %SYS-5-CONFIG_I: Configured from console by console
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#route-map set_localpref permit 10
R1(config-route-map)# set local-preference 200
R1(config-route-map)#exit
R1(config)#router bgp 100
R1(config-router)# neighbor 13.0.0.3 route-map set_localpref in
R1(config-router)#
```

R1#ping 12.0.0.2
R1#ping 13.0.0.3
R1#ping 24.0.0.1
R1#ping 34.0.0.4

```
R1#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/33/48 ms
R1#ping 13.0.0.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 13.0.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/32/40 ms
R1#ping 24.0.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 24.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/63/72 ms
R1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/64/84 ms
```

R2

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface fastEthernet 0/0
R2(config-if)# ip address 12.0.0.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config)#interface fastEthernet 1/0
R2(config-if)# ip address 24.0.0.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface fastEthernet 0/0
R2(config-if)# ip address 12.0.0.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#
R2(config-if)#
*Jun 20 23:35:15.639: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 23:35:16.639: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#exit
R2(config)#interface fastEthernet 1/0
R2(config-if)# ip address 24.0.0.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#
*Jun 20 23:35:32.867: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 20 23:35:33.867: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R2(config-if)#exit
```

BGP CONFIGURATION

R2(config)#router bgp 200
R2(config-router)#neighbor 12.0.0.1 remote-as 100
R2(config-router)#neighbor 24.0.0.4 remote-as 200
R2(config-router)#neighbor 24.0.0.4 update-source fastEthernet 1/0
R2(config-router)#network 12.0.0.0 mask 255.255.255.0
R2(config-router)# network 24.0.0.0 mask 255.255.255.0

MED on R2

R2(config)#route-map set_med permit 10
R2(config-route-map)# set metric 50
R2(config-route-map)#exit
R2(config)#router bgp 200
R2(config-router)#
R2(config-router)# neighbor 12.0.0.1 route-map set_med out

```
R2(config)#router bgp 200
R2(config-router)#neighbor 12.0.0.1 remote-as 100
R2(config-router)#
*Jun 20 23:41:53.991: %BGP-5-ADJCHANGE: neighbor 12.0.0.1 Up
R2(config-router)#neighbor 24.0.0.4 remote-as 200
R2(config-router)#neighbor 24.0.0.4 update-source fastEthernet 1/0
R2(config-router)#network 12.0.0.0 mask 255.255.255.0
R2(config-router)# network 24.0.0.0 mask 255.255.255.0
R2(config-router)#
*Jun 20 23:43:17.755: %BGP-5-ADJCHANGE: neighbor 24.0.0.4 Up
R2(config-router)#
R2#
*Jun 20 23:44:09.547: %SYS-5-CONFIG_I: Configured from console by console
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#route-map set_med permit 10
R2(config-route-map)# set metric 50
R2(config-route-map)#exit
R2(config)#router bgp 200
R2(config-router)#
R2(config-router)# neighbor 12.0.0.1 route-map set_med out
```

R3

R3#conf t
R3(config)#interface fastEthernet 0/0
R3(config-if)# ip address 34.0.0.1 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#interface fastEthernet 1/0
R3(config-if)# ip address 13.0.0.3 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config-if)#exit

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#interface fastEthernet 0/0
R3(config-if)# ip address 34.0.0.1 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#
*Jun 20 23:35:58.995: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 23:35:59.995: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#exit
R3(config)#interface fastEthernet 1/0
R3(config-if)# ip address 13.0.0.3 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
*Jun 20 23:36:15.339: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 20 23:36:16.339: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R3(config-if)#exit
```

BGP CONFIGURATION

R3(config)#router bgp 100
R3(config-router)#neighbor 13.0.0.1 remote-as 100
R3(config-router)#neighbor 13.0.0.1 update-source fastEthernet 1/0
R3(config-router)#neighbor 13.0.0.1 update-source fastEthernet 1/0
R3(config-router)#neighbor 34.0.0.4 remote-as 200
R3(config-router)# network 13.0.0.0 mask 255.255.255.0
R3(config-router)# network 34.0.0.0 mask 255.255.255.0

R4

R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#interface fastEthernet 0/0
R4(config-if)# ip address 34.0.0.4 255.255.255.0
R4(config-if)# no shutdown
R4(config-if)#exit

R4(config)#interface fastEthernet 1/0
R4(config-if)# ip address 24.0.0.4 255.255.255.0
R4(config-if)# no shutdown
R4(config-if)#exit

```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#interface fastEthernet 0/0
R4(config-if)# ip address 34.0.0.4 255.255.255.0
R4(config-if)# no shutdown
R4(config-if)#
*Jun 20 23:36:39.215: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 20 23:36:40.215: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R4(config-if)#exit
R4(config)#interface fastEthernet 1/0
R4(config-if)# ip address 24.0.0.4 255.255.255.0
R4(config-if)# no shutdown
R4(config-if)#exit
```

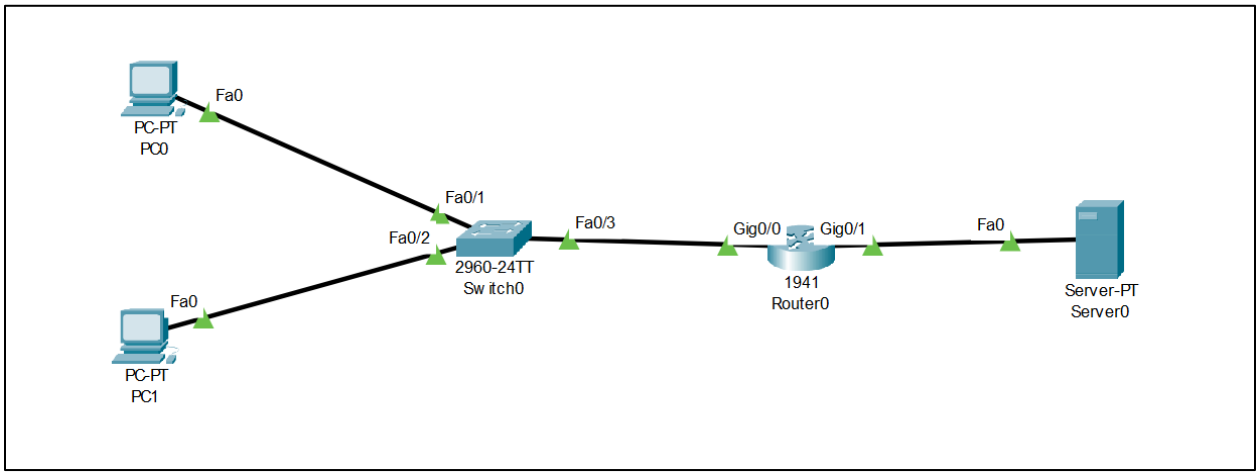
BGP CONFIGURATION

R4(config)#router bgp 200
R4(config-router)#neighbor 24.0.0.1 remote-as 200
R4(config-router)#neighbor 24.0.0.1 update-source fastEthernet 1/0
R4(config-router)#neighbor 34.0.0.1 remote-as 100
R4(config-router)#network 24.0.0.0 mask 255.255.255.0
R4(config-router)#network 34.0.0.0 mask 255.255.255.0

```
R4(config)#router bgp 200
R4(config-router)#neighbor 24.0.0.1 remote-as 200
R4(config-router)#
*Jun 20 23:43:17.439: %BGP-5-ADJCHANGE: neighbor 24.0.0.1 Up
R4(config-router)#neighbor 24.0.0.1 update-source fastEthernet 1/0
R4(config-router)#neighbor 34.0.0.1 remote-as 100
R4(config-router)#
*Jun 20 23:43:29.703: %BGP-5-ADJCHANGE: neighbor 34.0.0.1 Up
R4(config-router)#network 24.0.0.0 mask 255.255.255.0
R4(config-router)#network 34.0.0.0 mask 255.255.255.0
```

Practical: 4

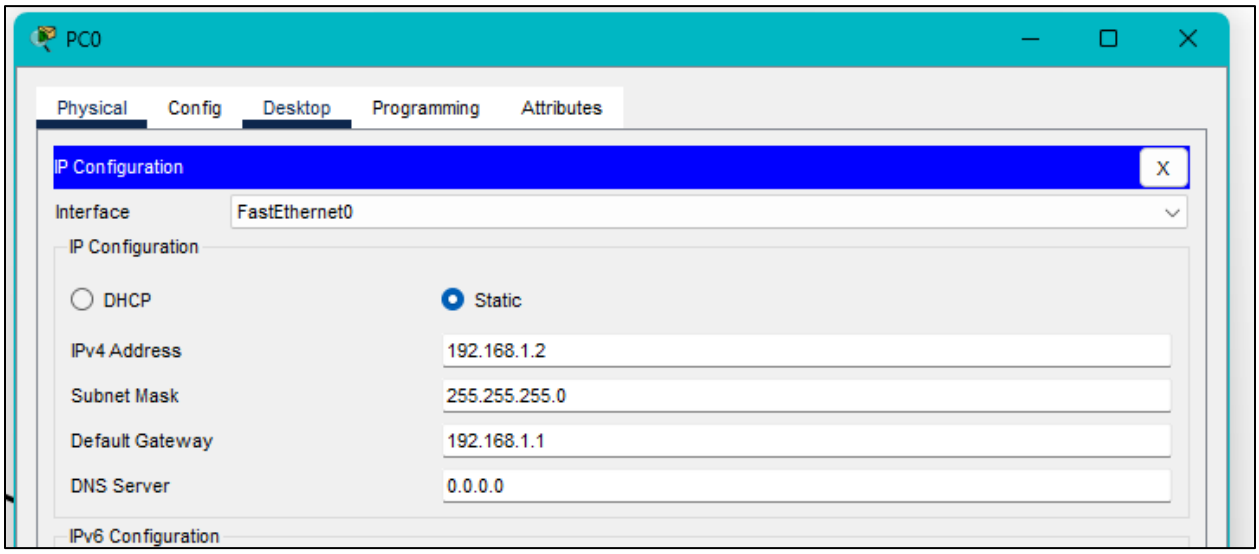
Secure the Management Plane



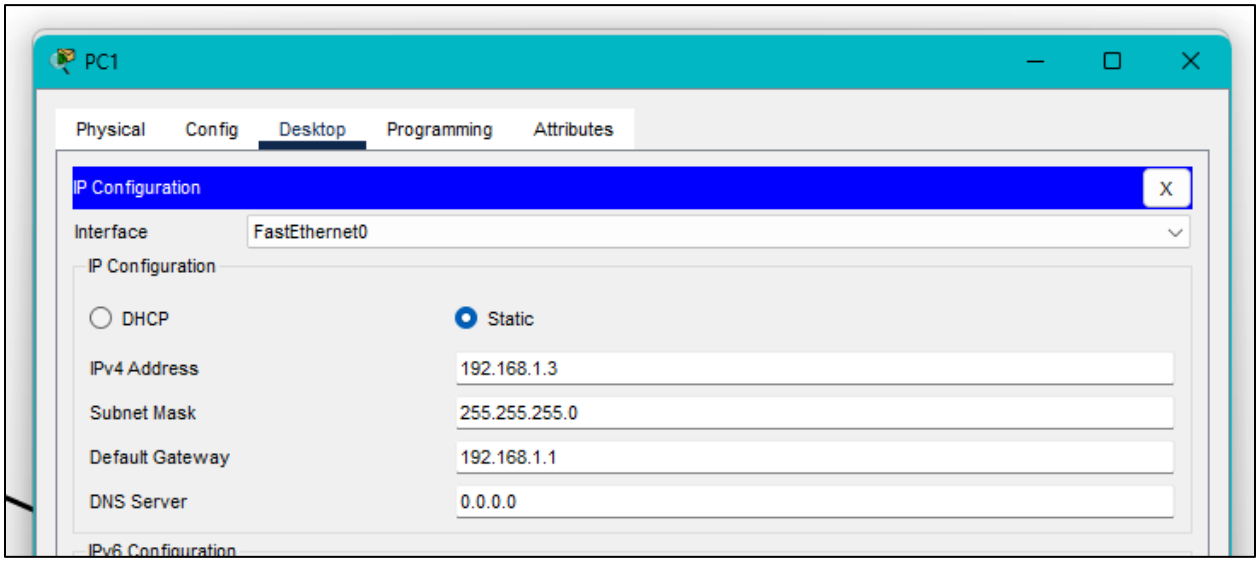
Device	Interface	IP Address	Subnet Mask	Gateway
PC0	FastEthernet0	192.168.1.2	255.255.255.0	192.168.1.1
PC1	FastEthernet0	192.168.1.3	255.255.255.0	192.168.1.1
R1	GigabitEthernet0/0	192.168.1.1	255.255.255.0	
R1	GigabitEthernet0/1	192.168.2.1	255.255.255.0	
Server0	FastEthernet0	192.168.2.2	255.255.255.0	192.168.2.1

Assigning IP Address:

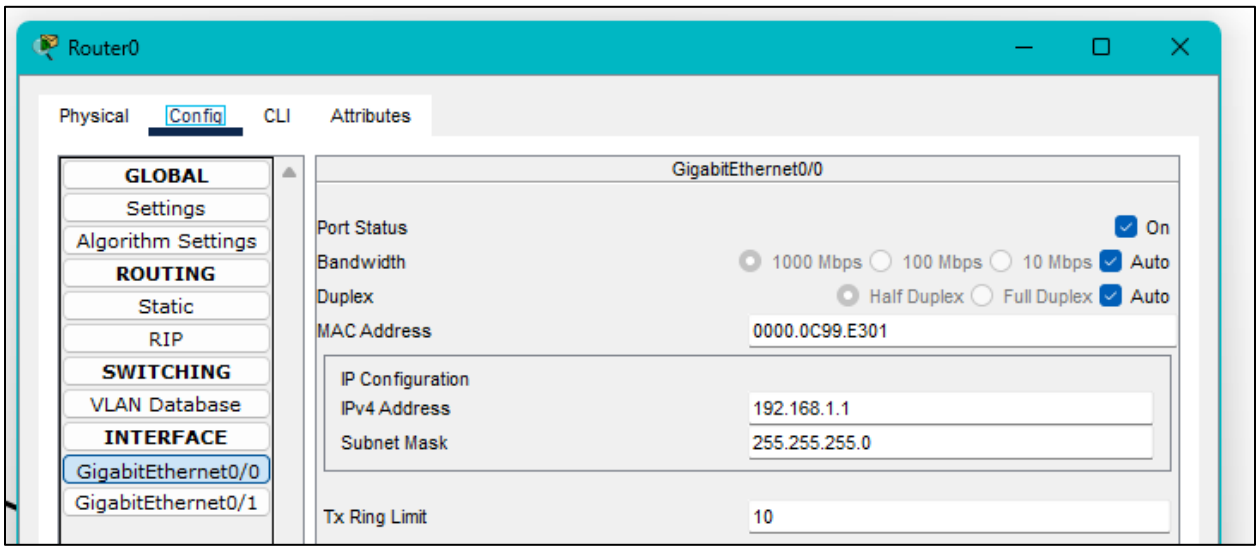
PC0

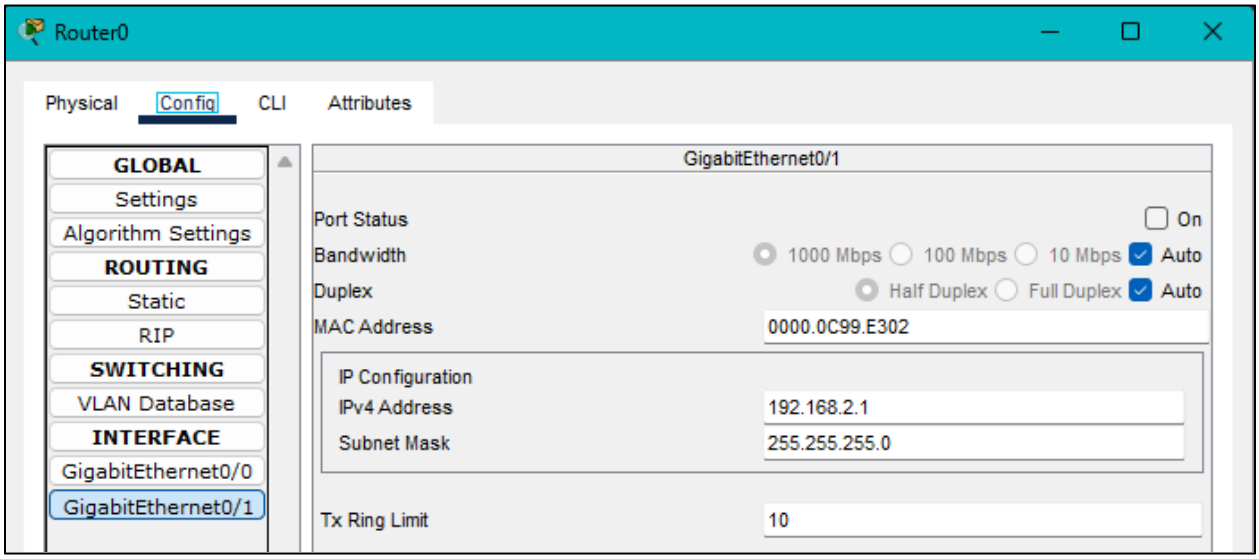


PC1

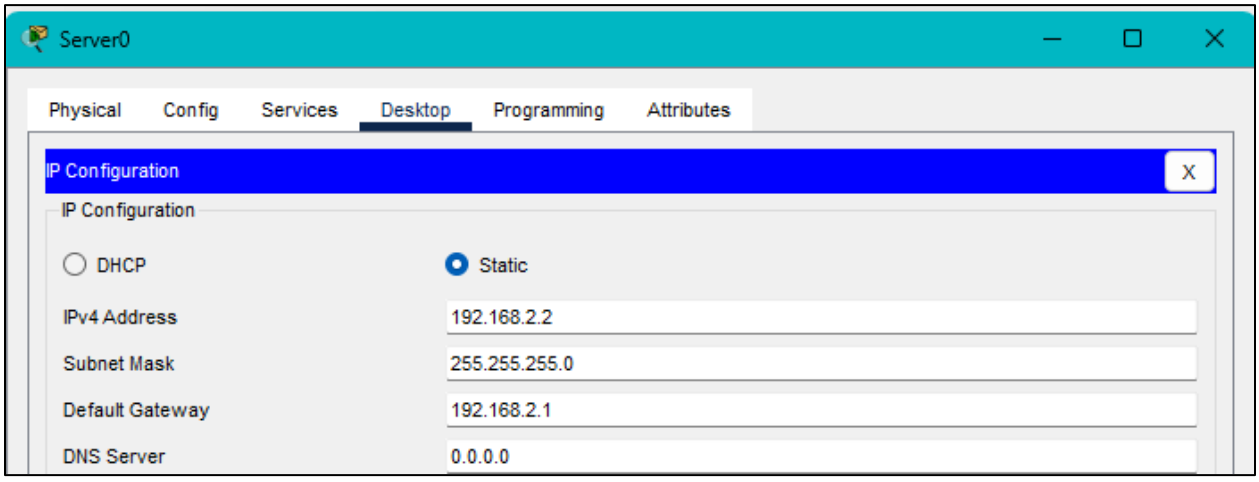


Router0





Server0



Command:

Configure SSH on Router R1

Router(config)#interface GigabitEthernet0/0
Router(config-if)#hostname R1
R1(config)#ip domain-name cln35h.in
R1(config)#crypto key generate rsa
R1(config)#ip ssh version 2
R1(config)#ip ssh time-out 60
R1(config)#ip ssh authentication-retries 2
R1(config)#username admin privilege 15 secret root
R1(config)#line vty 0 4
R1(config-line)#transport input ssh
R1(config-line)#login local
R1(config-line)#exit

```
R1(config)#ip domain-name cln35h.in
R1(config)#crypto key generate rsa
The name for the keys will be: R1.cln35h.in
Choose the size of the key modulus in the range of 360 to 4096 for your
  General Purpose Keys. Choosing a key modulus greater than 512 may take
  a few minutes.

How many bits in the modulus [512]: 2048
% Generating 2048 bit RSA keys, keys will be non-exportable...[OK]

R1(config)#ip ssh version 2
*Mar 1 0:19:17.870: %SSH-5-ENABLED: SSH 1.99 has been enabled
R1(config)#ip ssh time-out 60
R1(config)#ip ssh authentication-retries 2
R1(config)#username admin privilege 15 secret root
R1(config)#line vty 0 4
R1(config-line)#transport input ssh
R1(config-line)#login local
R1(config-line)#exit
R1(config)#
```

Restrict Router Access Using ACL

R1(config)#access-list 10 permit 192.168.1.2
R1(config)#access-list 10 deny any
R1(config)#line vty 0 4
R1(config-line)#access-class 10 in
R1(config-line)#exit
R1(config)#interface GigabitEthernet0/0
R1(config-if)#ip access-group 10 in
R1(config-if)#exit

```
R1(config)#access-list 10 permit 192.168.1.2
R1(config)#access-list 10 deny any
R1(config)#line vty 0 4
R1(config-line)#access-class 10 in
R1(config-line)#exit
R1(config)#interface GigabitEthernet0/0
R1(config-if)#ip access-group 10 in
R1(config-if)#exit
```

Disable Unused Services to the Server

R1(config)#ip access-list extended admin
R1(config-ext-nacl)#permit icmp host 192.168.1.2 host 192.168.2.2
R1(config-ext-nacl)#permit tcp host 192.168.1.2 host 192.168.2.2 eq 21
R1(config-ext-nacl)#permit tcp host 192.168.1.2 host 192.168.2.2 eq 22
R1(config-ext-nacl)#deny ip any host 192.168.2.2
R1(config-ext-nacl)#exit
R1(config)#interface GigabitEthernet0/1
R1(config-if)#ip access-group admin out
R1(config-if)#exit

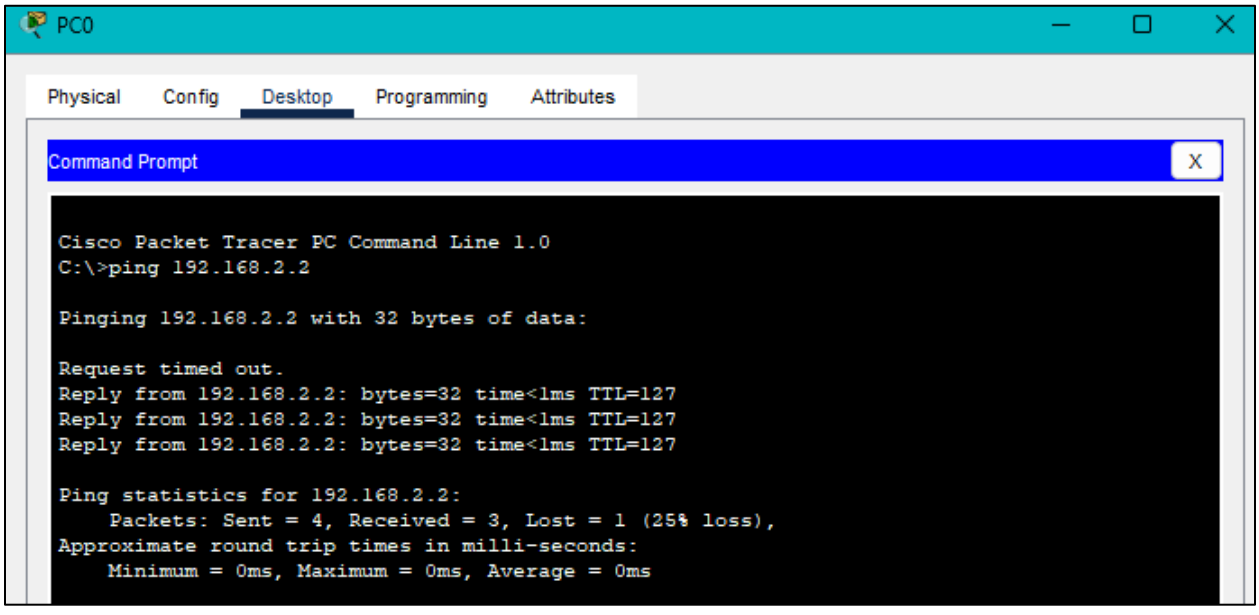
```
R1(config)#ip access-list extended admin
R1(config-ext-nacl)#permit icmp host 192.168.1.2 host 192.168.2.2
R1(config-ext-nacl)#permit tcp host 192.168.1.2 host 192.168.2.2 eq 21
R1(config-ext-nacl)#permit tcp host 192.168.1.2 host 192.168.2.2 eq 22
R1(config-ext-nacl)#deny ip any host 192.168.2.2
R1(config-ext-nacl)#exit
R1(config)#interface GigabitEthernet0/1
R1(config-if)#ip access-group admin out
R1(config-if)#exit
```

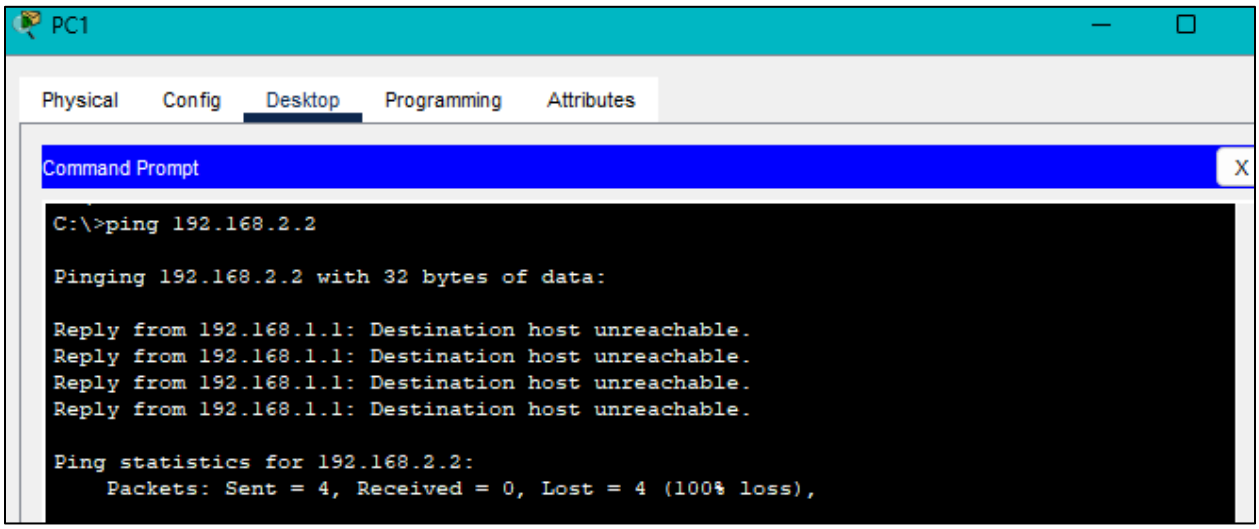
Configure Banner Messages

R1(config)#banner login #
R1(config)#banner motd #

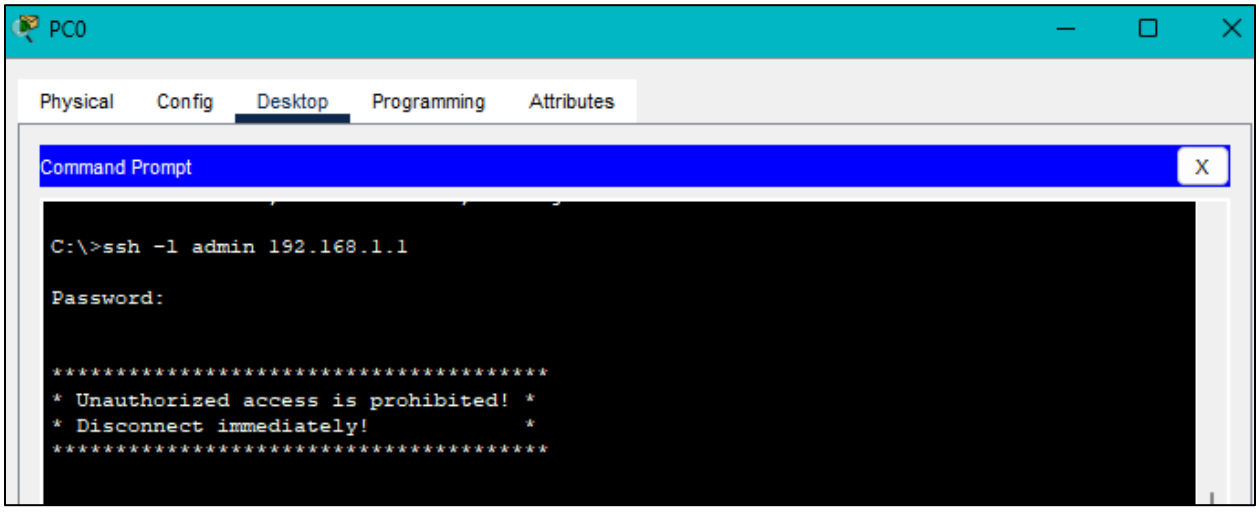
```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#banner login #
Enter TEXT message.  End with the character '#'.
****************************************
* Authorized Personnel Only!           *
* Monitoring Enabled!                  *
****************************************
#

R1(config)#banner motd #
Enter TEXT message.  End with the character '#'.
****************************************
* Unauthorized access is prohibited! *
* Disconnect immediately!            *
****************************************
#
```

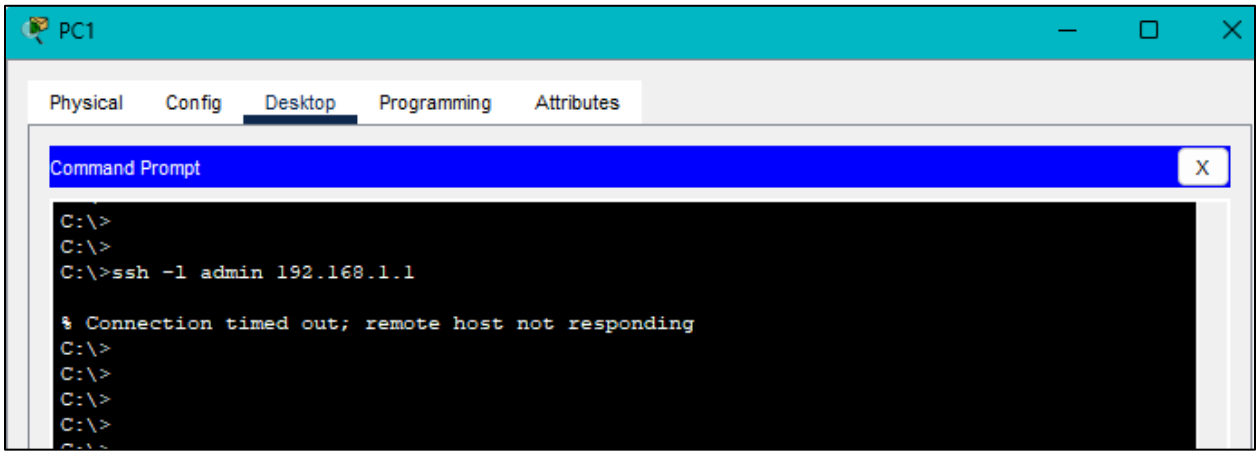
PING



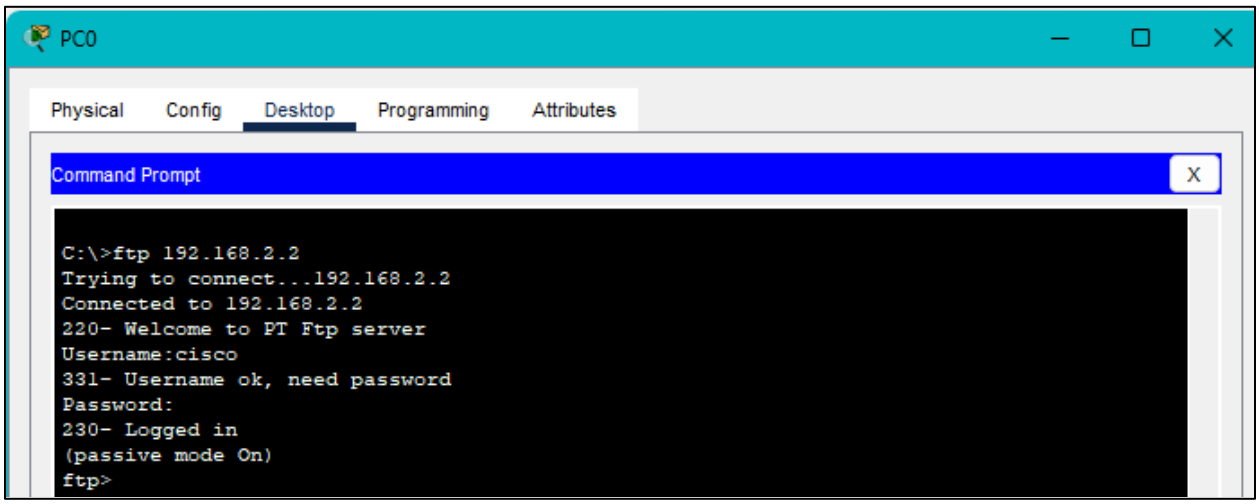

PC1
Physical
Config
Desktop
Programming
Attributes
Command Prompt
C:\>ping 192.168.2.2
Pinging 192.168.2.2 with 32 bytes of data:
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Ping statistics for 192.168.2.2:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

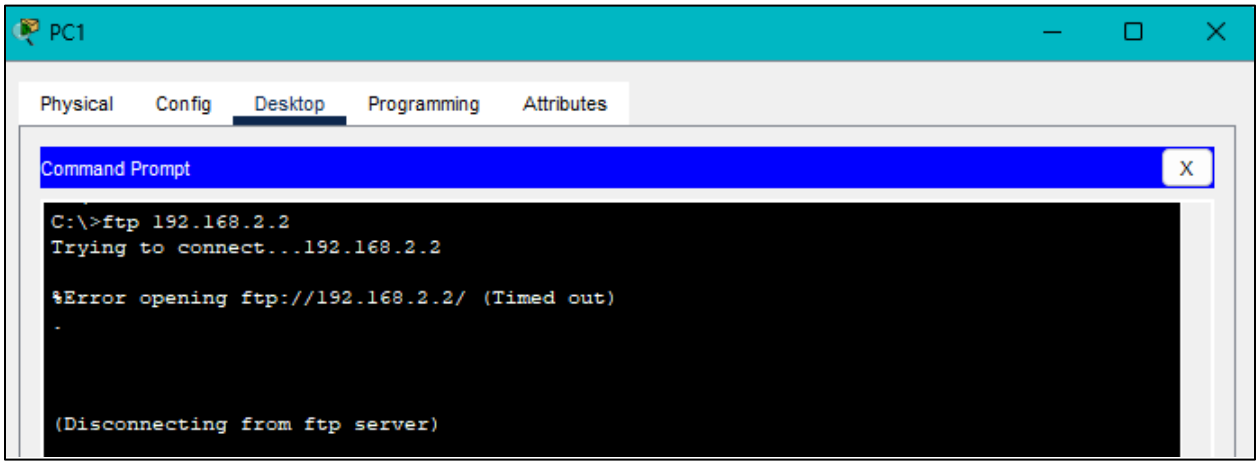
SSH


PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
C:\>ssh -l admin 192.168.1.1
Password:
* Unauthorized access is prohibited! *
* Disconnect immediately! *

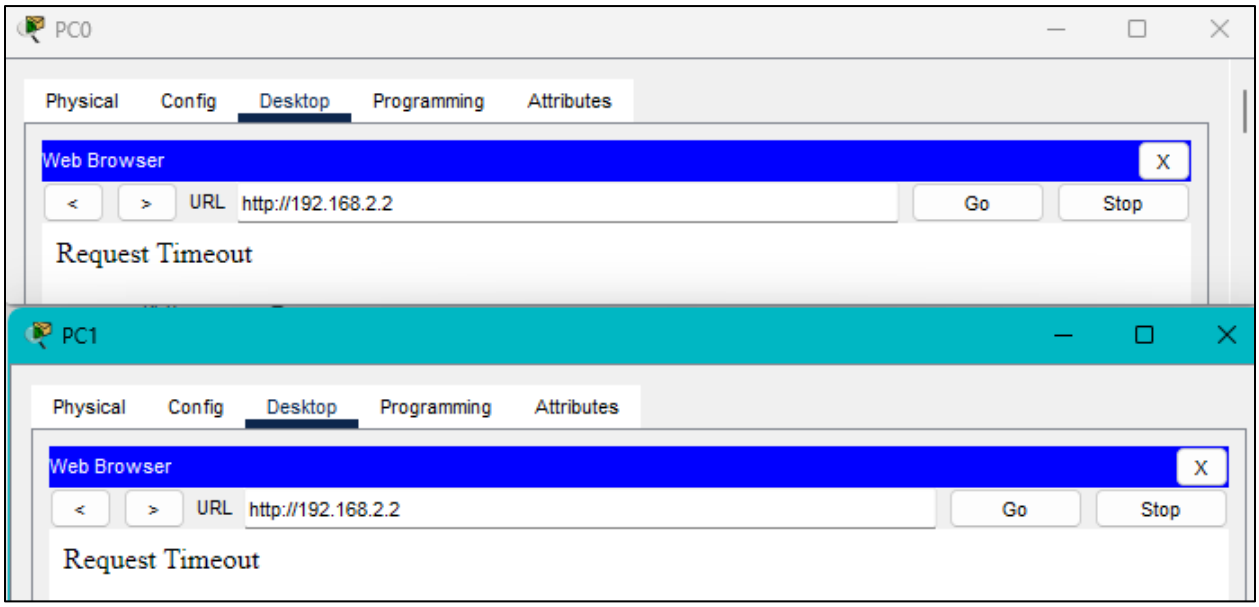

PC1
Physical
Config
Desktop
Programming
Attributes
Command Prompt
C:\>
C:\>
C:\>ssh -l admin 192.168.1.1
% Connection timed out; remote host not responding
C:\>
C:\>
C:\>
C:\>

FTP


PC0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
C:\>ftp 192.168.2.2
Trying to connect...192.168.2.2
Connected to 192.168.2.2
220- Welcome to PT Ftp server
Username:cisco
331- Username ok, need password
Password:
230- Logged in
(passive mode On)
ftp>

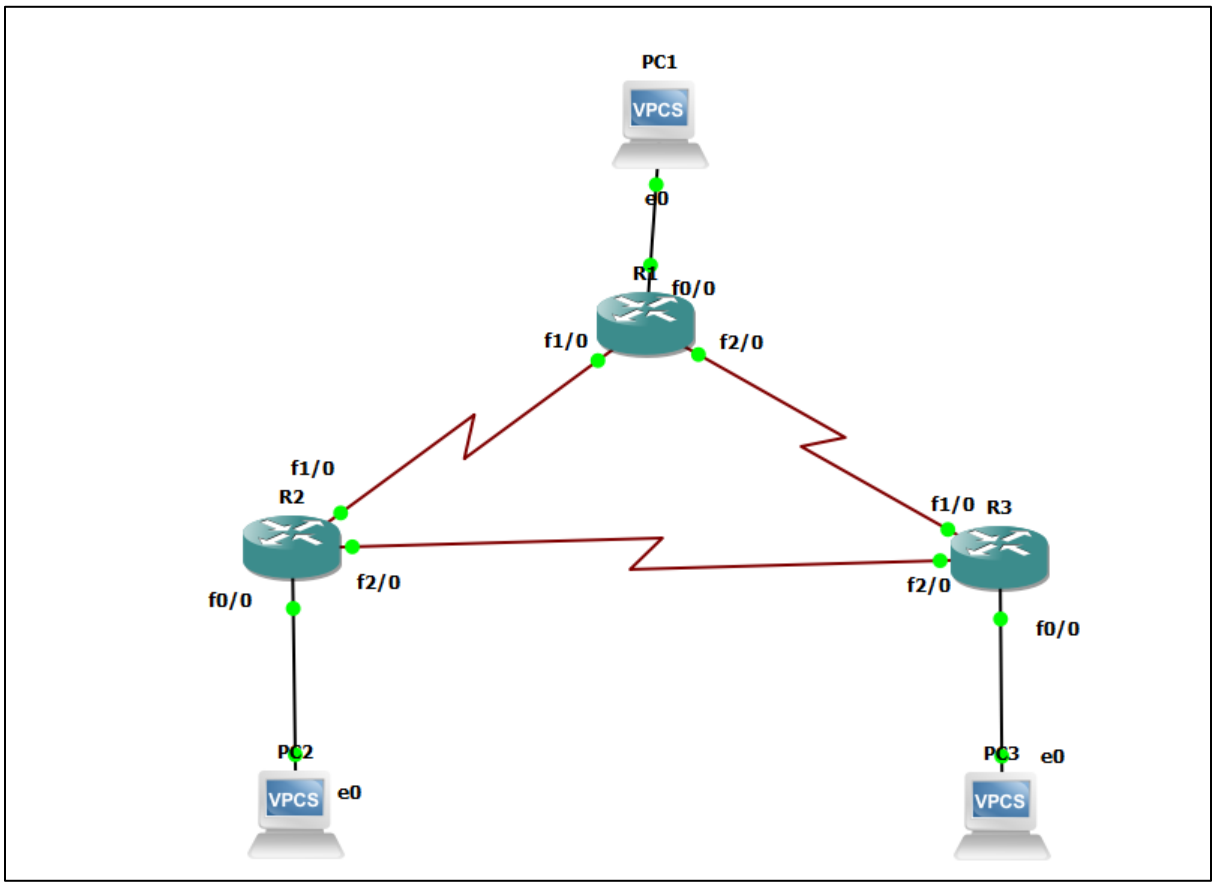

PC1
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
C:\>ftp 192.168.2.2
Trying to connect...192.168.2.2
%Error opening ftp://192.168.2.2/ (Timed out)
.
(Disconnecting from ftp server)

HTTP


PC0
Physical
Config
Desktop
Programming
Attributes
Web Browser
X
<
>
URL
http://192.168.2.2
Go
Stop
Request Timeout
PC1
Physical
Config
Desktop
Programming
Attributes
Web Browser
X
<
>
URL
http://192.168.2.2
Go
Stop
Request Timeout

Practical: 5

Configure and Verify Path Control Using PBR



Command:

PC1> ip 192.168.1.2 255.255.255.0 192.168.1.1

```
PC1> ip 192.168.1.2 255.255.255.0 192.168.1.1
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.0 gateway 192.168.1.1
```

PC2> ip 192.168.2.2 255.255.255.0 192.168.2.1

```
PC2> ip 192.168.2.2 255.255.255.0 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.2 255.255.255.0 gateway 192.168.2.1
```

PC3> ip 192.168.3.2 255.255.255.0 192.168.3.1

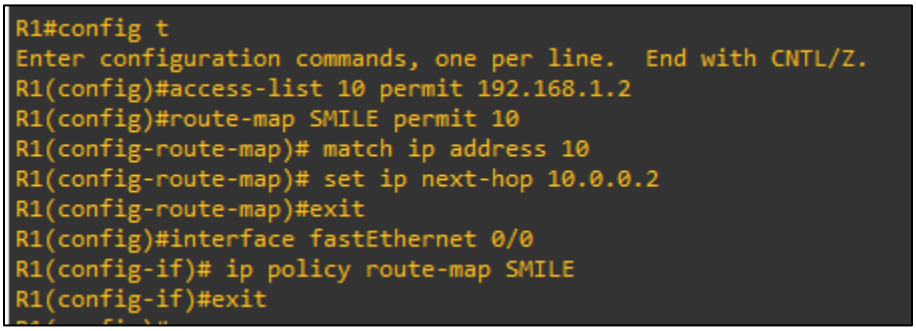
```
PC3> ip 192.168.3.2 255.255.255.0 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.2 255.255.255.0 gateway 192.168.3.1
```

R1

R1(config)#interface fastEthernet 0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#interface fastEthernet 1/0
R1(config-if)# ip address 10.0.0.1 255.0.0.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#interface fastEthernet 2/0
R1(config-if)# ip address 20.0.0.1 255.0.0.0
R1(config-if)# no shutdown
R1(config-if)#exit
R1(config)#router rip
R1(config-router)# version 2
R1(config-router)# no auto-summary
R1(config-router)# network 192.168.1.0
R1(config-router)# network 10.0.0.0
R1(config-router)# network 20.0.0.0
R1(config-router)#exit

```
R1(config)#interface fastEthernet 0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#
*Jun 21 00:34:53.331: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 21 00:34:54.331: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#exit
R1(config)#interface fastEthernet 1/0
R1(config-if)# ip address 10.0.0.1 255.0.0.0
R1(config-if)# no shutdown
R1(config-if)#
*Jun 21 00:35:24.251: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 21 00:35:25.251: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R1(config-if)#exit
R1(config)#interface fastEthernet 2/0
R1(config-if)# ip address 20.0.0.1 255.0.0.0
R1(config-if)# no shutdown
R1(config-if)#
*Jun 21 00:35:42.103: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Jun 21 00:35:43.103: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R1(config-if)#exit
R1(config)#router rip
R1(config-router)# version 2
R1(config-router)# no auto-summary
R1(config-router)# network 192.168.1.0
R1(config-router)# network 10.0.0.0
R1(config-router)# network 20.0.0.0
R1(config-router)#exit
```

R1#config t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#access-list 10 permit 192.168.1.2
R1(config)#route-map SMILE permit 10
R1(config-route-map)# match ip address 10
R1(config-route-map)# set ip next-hop 10.0.0.2
R1(config-route-map)#exit
R1(config)#interface fastEthernet 0/0
R1(config-if)# ip policy route-map SMILE
R1(config-if)#exit



R2

R2#conf t
R2(config)#interface fastEthernet 0/0
R2(config-if)# ip address 192.168.2.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config-if)#exit
R2(config)#interface fastEthernet 1/0
R2(config-if)# ip address 10.0.0.2 255.0.0.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config)#interface fastEthernet 2/0
R2(config-if)# ip address 30.0.0.1 255.0.0.0
R2(config-if)# no shutdown
R2(config-if)#exit
R2(config)#router rip
R2(config-router)# version 2
R2(config-router)# no auto-summary
R2(config-router)# network 192.168.2.0
R2(config-router)# network 10.0.0.0
R2(config-router)# network 30.0.0.0
R2(config-router)#exit

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface fastEthernet 0/0
R2(config-if)# ip address 192.168.2.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)#exit
*Jun 21 00:37:44.923: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 21 00:37:45.923: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#exit
R2(config)#interface fastEthernet 1/0
R2(config-if)# ip address 10.0.0.2 255.0.0.0
R2(config-if)# no shutdown
R2(config-if)#
*Jun 21 00:38:02.907: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 21 00:38:03.907: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R2(config-if)#exit
R2(config)#interface fastEthernet 2/0
R2(config-if)# ip address 30.0.0.1 255.0.0.0
R2(config-if)# no shutdown
R2(config-if)#
*Jun 21 00:38:20.563: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Jun 21 00:38:21.563: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R2(config-if)#exit
R2(config)#router rip
R2(config-router)# version 2
R2(config-router)# no auto-summary
R2(config-router)# network 192.168.2.0
R2(config-router)# network 10.0.0.0
R2(config-router)# network 30.0.0.0
R2(config-router)#exit
```

R3

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#interface fastEthernet 0/0
R3(config-if)# ip address 192.168.3.1 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#interface fastEthernet 1/0
R3(config-if)# ip address 20.0.0.2 255.0.0.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#interface fastEthernet 2/0
R3(config-if)# ip address 30.0.0.2 255.0.0.0
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#router rip
R3(config-router)# version 2
R3(config-router)# no auto-summary
R3(config-router)# network 192.168.3.0
R3(config-router)# network 20.0.0.0
R3(config-router)# network 30.0.0.0
R3(config-router)#exit

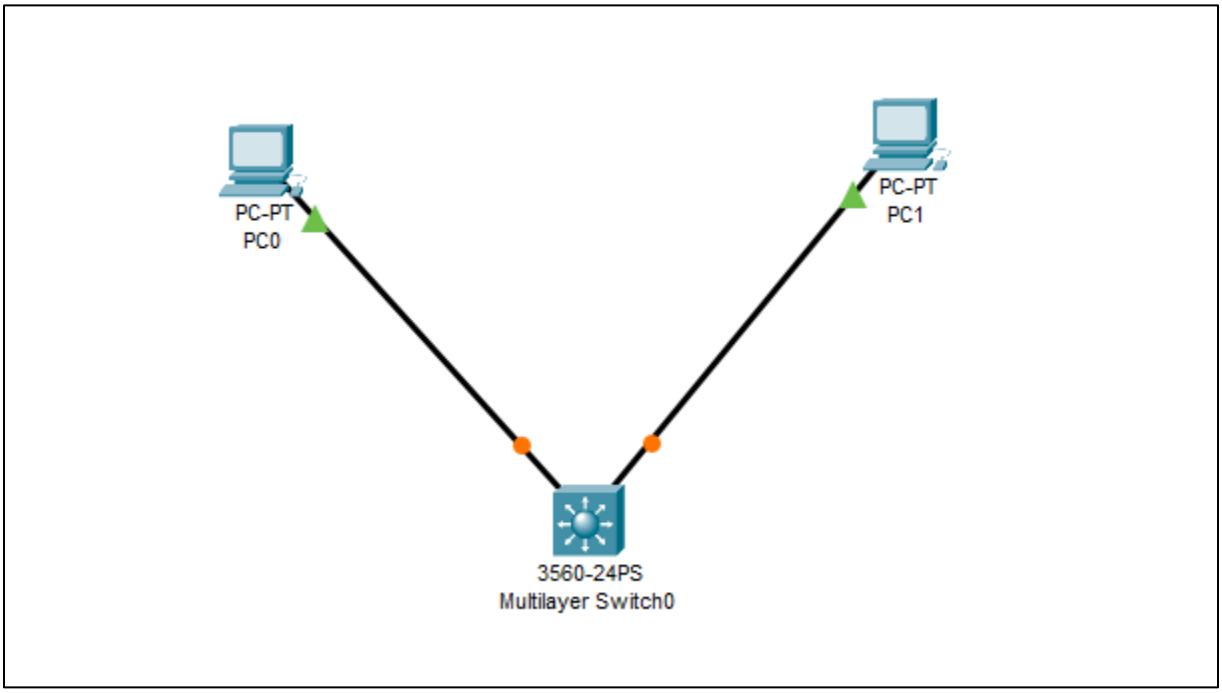
```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#interface fastEthernet 0/0
R3(config-if)# ip address 192.168.3.1 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)#
*Jun 21 00:40:26.303: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Jun 21 00:40:27.303: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#exit
R3(config)#interface fastEthernet 1/0
R3(config-if)# ip address 20.0.0.2 255.0.0.0
R3(config-if)# no shutdown
R3(config-if)#
*Jun 21 00:40:45.127: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Jun 21 00:40:46.127: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R3(config-if)#exit
R3(config)#interface fastEthernet 2/0
R3(config-if)# ip address 30.0.0.2 255.0.0.0
R3(config-if)# no shutdown
R3(config-if)#
*Jun 21 00:41:02.819: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Jun 21 00:41:03.819: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
R3(config-if)#exit
R3(config)#router rip
R3(config-router)# version 2
R3(config-router)# no auto-summary
R3(config-router)# network 192.168.3.0
R3(config-router)# network 20.0.0.0
R3(config-router)# network 30.0.0.0
R3(config-router)#exit
```

After applying PBR

```
PC1> trace 192.168.3.2
trace to 192.168.3.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   15.317 ms  15.697 ms  15.123 ms
 2   10.0.0.2   45.006 ms  45.412 ms  46.828 ms
 3   30.0.0.2   60.977 ms  61.201 ms  60.910 ms
 4   *192.168.3.2   75.608 ms (ICMP type:3, code:3, Destination port unreachable)
```

Practical: 6

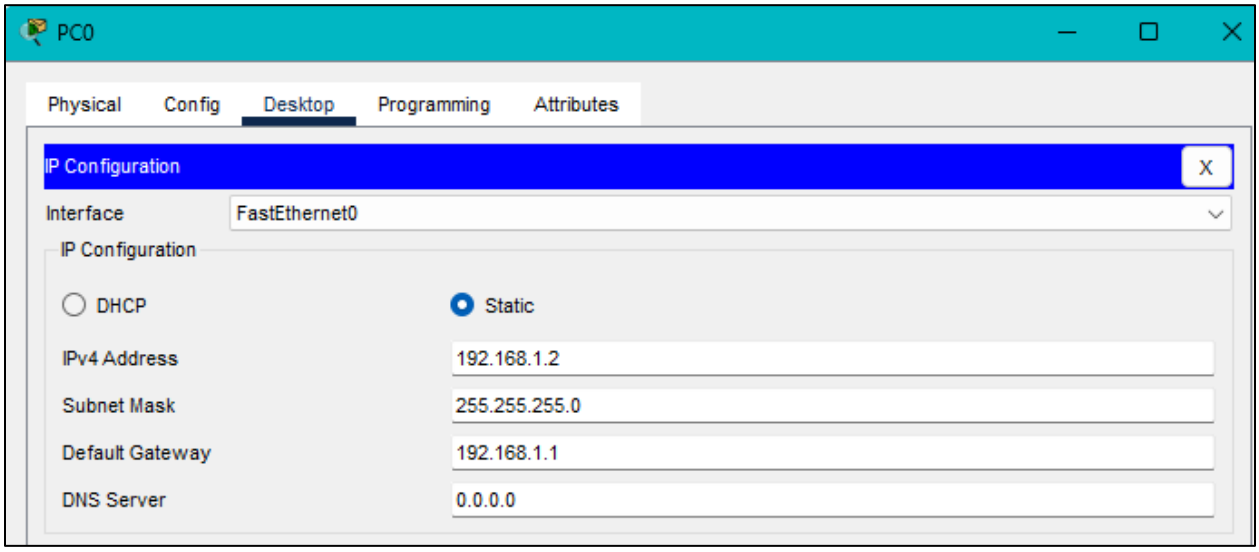
Inter-VLAN Routing



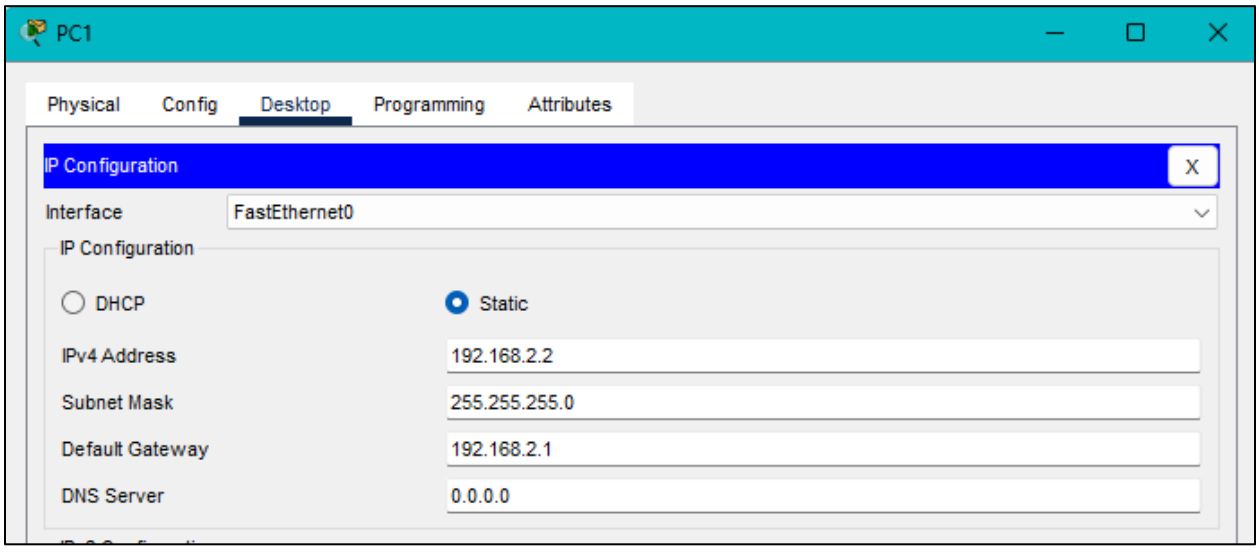
Device	Interface	IP Address	VLAN	Gateway
PC0	FastEthernet0	192.168.1.2	VLAN 10	192.168.1.1
PC1	FastEthernet0	192.168.2.2	VLAN 20	192.168.2.1
Switch	VLAN 10 (SVI)	192.168.1.1		
Switch	VLAN 20 (SVI)	192.168.2.1		

Assigning IP Address:

PC0



PC1



Command:

Create VLANs

Switch>enable

Switch#conf t

Switch(config)#vlan 10

Switch(config-vlan)#name library

Switch(config-vlan)#exit

Switch(config)#vlan 20

Switch(config-vlan)#name lab

Switch(config-vlan)#exit

Switch(config)#

```
Switch>enable
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#name library
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name lab
Switch(config-vlan)#exit
```

Create SVIs for VLANs

Switch(config)#interface vlan 10

Switch(config-if)#ip address 192.168.1.1 255.255.255.0

Switch(config-if)#no shutdown

Switch(config-if)#exit

Switch(config)#interface vlan 20

Switch(config-if)#ip address 192.168.2.1 255.255.255.0

Switch(config-if)#no shutdown

Switch(config-if)#exit

Switch(config)#ip routing

Switch(config)#exit

Switch#

```
Switch(config)#interface vlan 10
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up

Switch(config-if)#ip address 192.168.1.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#interface vlan 20
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan20, changed state to up

Switch(config-if)#ip address 192.168.2.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#ip routing
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console
```

Assign Access Ports to VLANs

Switch(config)#interface fastEthernet 0/1

Switch(config-if)#switchport mode access

Switch(config-if)#switchport access vlan 10

Switch(config-if)#exit

Switch(config)#interface fastEthernet 0/2

Switch(config-if)#switchport mode access

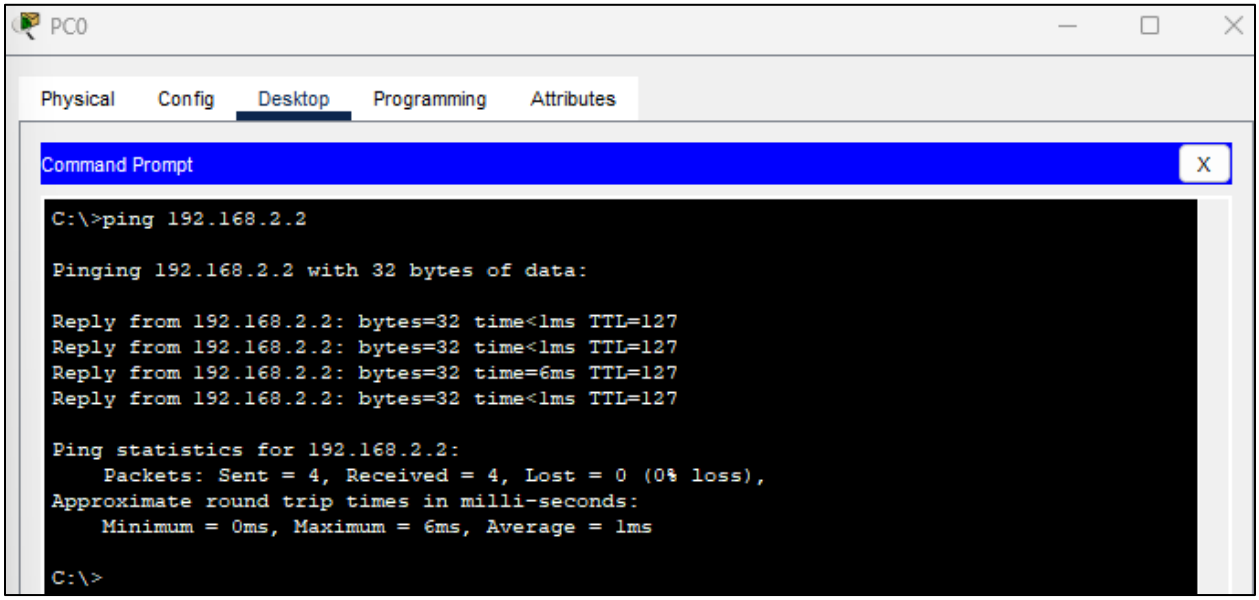
Switch(config-if)#switchport access vlan 20

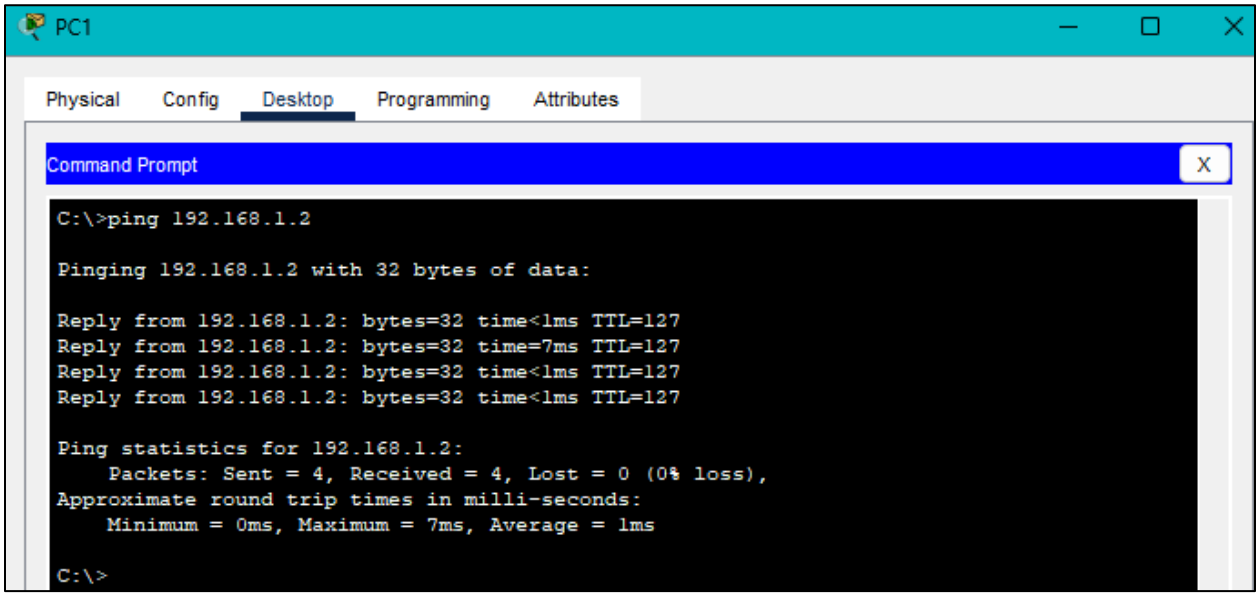
Switch(config-if)#exit

Switch(config)#exit

```
Switch(config)#interface fastEthernet 0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 10
Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed state to up

Switch(config-if)#exit
Switch(config)#interface fastEthernet 0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed state to up

Switch(config-if)#exit
Switch(config)#exit
Switch#
```

Successful Ping





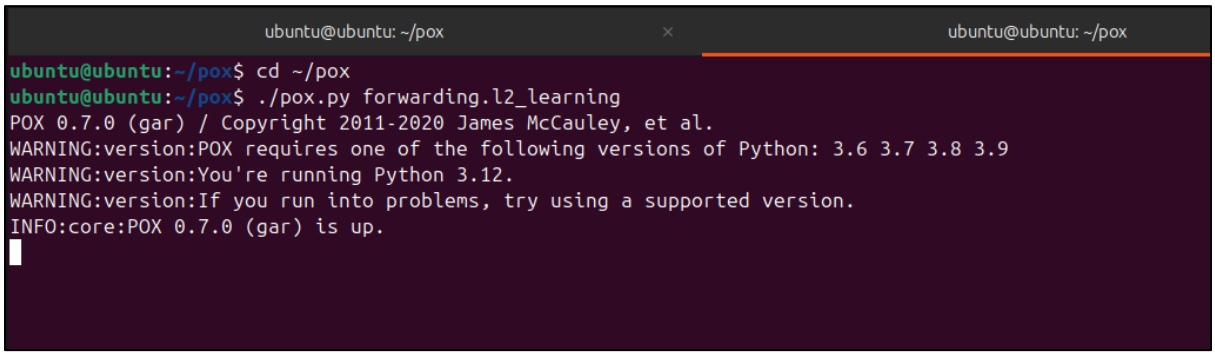
Practical: 7

Simulating OpenFlow Using MININET

Command

sudo apt update
sudo apt install -y mininet openvswitch-switch python3 git curl

cd ~
git clone https://github.com/noxrepo/pox.git
cd pox
chmod +x pox.py
cd ~/pox
./pox.py forwarding.l2_learning



sudo mn --topo single,3 --mac --switch ovsk --controller remote

pingall

```
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3
h2 -> h1 h3
h3 -> h1 h2
*** Results: 0% dropped (6/6 received)
```

h1 iperf -s &
h2 iperf -c h1
sh ovs-ofctl dump-flows s1

```
mininet> h1 iperf -s &
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
------------------------------------------------------------
mininet> h2 iperf -c h1
------------------------------------------------------------
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85.3 KByte (default)
------------------------------------------------------------
[  1] local 10.0.0.2 port 50664 connected with 10.0.0.1 port 5001 (icwnd/mss/irtt=14/1448/2588)
[ ID] Interval       Transfer     Bandwidth
[  1] 0.0000-10.0008 sec  25.2 GBytes  21.6 Gbits/sec
mininet> sh ovs-ofctl dump-flows s1
 cookie=0x0, duration=16.727s, table=0, n_packets=536521, n_bytes=27090938238, idle_timeout=10, hard_timeout=30, priorit
y=65535,tcp,in_port="s1-eth2",vlan_tci=0x0000,dl_src=00:00:00:00:00:02,dl_dst=00:00:00:00:00:01,nw_src=10.0.0.2,nw_dst=1
0.0.0.1,nw_tos=0,tp_src=50664,tp_dst=5001 actions=output:"s1-eth1"
 cookie=0x0, duration=16.719s, table=0, n_packets=229647, n_bytes=15156978, idle_timeout=10, hard_timeout=30, priority=6
5535,tcp,in_port="s1-eth1",vlan_tci=0x0000,dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:02,nw_src=10.0.0.1,nw_dst=10.0
.0.2,nw_tos=0,tp_src=5001,tp_dst=50664 actions=output:"s1-eth2"
mininet>
```

exit

```
mininet> exit
*** Stopping 1 controllers
c0
*** Stopping 3 links
...
*** Stopping 1 switches
s1
*** Stopping 3 hosts
h1 h2 h3
*** Done
completed in 276.864 seconds
```

PRACTICAL REPORT

On

Computer Vision

Submitted in fulfilment of the

Requirements for the award of the Degree of

MASTER OF SCIENCE (INFORMATION TECHNOLOGY) – SEM II

By

NAME: DINESHKUMAR SHANKARLAL KUMAWAT

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DEPARTMENT OF INFORMATION TECHNOLOGY

THE SIA COLLEGE OF HIGHER EDUCATION

Affiliated to University of Mumbai

DOMBIVLI

MAHARASHTRA - 421203

2024-2025

THE SIA COLLEGE OF HIGHER EDUCATION

(Affiliated to University of Mumbai)

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DOMBIVLI, MAHARASHTRA 421203

Department of Information Technology

CERTIFICATE

Certified that the experimental work as entered in this journal is as per syllabus in M.Sc. Information Technology for _____ as prescribed by University of Mumbai and was done in the Information Technology laboratory of The S.I.A College of Higher Education by the student Mr/ Ms _____ having Seat No. _____ of class M.Sc. Information Technology - PART I during the academic year 2024-2025.

No. of Experiments completed _____ out of _____.

Course Coordinator
Date:

Sign of Incharge
Date:

College Seal

Sign of Examiner
Date:

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Practical: 1

Perform Geometric transformations

Code:

```
import numpy as np
import cv2 as cv
from google.colab.patches import cv2_imshow

from skimage import io
from PIL import Image
import requests
from io import BytesIO

url = "https://iiif.lib.ncsu.edu/iiif/0052574/full/800,/0/default.jpg"

response = requests.get(url)
img_bytes = BytesIO(response.content)

image_pil = Image.open(img_bytes)
image = np.array(image_pil)

image_bgr = cv.cvtColor(image, cv.COLOR_RGB2BGR)

cv2_imshow(image_bgr)
print('\n')
gray_image = cv.cvtColor(image_bgr, cv.COLOR_BGR2GRAY)
cv2_imshow(gray_image)
print('\n')
```

```
# 2. Apply Gaussian Blur and Canny Edge Detection
blurred_image = cv.GaussianBlur(gray_image, (5, 5), 1.4)
edges = cv.Canny(blurred_image, 100, 200)
cv2_imshow(edges)
print('\n')
```

```
# 3. Draw a Square on the Original Image
image_with_square = image_bgr.copy()
cv.rectangle(image_with_square, (30, 30), (130, 130), (0, 255, 0), 6)
cv2_imshow(image_with_square)
print('\n')
```

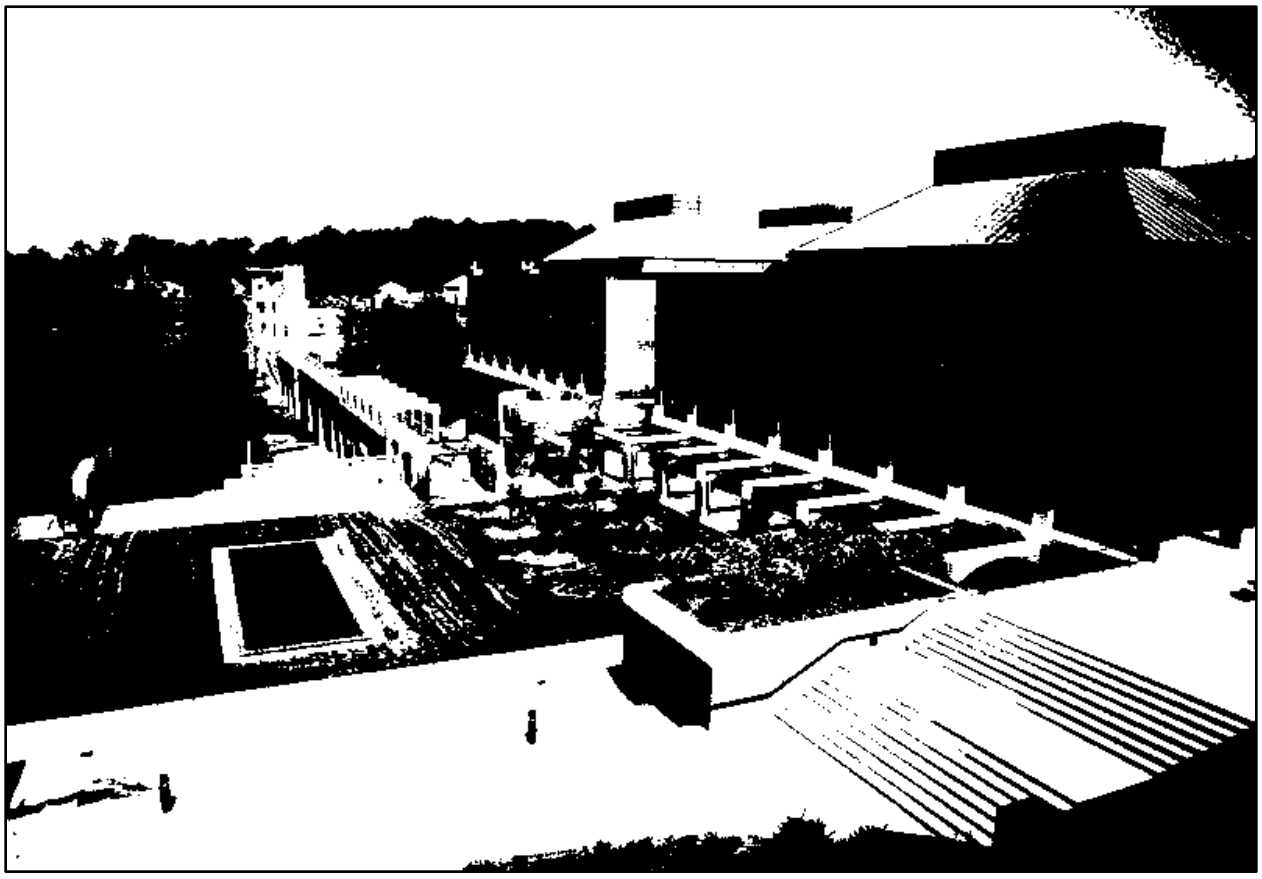
```
# 4. Resize the Image
resized_image = cv.resize(image_bgr, (300, 300))
cv2_imshow(resized_image)
print('\n')
```

5. Apply Thresholding

_, thresholded_image = cv.threshold(gray_image, 127, 255, cv.THRESH_BINARY)

cv2_imshow(thresholded_image)

print('\n')



```
# 6. Rotate the Image (Using PIL for rotation)
rotated_image = image_pil.rotate(90)  # Rotate by 180 degrees
rotated_image_cv = np.array(rotated_image)  # Convert the PIL image to a NumPy array
rotated_image_cv = cv.cvtColor(rotated_image_cv, cv.COLOR_RGB2BGR)  # Convert RGB to BGR
cv2_imshow(rotated_image_cv)
print('\n')
```

Practical: 2

Perform Image Stitching

Code:

```
import cv2
import numpy as np
import urllib.request
import matplotlib.pyplot as plt

url1 = "https://github.com/daeyun/Image-Stitching/blob/master/img/hill/1.JPG?raw=true"
url2 = "https://github.com/daeyun/Image-Stitching/blob/master/img/hill/2.JPG?raw=true"
url3 = "https://github.com/daeyun/Image-Stitching/blob/master/img/hill/3.JPG?raw=true"

urllib.request.urlretrieve(url1, "image1.JPG")
urllib.request.urlretrieve(url2, "image2.JPG")
urllib.request.urlretrieve(url3, "image3.JPG")

img1 = cv2.imread('image1.JPG')
img2 = cv2.imread('image2.JPG')
img3 = cv2.imread('image3.JPG')

fig, ax = plt.subplots(1, 3, figsize=(16, 5))

ax[0].imshow(cv2.cvtColor(img1, cv2.COLOR_BGR2RGB))
ax[0].set_title('Image 1')
ax[0].axis('off')
ax[1].imshow(cv2.cvtColor(img2, cv2.COLOR_BGR2RGB))
ax[1].set_title('Image 2')
ax[1].axis('off')
```

```
ax[2].imshow(cv2.cvtColor(img3, cv2.COLOR_BGR2RGB))
ax[2].set_title('Image 3')
ax[2].axis('off')
plt.show()
print('\n')
gray1 = cv2.cvtColor(img1, cv2.COLOR_BGR2GRAY)
gray2 = cv2.cvtColor(img2, cv2.COLOR_BGR2GRAY)
gray3 = cv2.cvtColor(img3, cv2.COLOR_BGR2GRAY)
sift = cv2.SIFT_create()
kp1, des1 = sift.detectAndCompute(gray1, None)
kp2, des2 = sift.detectAndCompute(gray2, None)
kp3, des3 = sift.detectAndCompute(gray3, None)
index_params = dict(algorithm=1, trees=10)  # FLANN parameters
search_params = dict(checks=50)  # Limit the number of checks for efficiency
flann = cv2.FlannBasedMatcher(index_params, search_params)
matches1to2 = flann.knnMatch(des1, des2, k=2)
matches2to3 = flann.knnMatch(des2, des3, k=2)
good_matches1to2 = []
good_matches2to3 = []

for m, n in matches1to2:
    if m.distance < 0.7 * n.distance:
        good_matches1to2.append(m)
for m, n in matches2to3:
    if m.distance < 0.7 * n.distance:
        good_matches2to3.append(m)
img_matches1to2 = cv2.drawMatches(img1, kp1, img2, kp2, good_matches1to2[:10], None,
flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)
img_matches2to3 = cv2.drawMatches(img2, kp2, img3, kp3, good_matches2to3[:10], None,
flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)
plt.figure(figsize=(16, 8))
```

```
plt.subplot(1, 2, 1)
plt.imshow(cv2.cvtColor(img_matches1to2, cv2.COLOR_BGR2RGB))
plt.title('Matches between Image 1 and Image 2')
plt.axis('off')
plt.subplot(1, 2, 2)
plt.imshow(cv2.cvtColor(img_matches2to3, cv2.COLOR_BGR2RGB))
plt.title('Matches between Image 2 and Image 3')
plt.axis('off')
plt.show()
print('\n')
pts1 = np.float32([kp1[m.queryIdx].pt for m in good_matches1to2]).reshape(-1, 1, 2)
pts2 = np.float32([kp2[m.trainIdx].pt for m in good_matches1to2]).reshape(-1, 1, 2)
pts3 = np.float32([kp2[m.queryIdx].pt for m in good_matches2to3]).reshape(-1, 1, 2)
pts4 = np.float32([kp3[m.trainIdx].pt for m in good_matches2to3]).reshape(-1, 1, 2)
H1, _ = cv2.findHomography(pts2, pts1, cv2.RANSAC)
H2, _ = cv2.findHomography(pts3, pts4, cv2.RANSAC)
height, width, _ = img1.shape
img2_warped = cv2.warpPerspective(img2, H1, (width * 2, height))
img3_warped = cv2.warpPerspective(img3, H2, (width * 2, height))
img2_warped[0:height, 0:width] = img1
img3_warped[0:height, 0:width] = img2
final_stitched = img2_warped[0:height, 0:width + img3_warped.shape[1]]
plt.figure(figsize=(20, 5))  # Adjust the figure size to make the image larger
plt.imshow(cv2.cvtColor(final_stitched, cv2.COLOR_BGR2RGB))
plt.title('Final Stitched Image')
plt.axis('off')
plt.show()
```

Output:

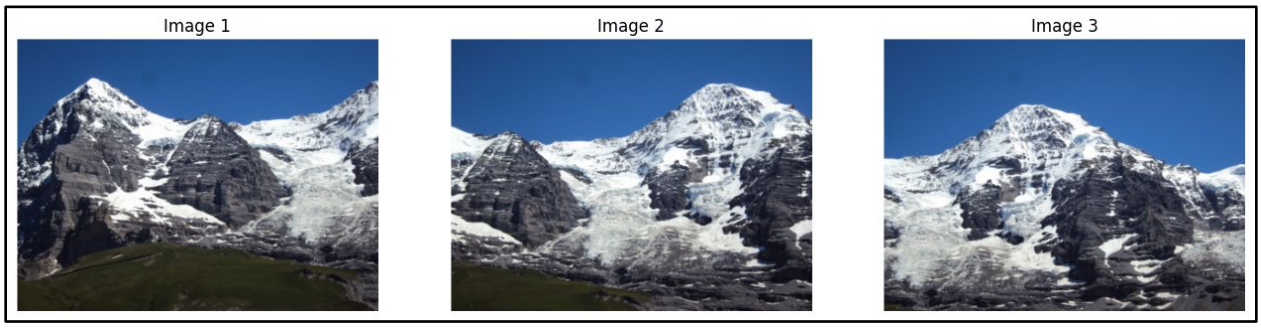
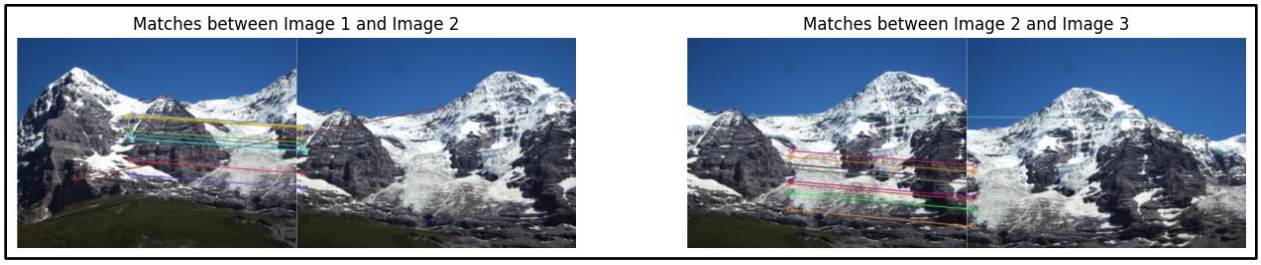
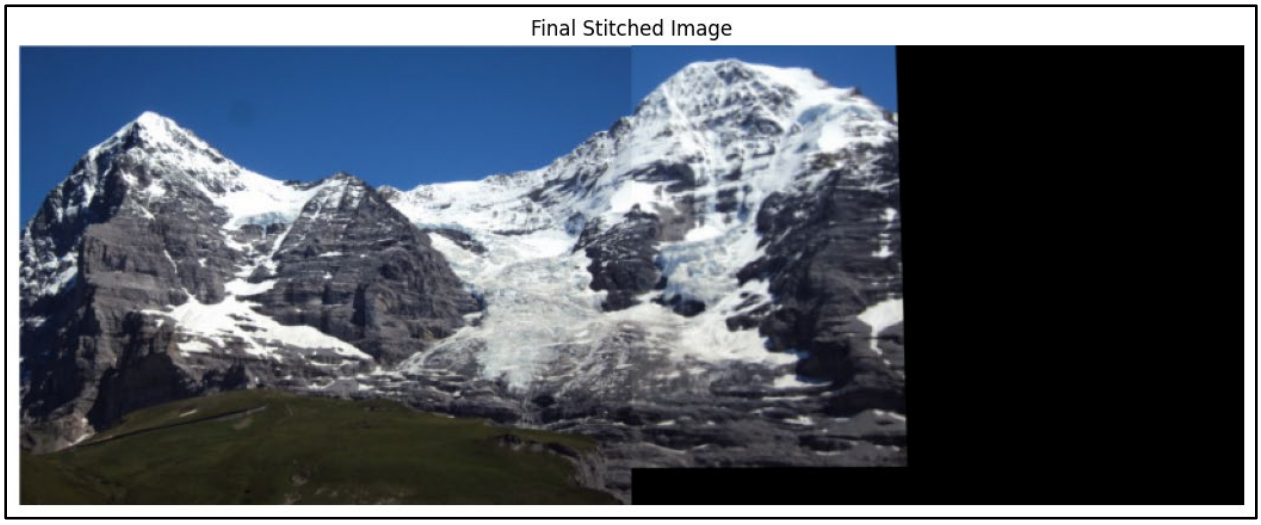


Image 1
Image 2
Image 3


Matches between Image 1 and Image 2
Matches between Image 2 and Image 3


Final Stitched Image

Practical: 3

Perform Camera Calibration

Code:

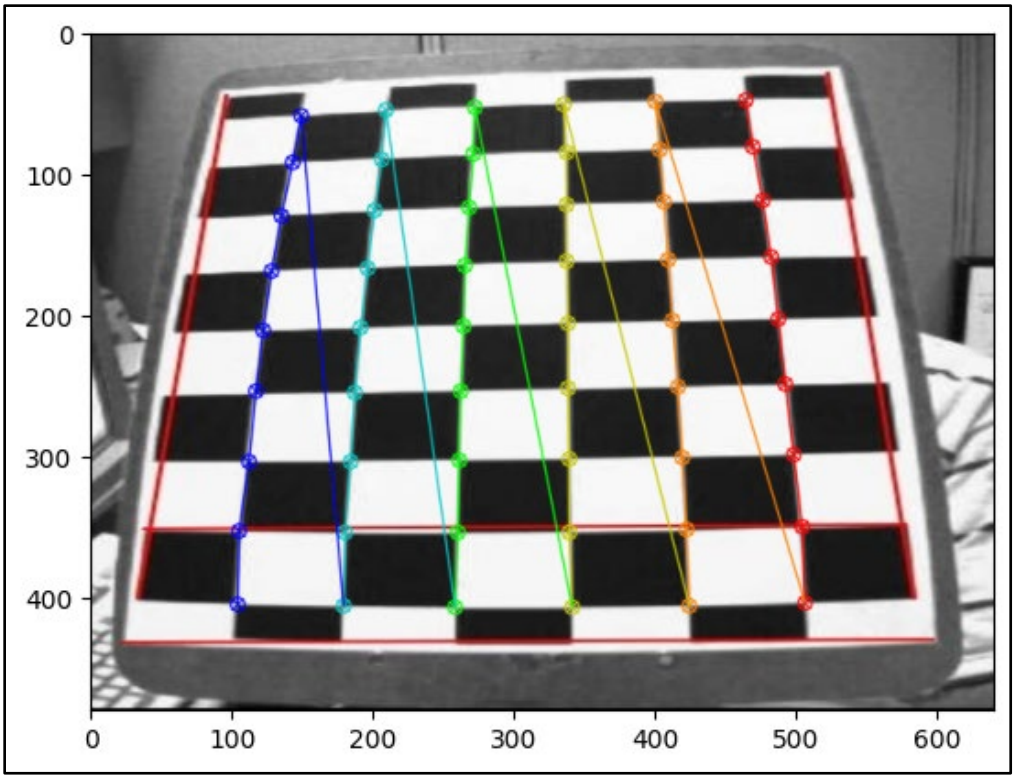
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import requests
from io import BytesIO
image_url = "https://docs.opencv.org/4.x/calib_radial.jpg"
response = requests.get(image_url)
img_arr = np.asarray(bytearray(response.content), dtype=np.uint8)
img = cv2.imdecode(img_arr, -1)
if img is None:
    print(f"Error: Could not load image from {image_url}")
    exit()
chessboard_size = (9, 6)  # (number of inner corners in the chessboard pattern)
square_size = 1.0  # Size of the square in some unit (e.g., 1cm or 1inch)

objp = np.zeros((chessboard_size[0] * chessboard_size[1], 3), np.float32)
objp[:, :2] = np.indices(chessboard_size).T.reshape(-1, 2) * square_size
obj_points = []  # List to store object points from all images
img_points = []  # List to store image points from all images

img = cv2.resize(img, (640, 480))  # Resize to smaller dimensions
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)



print("Starting chessboard detection...")
ret, corners = cv2.findChessboardCorners(gray, chessboard_size, None)
```

```
print(f"Chessboard detection result: {ret}")

if ret:
    obj_points.append(objp)
    img_points.append(corners)
    img = cv2.drawChessboardCorners(img, chessboard_size, corners, ret)
    plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
    plt.show()
else:
    print("Chessboard corners not found in the image.")
    exit()
ret, camera_matrix, dist_coeffs, rvecs, tvecs = cv2.calibrateCamera(
    obj_points, img_points, gray.shape[::-1], None, None)
print("Camera matrix:")
print(camera_matrix)
print("\nDistortion coefficients:")
print(dist_coeffs)
h, w = img.shape[:2]
new_camera_matrix, roi = cv2.getOptimalNewCameraMatrix(camera_matrix, dist_coeffs, (w,
h), 1, (w, h))
undistorted_img = cv2.undistort(img, camera_matrix, dist_coeffs, None, new_camera_matrix)
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title('Original Image')
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.subplot(1, 2, 2)
plt.title('Undistorted Image')
plt.imshow(cv2.cvtColor(undistorted_img, cv2.COLOR_BGR2RGB))
plt.show()
```

Output:

Starting chessboard detection...

Chessboard detection result: True



Camera matrix:

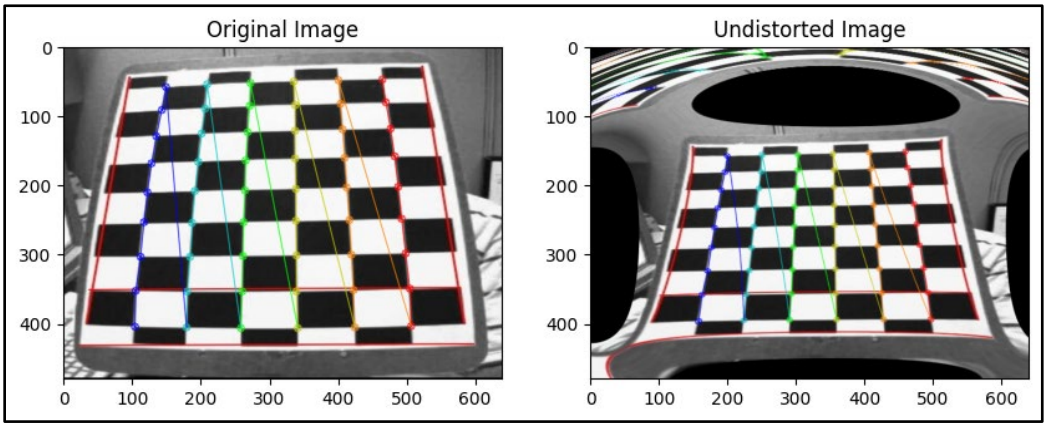
[[919.97485852 0. 315.59479329]

[0. 636.22054872 259.80557892]

[0. 0. 1.]]

Distortion coefficients:

[[-0.41553522 1.33907989 -0.02748822 0.01092723 -6.98402636]]



Practical: 4

Perform the following:

a. **Face detection**

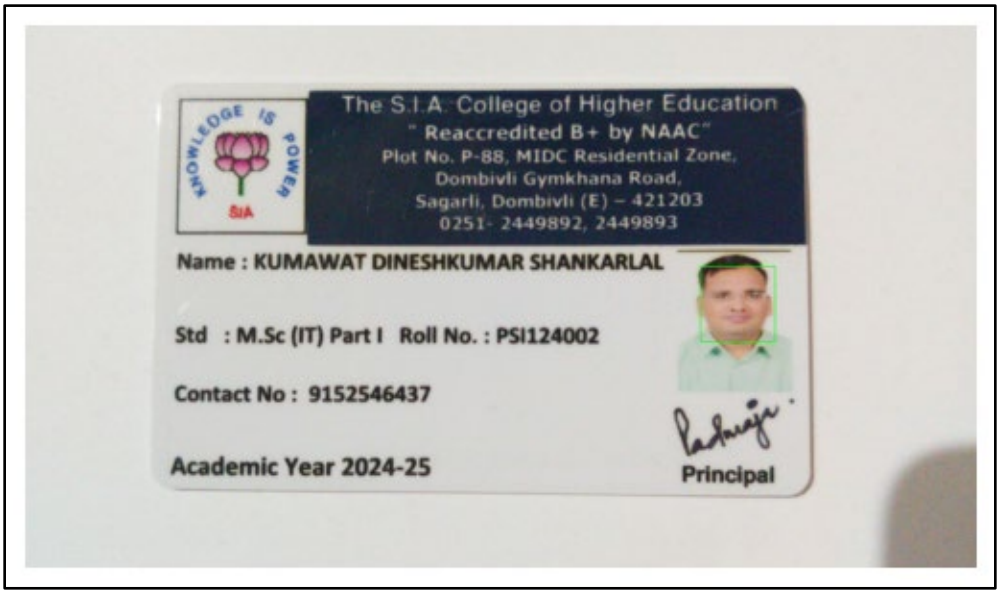
Code:

```
import cv2
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow

face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades +
'haarcascade_frontalface_default.xml')

from google.colab import files
uploaded = files.upload()

image = cv2.imread(next(iter(uploaded)))
gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=5, minSize=(30,
30))

for (x, y, w, h) in faces:
    cv2.rectangle(image, (x, y), (x + w, y + h), (0, 255, 0), 2)

image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

plt.imshow(image_rgb)
plt.axis('off')  # No axes for the image
plt.show()
```

Output:

Dinesh_College.jpg(image/jpeg) - 398416 bytes, last modified: 12/31/2024 - 100% done

Saving Dinesh_College.jpg to Dinesh_College.jpg



Practical: 4

Perform the following:

b. Object detection

Code:

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow
!wget https://pjreddie.com/media/files/yolov3.weights
!wget https://raw.githubusercontent.com/pjreddie/darknet/master/cfg/yolov3.cfg
```

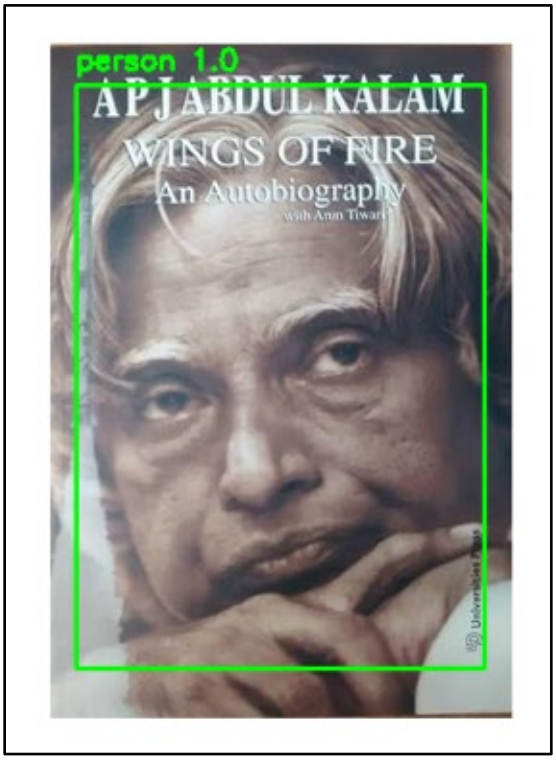
```
!wget https://raw.githubusercontent.com/pjreddie/darknet/master/data/coco.names
net = cv2.dnn.readNet("yolov3.weights", "yolov3.cfg")
layer_names = net.getLayerNames()
output_layers = [layer_names[i - 1] for i in net.getUnconnectedOutLayers()]
with open("coco.names", "r") as f:
    classes = [line.strip() for line in f.readlines()]
from google.colab import files
uploaded = files.upload()
image = cv2.imread(next(iter(uploaded)))
height, width, channels = image.shape
blob = cv2.dnn.blobFromImage(image, 0.00392, (416, 416), (0, 0, 0), True, crop=False)
net.setInput(blob)
outs = net.forward(output_layers)
class_ids = []
confidences = []
boxes = []
for out in outs:
    for detection in out:
        scores = detection[5:]
        class_id = np.argmax(scores)
        confidence = scores[class_id]
        if confidence > 0.5:
            center_x = int(detection[0] * width)
            center_y = int(detection[1] * height)
            w = int(detection[2] * width)
            h = int(detection[3] * height)
            x = int(center_x - w / 2)
            y = int(center_y - h / 2)
            boxes.append([x, y, w, h])
            confidences.append(float(confidence))
            class_ids.append(class_id)
```

```
indices = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.4)
if len(indices) > 0:
    for i in indices.flatten():
        x, y, w, h = boxes[i]
        label = str(classes[class_ids[i]])
        confidence = str(round(confidences[i], 2))
        cv2.rectangle(image, (x, y), (x + w, y + h), (0, 255, 0), 2)
        cv2.putText(image, label + " " + confidence, (x, y - 10),
cv2.FONT_HERSHEY_SIMPLEX, 0.6, (0, 255, 0), 2)
image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
plt.imshow(image_rgb)
plt.axis('off')
plt.show()
```

Output:

Screenshot 2024-08-03 164009.png(image/png) - 224267 bytes, last modified: 8/3/2024 - 100% done

Saving Screenshot 2024-08-03 164009.png to Screenshot 2024-08-03 164009.png



Practical: 4

Perform the following:

c. Pedestrian detection

Code:

```
import cv2
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow

hog = cv2.HOGDescriptor()
hog.setSVMDetector(cv2.HOGDescriptor_getDefaultPeopleDetector())

from google.colab import files
uploaded = files.upload()

image = cv2.imread(next(iter(uploaded)))
image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
boxes, weights = hog.detectMultiScale(image, winStride=(8, 8), padding=(8, 8), scale=1.05)

for (x, y, w, h) in boxes:
    cv2.rectangle(image, (x, y), (x + w, y + h), (0, 255, 0), 3)
image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

plt.imshow(image_rgb)
plt.axis('off')

plt.show()
```

Output:

wsky-ago-f6gqms-yhDY.jpg(image/jpeg) - 3227596 bytes, last modified: 3/12/2025 - 100% done

Saving wsky-ago-f6gqms-yhDY.jpg to wsky-ago-f6gqms-yhDY.jpg

Practical: 5

Implement object detection and tracking from video

Code:

```
import cv2
import numpy as np
from google.colab import files
import urllib.request
import os
uploaded = files.upload()
yolo_cfg_url = 'https://github.com/pjreddie/darknet/blob/master/cfg/yolov3-tiny.cfg?raw=true'
yolo_weights_url = 'https://pjreddie.com/media/files/yolov3-tiny.weights'
os.makedirs('yolo', exist_ok=True)
urllib.request.urlretrieve(yolo_cfg_url, 'yolo/yolov3-tiny.cfg')
urllib.request.urlretrieve(yolo_weights_url, 'yolo/yolov3-tiny.weights')
net = cv2.dnn.readNetFromDarknet('yolo/yolov3-tiny.cfg', 'yolo/yolov3-tiny.weights')
layer_names = net.getLayerNames()
output_layers = [layer_names[i - 1] for i in net.getUnconnectedOutLayers()]
video_path = list(uploaded.keys())[0]
cap = cv2.VideoCapture(video_path)
output_video_path = '/content/outputCarTracking.mp4'
fourcc = cv2.VideoWriter_fourcc(*'mp4v')
frame_width = int(cap.get(cv2.CAP_PROP_FRAME_WIDTH))
frame_height = int(cap.get(cv2.CAP_PROP_FRAME_HEIGHT))
out = cv2.VideoWriter(output_video_path, fourcc, 20.0, (frame_width, frame_height))
while cap.isOpened():
    ret, frame = cap.read()
    if not ret:
        break
    blob = cv2.dnn.blobFromImage(frame, 0.00392, (416, 416), (0, 0, 0), True, crop=False)
```

```
    net.setInput(blob)
    detections = net.forward(output_layers)
    for detection in detections:
        for obj in detection:
            scores = obj[5:]
            class_id = np.argmax(scores)
            confidence = scores[class_id]
            if confidence > 0.5 and class_id == 2:
                center_x = int(obj[0] * frame.shape[1])
                center_y = int(obj[1] * frame.shape[0])
                w = int(obj[2] * frame.shape[1])
                h = int(obj[3] * frame.shape[0])
                cv2.rectangle(frame, (center_x - w//2, center_y - h//2), (center_x + w//2, center_y +
h//2), (0, 255, 0), 2)
    out.write(frame)
cap.release()
out.release()
files.download(output_video_path)
```

Output:

Practical: 6

Perform Feature extraction using RANSAC

Code:

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab import files
from io import BytesIO
from PIL import Image

def upload_images():
    uploaded = files.upload()
    images = []

    for filename in uploaded.keys():
        img = Image.open(BytesIO(uploaded[filename]))
        img = np.array(img.convert("L"))  # Convert to grayscale
        images.append(img)

    if len(images) != 2:
        raise ValueError("You must upload exactly two images.")

    return images
image1, image2 = upload_images()
orb = cv2.ORB_create(nfeatures=1000)

keypoints1, descriptors1 = orb.detectAndCompute(image1, None)
keypoints2, descriptors2 = orb.detectAndCompute(image2, None)
```

```
print("Number of keypoints in image 1:", len(keypoints1))
print("Number of keypoints in image 2:", len(keypoints2))

bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)
matches = bf.match(descriptors1, descriptors2)

matches = sorted(matches, key=lambda x: x.distance)

matched_points1 = np.array([keypoints1[m.queryIdx].pt for m in matches], dtype=np.float32)
matched_points2 = np.array([keypoints2[m.trainIdx].pt for m in matches], dtype=np.float32)
print("Number of matches found:", len(matches))

src_pts = np.float32([keypoints1[m.queryIdx].pt for m in matches]).reshape(-1, 1, 2)
dst_pts = np.float32([keypoints2[m.trainIdx].pt for m in matches]).reshape(-1, 1, 2)

H, mask = cv2.findHomography(src_pts, dst_pts, cv2.RANSAC, 5.0)

print("Homography Matrix (H):")
print(H)

img_matches = cv2.drawMatches(image1, keypoints1, image2, keypoints2, matches[:10], None,
flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)

plt.figure(figsize=(15, 10))
plt.imshow(img_matches)
plt.title('Top 10 Matching Points')
plt.show()
```

Output:

Saving image-(1).jpg to image-(1).jpg

Saving image.jpg to image.jpg

Number of keypoints in image 1: 142

Number of keypoints in image 2: 1000

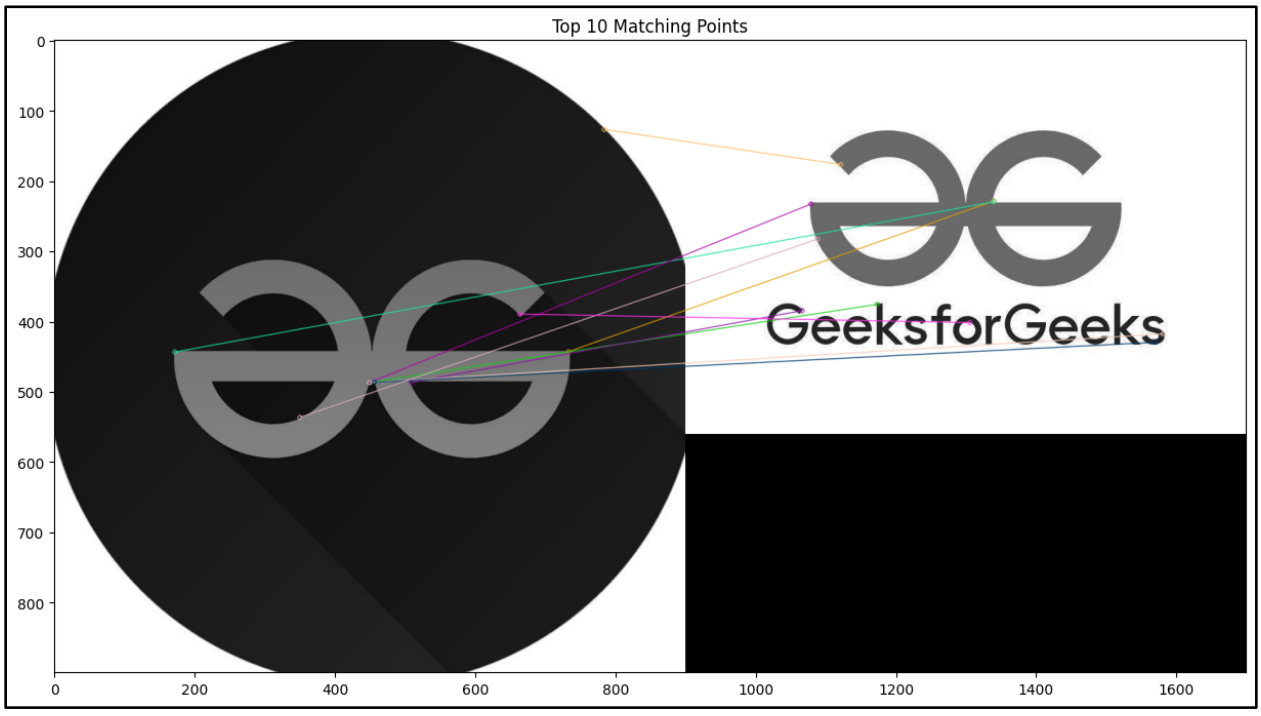
Number of matches found: 15

Homography Matrix (H):

[[-2.47559817e-01 -3.84332869e-01 2.98077267e+02]

 [-3.33430174e-01 -5.75811244e-01 4.29817180e+02]

 [-7.80861184e-04 -1.33754337e-03 1.00000000e+00]]



Practical: 7

Text detection and recognition

Code:

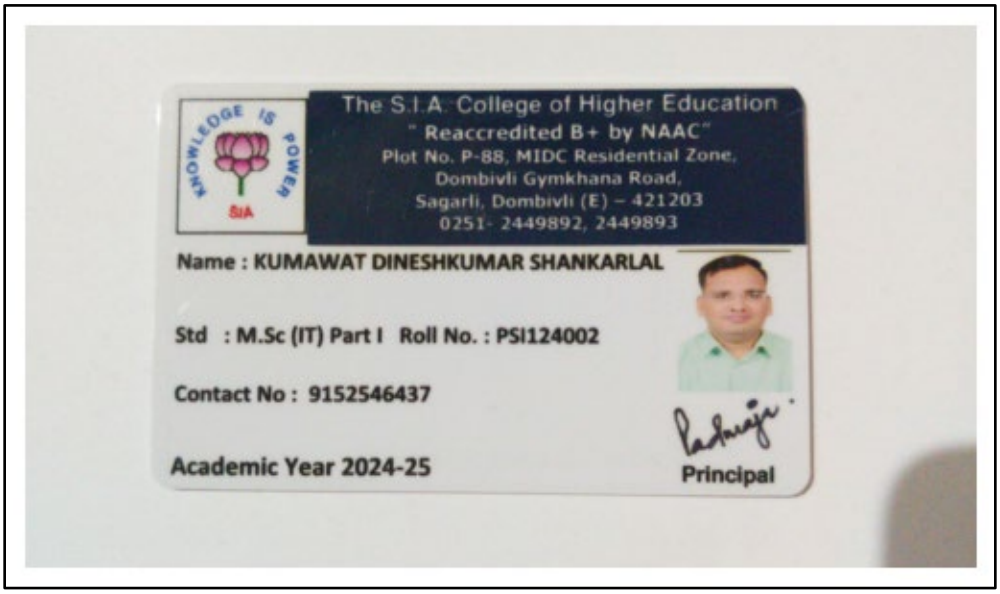
```
!apt-get install tesseract-ocr
!pip install pytesseract opencv-python

import cv2
import pytesseract
import numpy as np
from matplotlib import pyplot as plt
from google.colab import files
import io
import PIL.Image
uploaded = files.upload()
image_path = next(iter(uploaded))  # Get the file name of the uploaded image
img = PIL.Image.open(io.BytesIO(uploaded[image_path]))
plt.imshow(img)
plt.axis('off')
plt.show()
img_cv = cv2.cvtColor(np.array(img), cv2.COLOR_RGB2BGR)
gray = cv2.cvtColor(img_cv, cv2.COLOR_BGR2GRAY)
_, thresh = cv2.threshold(gray, 150, 255, cv2.THRESH_BINARY)

plt.imshow(thresh, cmap='gray')
plt.axis('off')
plt.show()
text = pytesseract.image_to_string(thresh)
print("Extracted Text: ", text)
h, w, _ = img_cv.shape
```

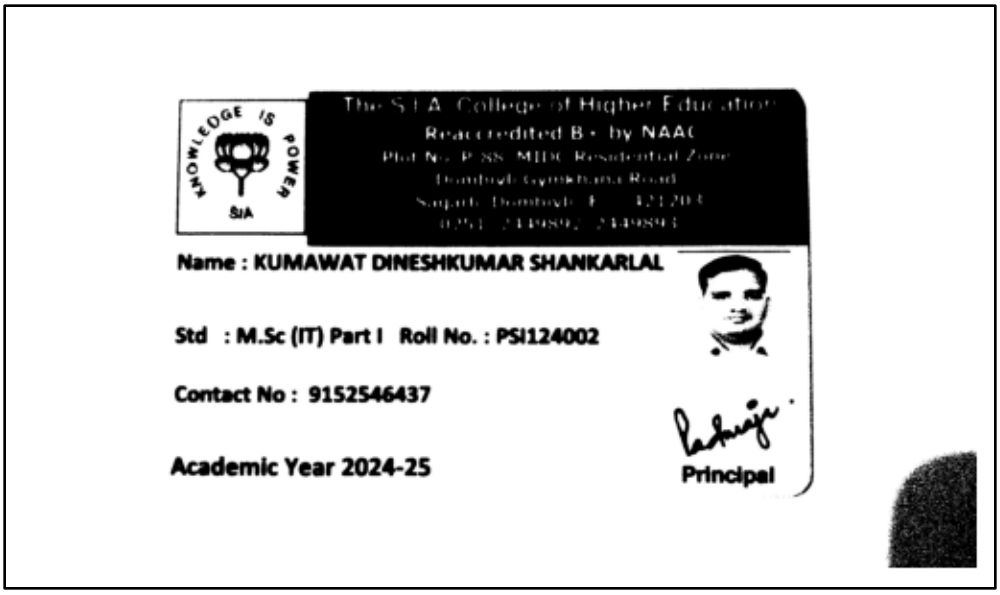
```
boxes = pytesseract.image_to_boxes(img_cv)
for b in boxes.splitlines():
    b = b.split()
    x, y, x2, y2 = int(b[1]), int(b[2]), int(b[3]), int(b[4])
    cv2.rectangle(img_cv, (x, h - y), (x2, h - y2), (0, 255, 0), 2)
plt.imshow(cv2.cvtColor(img_cv, cv2.COLOR_BGR2RGB))
plt.axis('off')
plt.show()
```

Output:

Dinesh_College.jpg(image/jpeg) - 398416 bytes, last modified: 12/31/2024 - 100% done

Saving Dinesh_College.jpg to Dinesh_College.jpg





Extracted Text: The SEA College of Higher Fduc atianr

Reaccredited Br by NAAC

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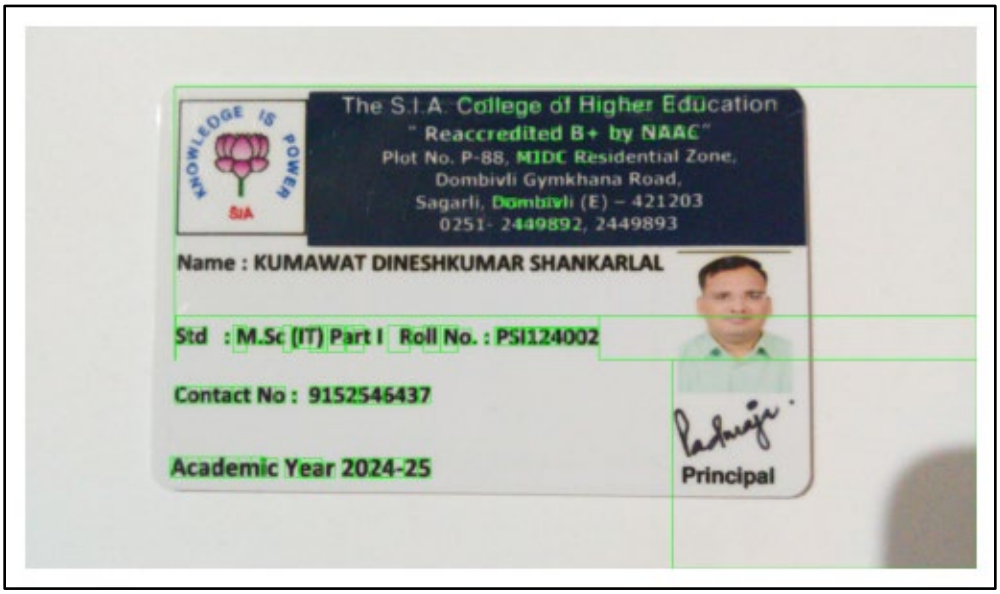
Std : M.Sc (IT) Part! Roll No. : PS1124002

Contact No: 9152546437

Academic Year 2024-25



Practical: 8

Perform Image matting and Composting

Code:

```
!pip install opencv-python opencv-python-headless numpy pillow matplotlib

from google.colab import files
uploaded = files.upload()
import cv2
import numpy as np
import matplotlib.pyplot as plt
from PIL import Image

for file_name in uploaded.keys():
    print(f'Uploaded file: {file_name}')

foreground_image_name = list(uploaded.keys())[0]  # Assuming the first uploaded file is the foreground image
background_image_name = list(uploaded.keys())[1]  # Assuming the second uploaded file is the background image

foreground_image = cv2.imread(foreground_image_name)  # Foreground image
background_image = cv2.imread(background_image_name)  # Background image

if foreground_image is None:
    print("Foreground image failed to load.")
else:
    print("Foreground image loaded successfully.")
```

```
if background_image is None:
    print("Background image failed to load.")
else:
    print("Background image loaded successfully.")

if foreground_image is not None and background_image is not None:
    # Print dimensions of the images
    print(f"Foreground image dimensions: {foreground_image.shape}")
    print(f"Background image dimensions: {background_image.shape}")

    foreground_image_rgb = cv2.cvtColor(foreground_image, cv2.COLOR_BGR2RGB)
    plt.imshow(foreground_image_rgb)
    plt.title("Foreground Image")
    plt.axis('off')
    plt.show()
    print('\n')

    background_image_rgb = cv2.cvtColor(background_image, cv2.COLOR_BGR2RGB)
    plt.imshow(background_image_rgb)
    plt.title("Background Image")
    plt.axis('off')
    plt.show()
    print('\n')

    foreground_gray = cv2.cvtColor(foreground_image, cv2.COLOR_BGR2GRAY)
    _, mask = cv2.threshold(foreground_gray, 120, 255, cv2.THRESH_BINARY)
    foreground_with_alpha = cv2.cvtColor(foreground_image, cv2.COLOR_BGR2BGRA)
    foreground_with_alpha[:, :, 3] = mask

    plt.imshow(cv2.cvtColor(foreground_with_alpha, cv2.COLOR_BGRA2RGBA))
```

```
    plt.title("Foreground with Alpha Matte")
    plt.axis('off')
    plt.show()
    print('\n')
    background_resized = cv2.resize(background_image, (foreground_image.shape[1],
foreground_image.shape[0]))

    foreground_rgb = foreground_with_alpha[:, :, :3]
    alpha_channel = foreground_with_alpha[:, :, 3] / 255.0  # Normalize alpha to [0, 1]
    blended_image = (alpha_channel[..., None] * foreground_rgb +
                     (1 - alpha_channel[..., None]) * background_resized)
    plt.imshow(blended_image.astype(np.uint8))
    plt.title("Composited Image")
    plt.axis('off')
    plt.show()
    print('\n')
    blended_image_bgr = cv2.cvtColor(blended_image.astype(np.uint8),
cv2.COLOR_RGB2BGR)

    cv2.imwrite('composited_image.jpg', blended_image_bgr)
    files.download('composited_image.jpg')
else:
    print("One or both images are missing. Please check the uploaded files.")
```

Output:

Saving Screenshot 2024-07-29 215534.png to Screenshot 2024-07-29 215534 (3).png

Saving Screenshot 2025-01-30 111524.png to Screenshot 2025-01-30 111524 (3).png

Uploaded file: Screenshot 2024-07-29 215534 (3).png

Uploaded file: Screenshot 2025-01-30 111524 (3).png

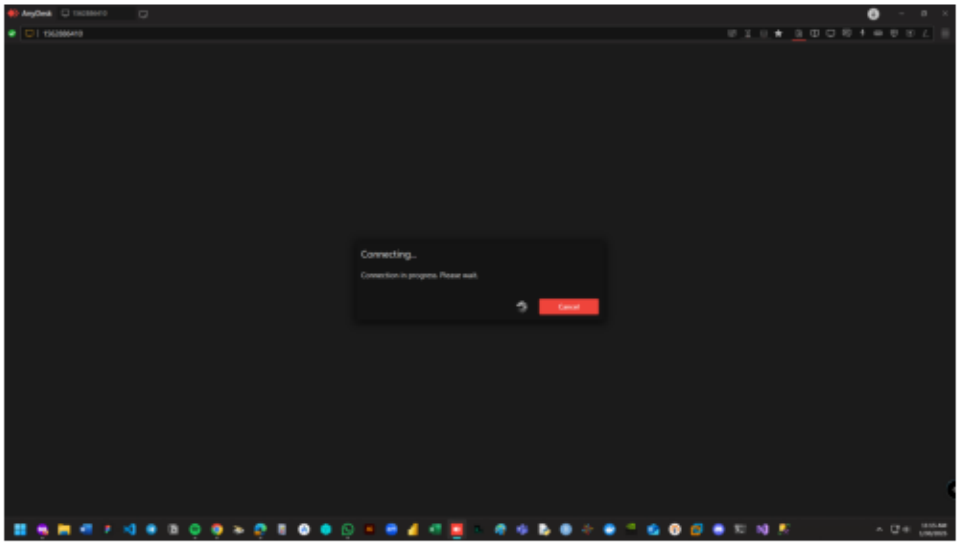
Foreground image loaded successfully.

Background image loaded successfully.

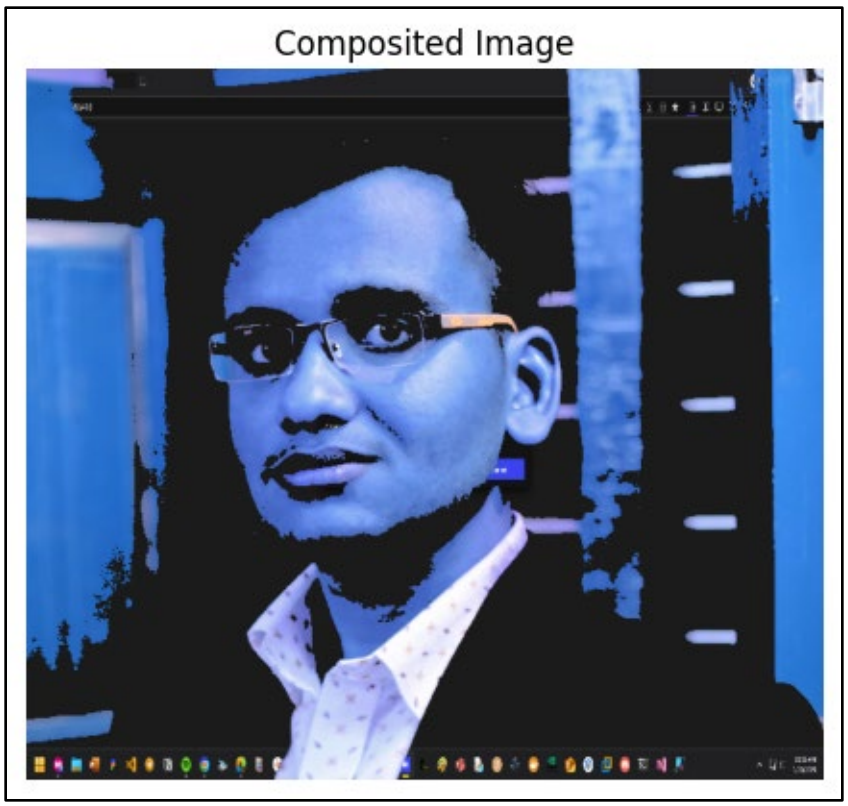
Foreground image dimensions: (564, 633, 3)

Background image dimensions: (1079, 1919, 3)

Background Image



Foreground with Alpha Matte


Composited Image