Name:
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Practical - 5 Matrix Multiplication

MapReduce is a technique in which a huge program is subdivided into small tasks and run parallel to make computation faster, save time, and mostly used in distributed systems. It has 2 important parts:

- **Mapper:** It takes raw data input and organizes into key, value pairs. For example, In a dictionary, you search for the word "Data" and its associated meaning is "facts and statistics collected together for reference or analysis". Here the Key is *Data* and the **Value** associated with is *facts and statistics collected together for reference or analysis.*
- **Reducer:** It is responsible for processing data in parallel and produce final output.

Matrix Multiplication:

Matrix-vector and matrix-matrix calculations fit nicely into the MapReduce style of computing.

Matrix Data Model for MapReduce

We represent matrix M as a relation M(I,J,V), with tuples (i, j, m_{ij}), and matrix N as a relation N(J,K,W), with tuples (j, k, n_{jk}). Most matrices are sparse so large amount of cells have value zero. When we represent matrices in this form, we do not need to keep entries for the cells that have values of zero to save large amount of disk space. As input data files, we store matrix M and N on HDFS

M, i, j, m_{ij}

```
M,0,0,10.0
M,0,2,9.0
M,0,3,9.0
M,1,0,1.0
```

N, j, k, n_{jk}

```
N,0,0,1.0
N,0,2,3.0
N,0,4,2.0
N,1,0,2.0
```

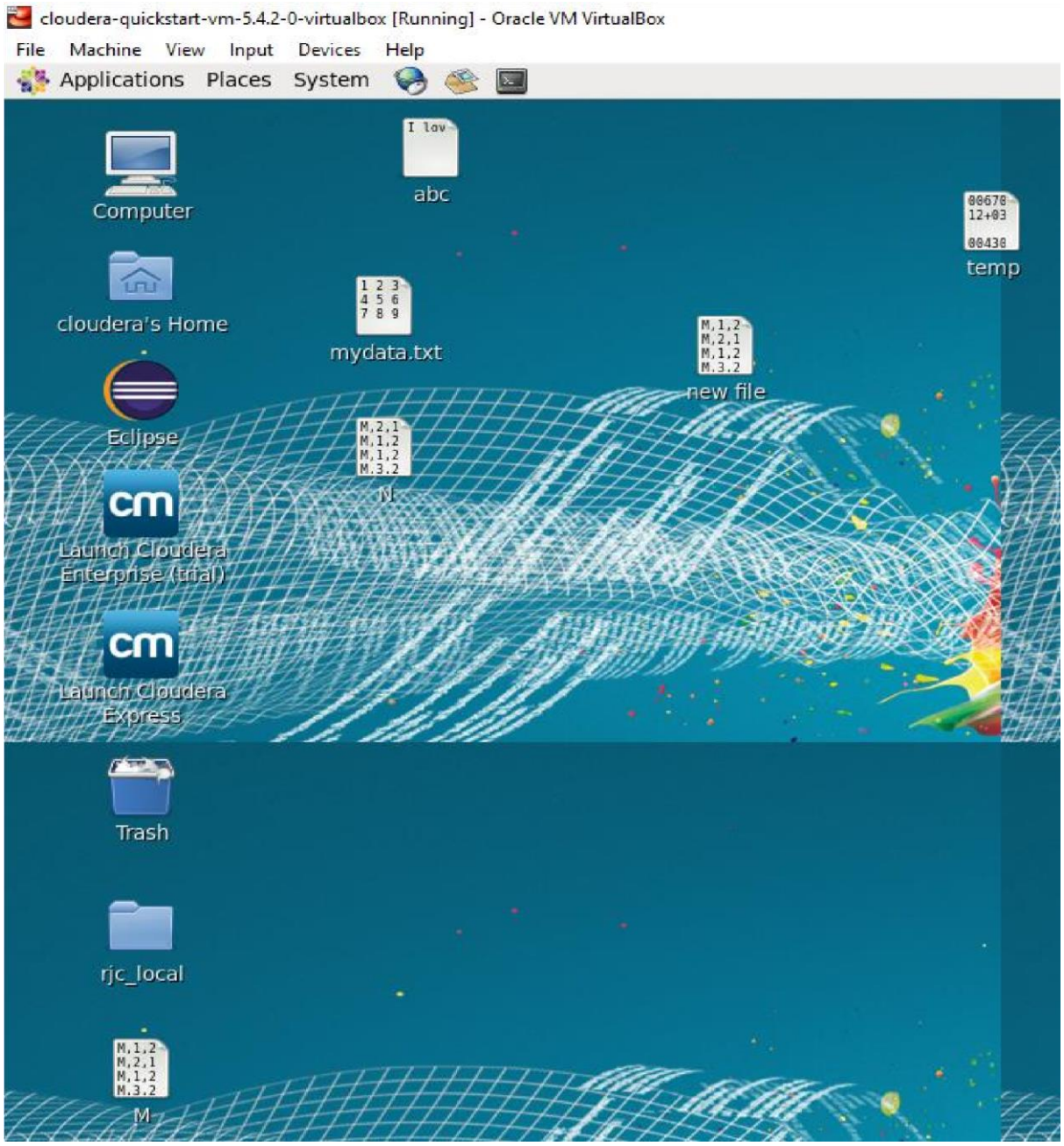
Map Reduce:

We will write Map and Reduce functions to process input files. Map function will produce $key, value$ pairs from the input data as it is described in Algorithm 1. Reduce function uses the output of the Map function and performs the calculations and produces $key, value$ pairs as described in Algorithm 2. All outputs are written to HDFS.

Steps for MatrixMultiplication :

Name:
Roll No:

1) Open virtual box and then start cloudera quickstart



2) Open Eclipse present on the cloudera desktop

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3) Create a new Java project clicking: File -> New -> Project -> Java Project -> Next ("Matrix" is the project name).

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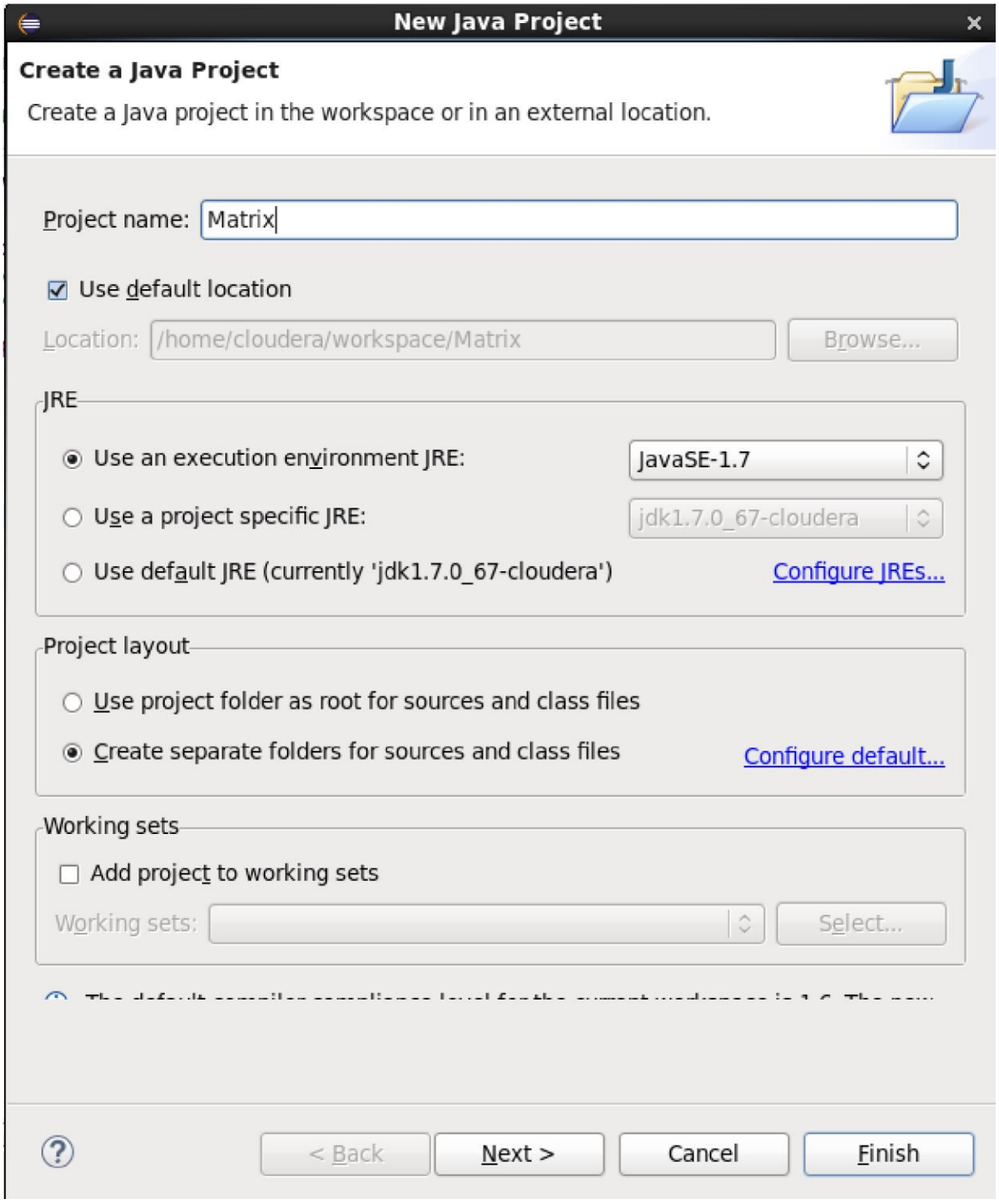
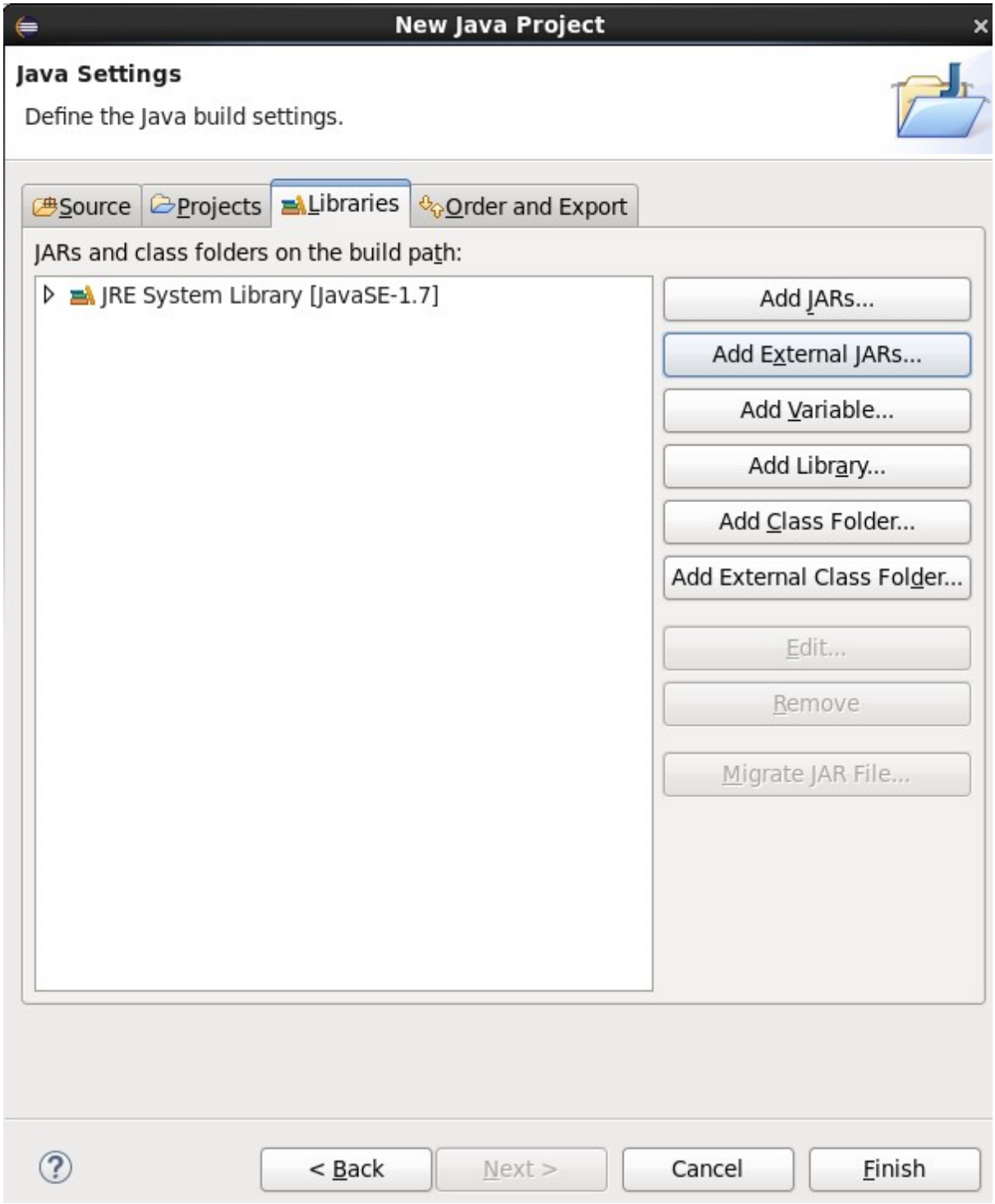


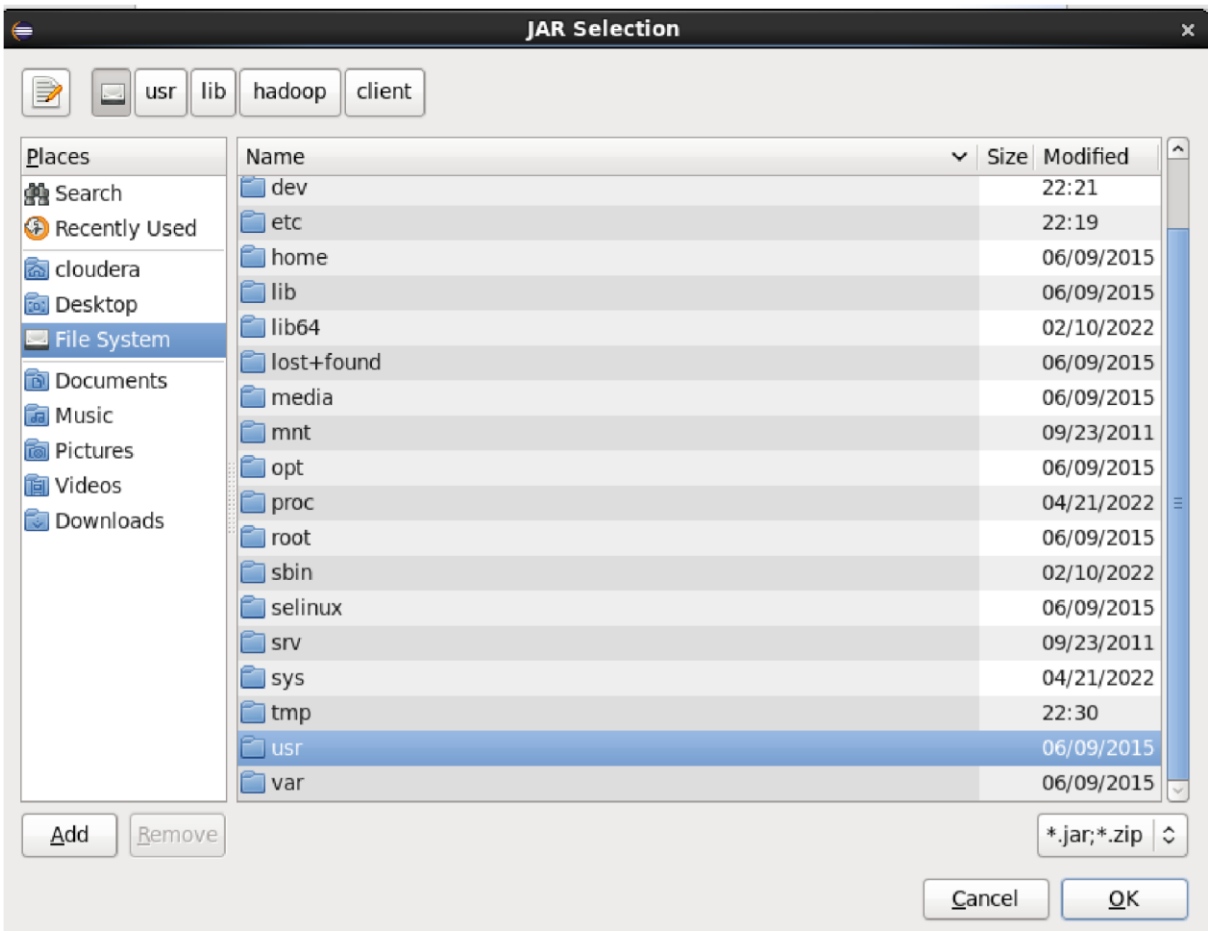
4) Adding the Hadoop libraries to the project Click on Libraries -> Add External JARs Click on

File System -> usr -> lib -> Hadoop, Select all the libraries (JAR Files) -> click OK Click on Add External jars, -> client -> select all jar files -> ok -> Finish

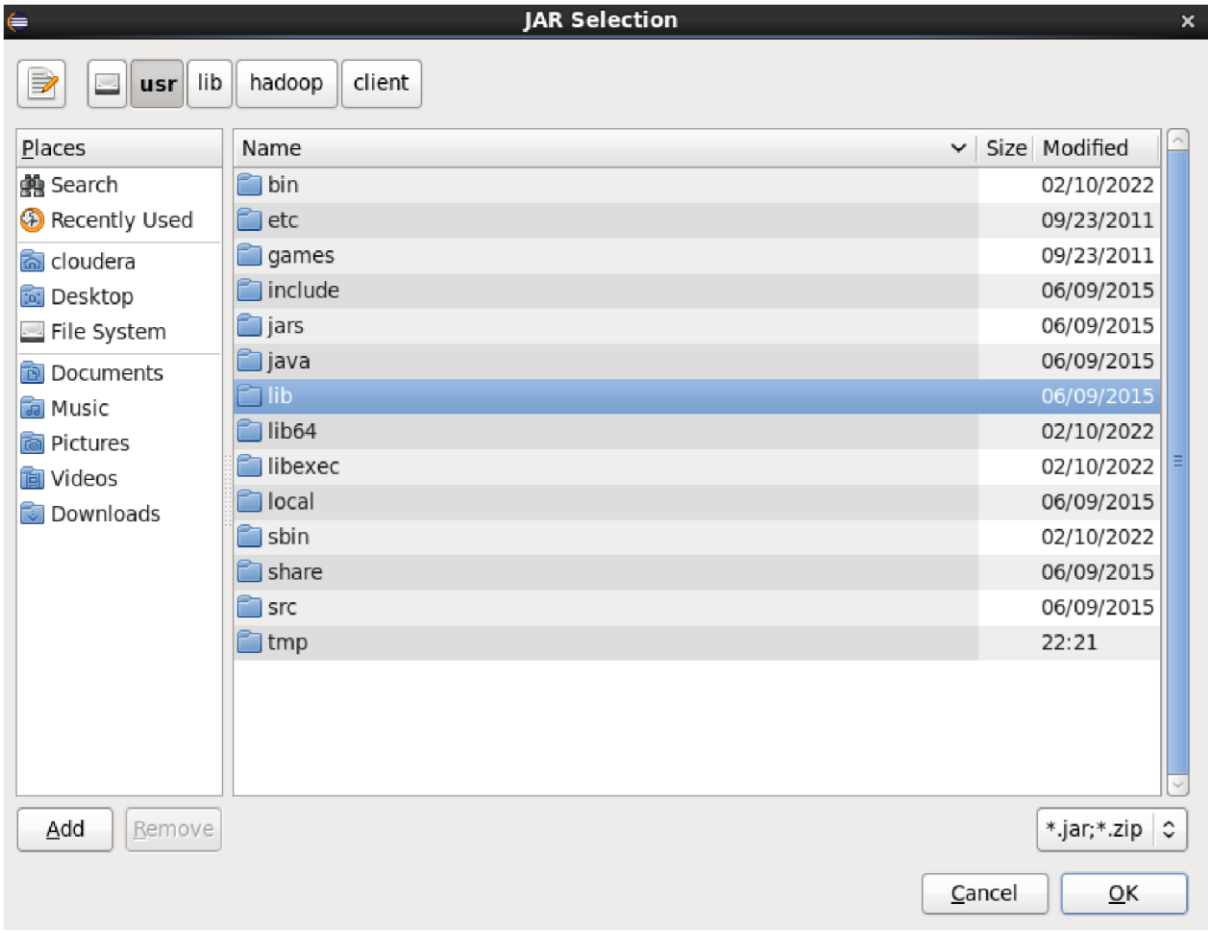
Name:
Roll No:


New Java Project
Java Settings
Define the Java build settings.
Source
Projects
Libraries
Order and Export
JARs and class folders on the build path:
JRE System Library [JavaSE-1.7]
Add JARs...
Add External JARs...
Add Variable...
Add Library...
Add Class Folder...
Add External Class Folder...
Edit...
Remove
Migrate JAR File...
< Back
Next >
Cancel
Finish

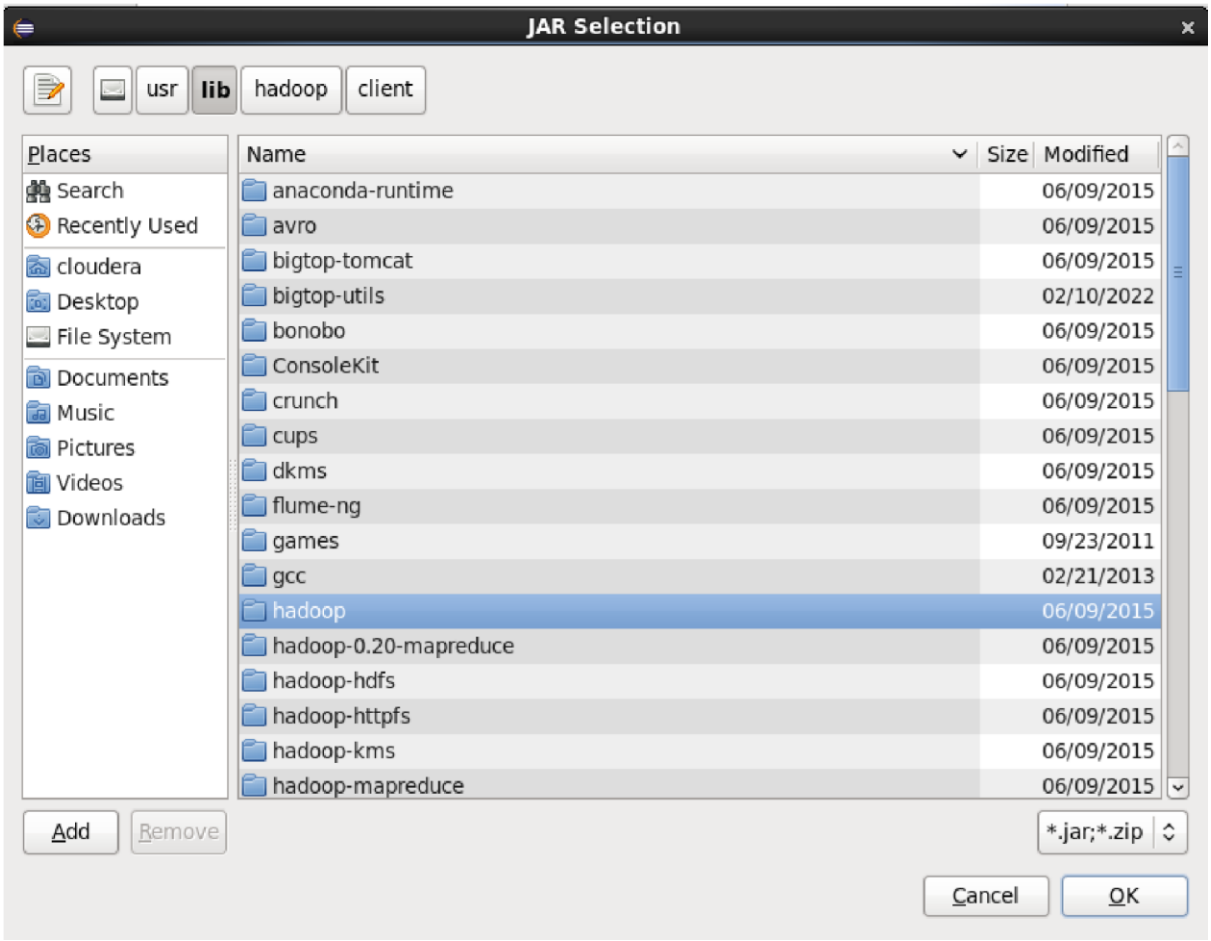
Name:
Roll No:


JAR Selection
usr
lib
hadoop
client
Places
Search
Recently Used
cloudera
Desktop
File System
Documents
Music
Pictures
Videos
Downloads
Name
Size
Modified
dev 22:21
etc 22:19
home 06/09/2015
lib 06/09/2015
lib64 02/10/2022
lost+found 06/09/2015
media 06/09/2015
mnt 09/23/2011
opt 06/09/2015
proc 04/21/2022
root 06/09/2015
sbin 02/10/2022
selinux 06/09/2015
srv 09/23/2011
sys 04/21/2022
tmp 22:30
usr 06/09/2015
var 06/09/2015
Add
Remove
.jar;.zip
Cancel
OK

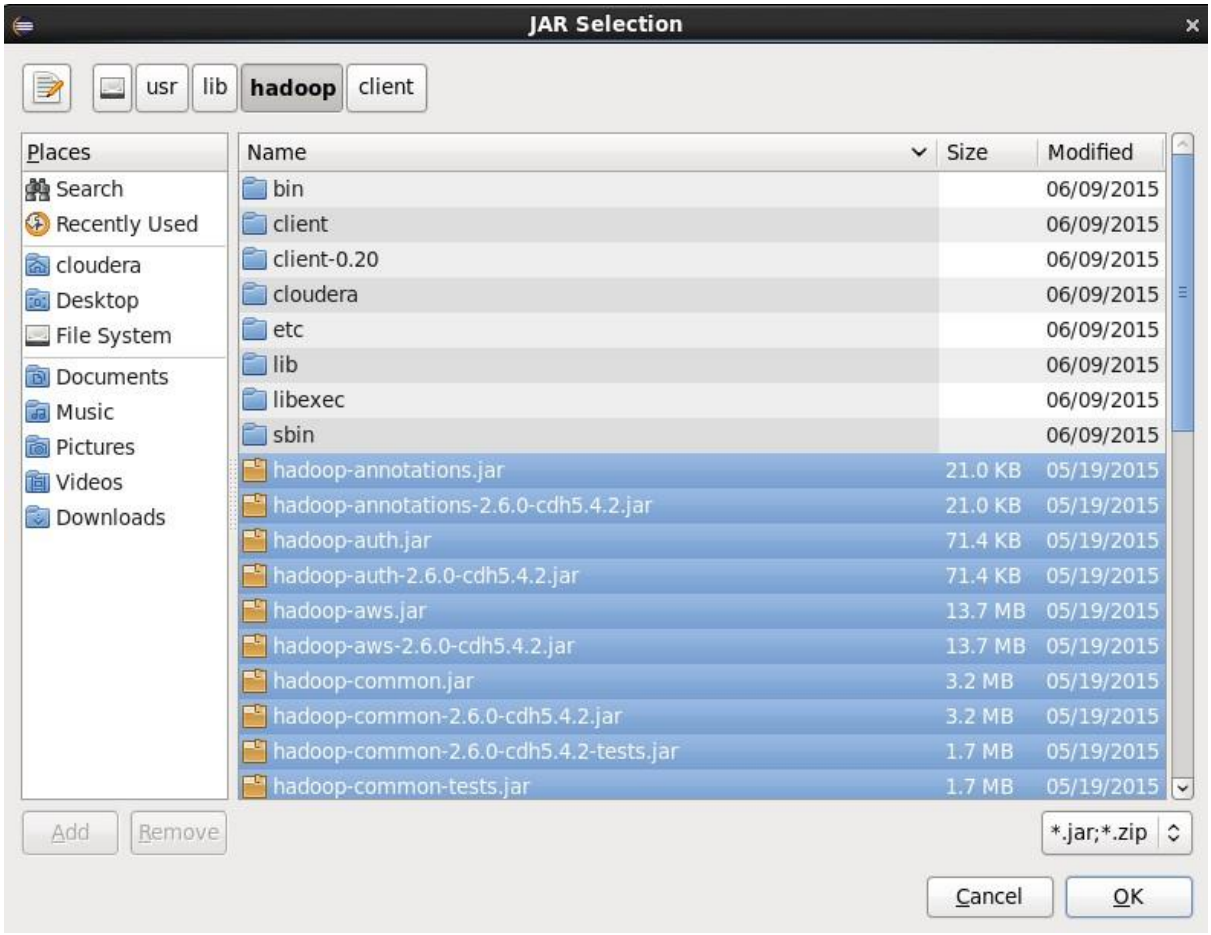
Name:
Roll No:


JAR Selection
usr
lib
hadoop
client
Places
Search
Recently Used
cloudera
Desktop
File System
Documents
Music
Pictures
Videos
Downloads
Name
Size
Modified
bin 02/10/2022
etc 09/23/2011
games 09/23/2011
include 06/09/2015
jars 06/09/2015
java 06/09/2015
lib 06/09/2015
lib64 02/10/2022
libexec 02/10/2022
local 06/09/2015
sbin 02/10/2022
share 06/09/2015
src 06/09/2015
tmp 22:21
Add
Remove
.jar;.zip
Cancel
OK

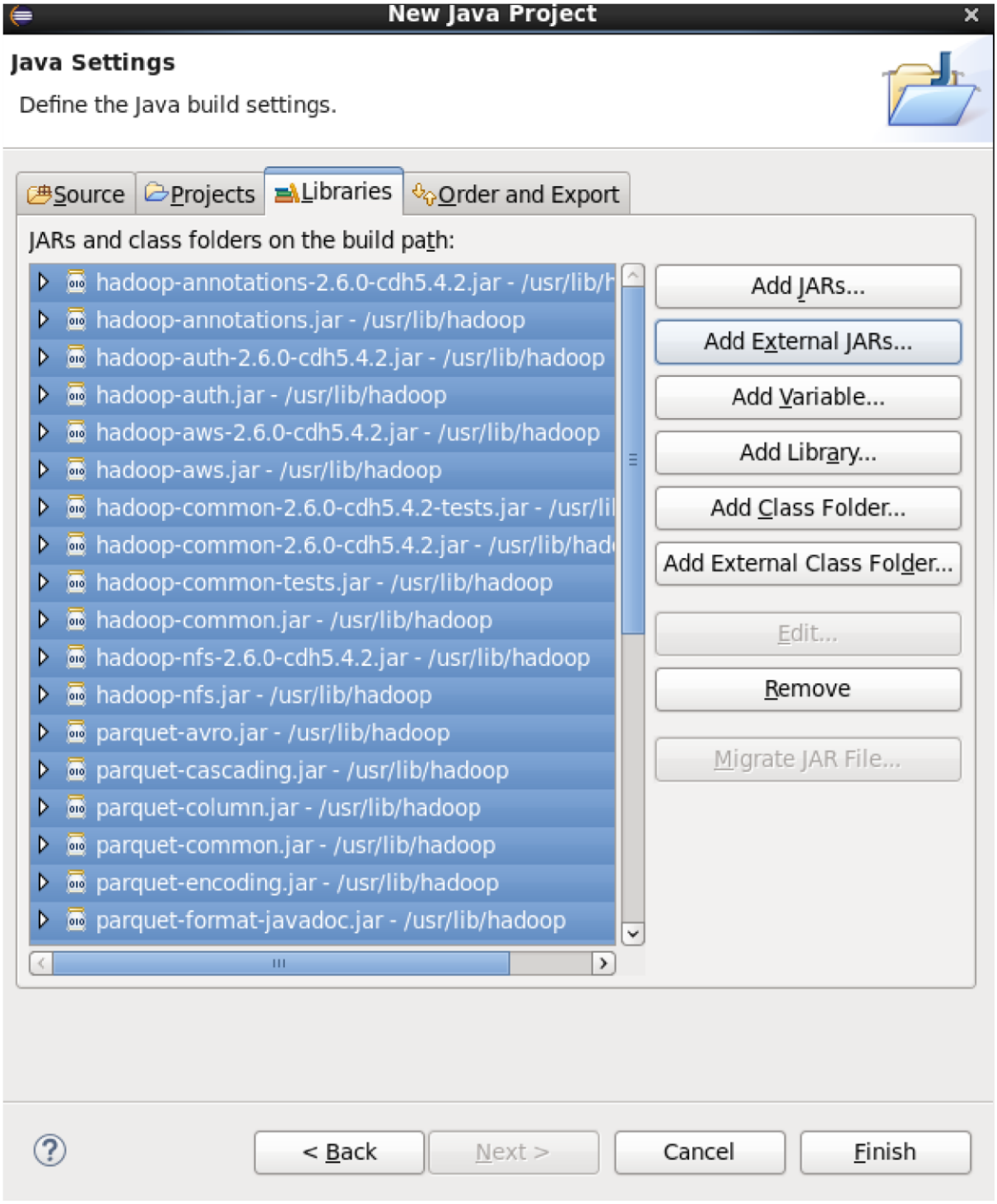
Name:
Roll No:


JAR Selection
usr
lib
hadoop
client
Places
Search
Recently Used
cloudera
Desktop
File System
Documents
Music
Pictures
Videos
Downloads
Name
Size
Modified
anaconda-runtime 06/09/2015
avro 06/09/2015
bigtop-tomcat 06/09/2015
bigtop-utils 02/10/2022
bonobo 06/09/2015
ConsoleKit 06/09/2015
crunch 06/09/2015
cups 06/09/2015
dkms 06/09/2015
flume-ng 06/09/2015
games 09/23/2011
gcc 02/21/2013
hadoop 06/09/2015
hadoop-0.20-mapreduce 06/09/2015
hadoop-hdfs 06/09/2015
hadoop-httpfs 06/09/2015
hadoop-kms 06/09/2015
hadoop-mapreduce 06/09/2015
Add
Remove
.jar;.zip
Cancel
OK

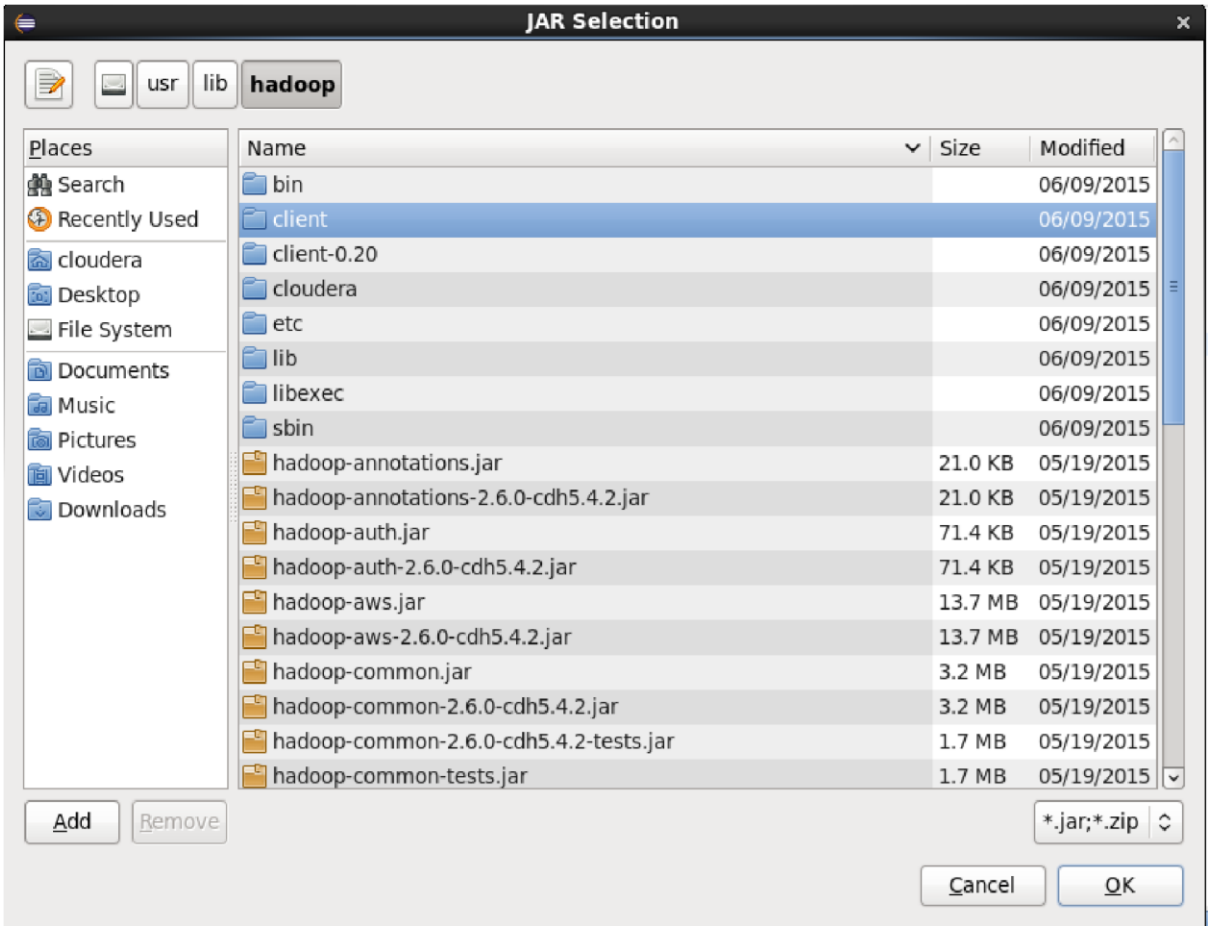
Name:
Roll No:

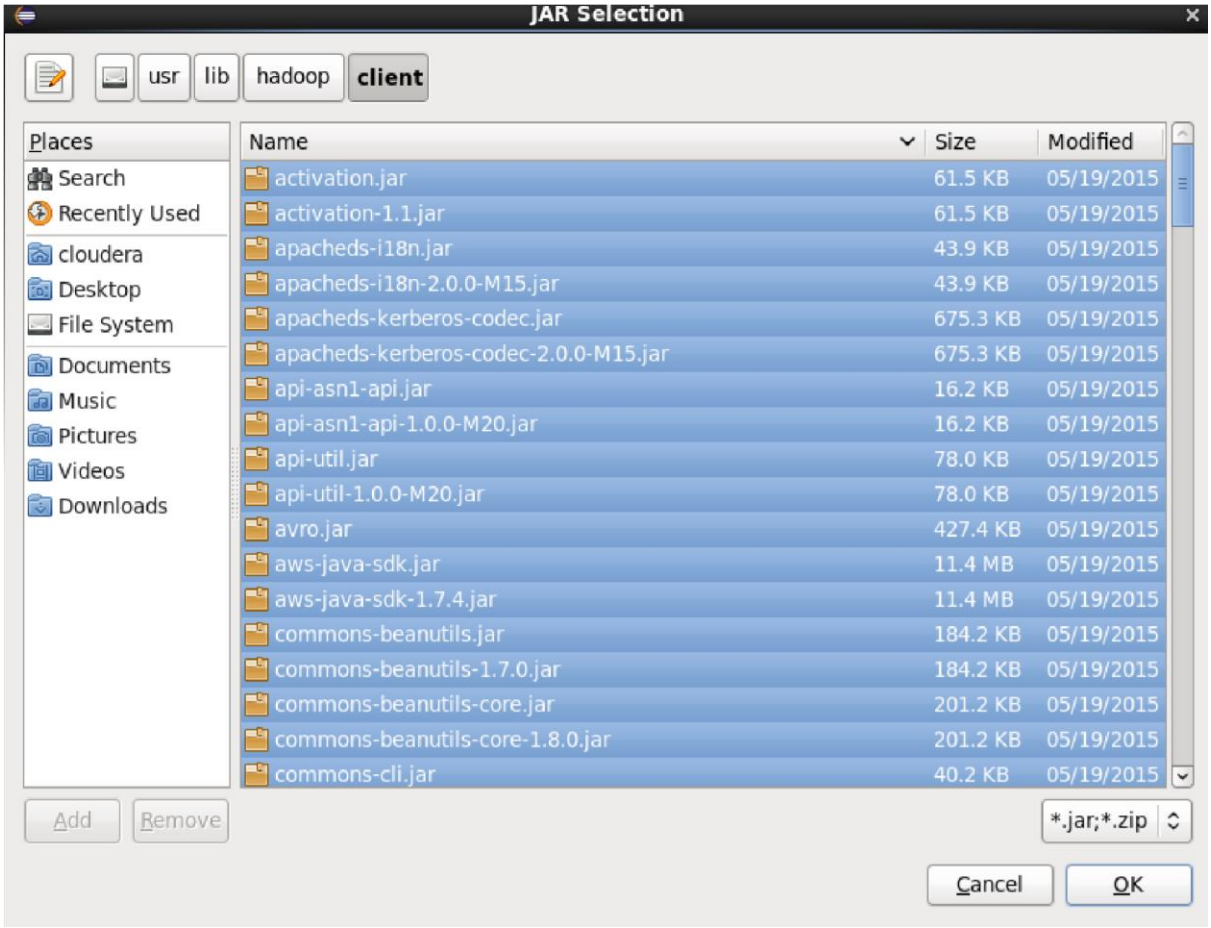

JAR Selection
usr
lib
hadoop
client
Places
Search
Recently Used
cloudera
Desktop
File System
Documents
Music
Pictures
Videos
Downloads
Name
Size
Modified
bin 06/09/2015
client 06/09/2015
client-0.20 06/09/2015
cloudera 06/09/2015
etc 06/09/2015
lib 06/09/2015
libexec 06/09/2015
sbin 06/09/2015
hadoop-annotations.jar 21.0 KB 05/19/2015
hadoop-annotations-2.6.0-cdh5.4.2.jar 21.0 KB 05/19/2015
hadoop-auth.jar 71.4 KB 05/19/2015
hadoop-auth-2.6.0-cdh5.4.2.jar 71.4 KB 05/19/2015
hadoop-aws.jar 13.7 MB 05/19/2015
hadoop-aws-2.6.0-cdh5.4.2.jar 13.7 MB 05/19/2015
hadoop-common.jar 3.2 MB 05/19/2015
hadoop-common-2.6.0-cdh5.4.2.jar 3.2 MB 05/19/2015
hadoop-common-2.6.0-cdh5.4.2-tests.jar 1.7 MB 05/19/2015
hadoop-common-tests.jar 1.7 MB 05/19/2015
Add
Remove
.jar;.zip
Cancel
OK

Name:
Roll No:

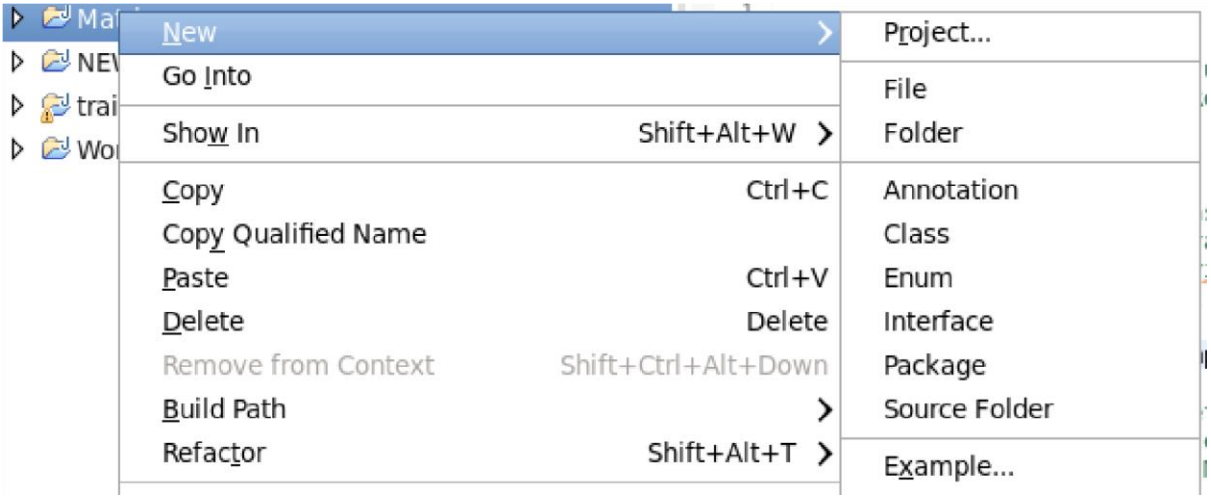

New Java Project
Java Settings
Define the Java build settings.
Source
Projects
Libraries
Order and Export
JARs and class folders on the build path:
hadoop-annotations-2.6.0-cdh5.4.2.jar - /usr/lib/h
hadoop-annotations.jar - /usr/lib/hadoop
hadoop-auth-2.6.0-cdh5.4.2.jar - /usr/lib/hadoop
hadoop-auth.jar - /usr/lib/hadoop
hadoop-aws-2.6.0-cdh5.4.2.jar - /usr/lib/hadoop
hadoop-aws.jar - /usr/lib/hadoop
hadoop-common-2.6.0-cdh5.4.2-tests.jar - /usr/li
hadoop-common-2.6.0-cdh5.4.2.jar - /usr/lib/had
hadoop-common-tests.jar - /usr/lib/hadoop
hadoop-common.jar - /usr/lib/hadoop
hadoop-nfs-2.6.0-cdh5.4.2.jar - /usr/lib/hadoop
hadoop-nfs.jar - /usr/lib/hadoop
parquet-avro.jar - /usr/lib/hadoop
parquet-cascading.jar - /usr/lib/hadoop
parquet-column.jar - /usr/lib/hadoop
parquet-common.jar - /usr/lib/hadoop
parquet-encoding.jar - /usr/lib/hadoop
parquet-format-javadoc.jar - /usr/lib/hadoop
Add JARs...
Add External JARs...
Add Variable...
Add Library...
Add Class Folder...
Add External Class Folder...
Edit...
Remove
Migrate JAR File...
< Back
Next >
Cancel
Finish

Name:
Roll No:


JAR Selection
usr
lib
hadoop
Places
Search
Recently Used
cloudera
Desktop
File System
Documents
Music
Pictures
Videos
Downloads
Name
Size
Modified
bin 06/09/2015
client 06/09/2015
client-0.20 06/09/2015
cloudera 06/09/2015
etc 06/09/2015
lib 06/09/2015
libexec 06/09/2015
sbin 06/09/2015
hadoop-annotations.jar 21.0 KB 05/19/2015
hadoop-annotations-2.6.0-cdh5.4.2.jar 21.0 KB 05/19/2015
hadoop-auth.jar 71.4 KB 05/19/2015
hadoop-auth-2.6.0-cdh5.4.2.jar 71.4 KB 05/19/2015
hadoop-aws.jar 13.7 MB 05/19/2015
hadoop-aws-2.6.0-cdh5.4.2.jar 13.7 MB 05/19/2015
hadoop-common.jar 3.2 MB 05/19/2015
hadoop-common-2.6.0-cdh5.4.2.jar 3.2 MB 05/19/2015
hadoop-common-2.6.0-cdh5.4.2-tests.jar 1.7 MB 05/19/2015
hadoop-common-tests.jar 1.7 MB 05/19/2015
Add
Remove
.jar;.zip
Cancel
OK



5) Right Click on the name of Project “Matrix” -> New -> class Don’t write anything for package Write Name Textbox write “Matrix” -> Finish Then MatrixMulltiply.java window will pop up



Name:
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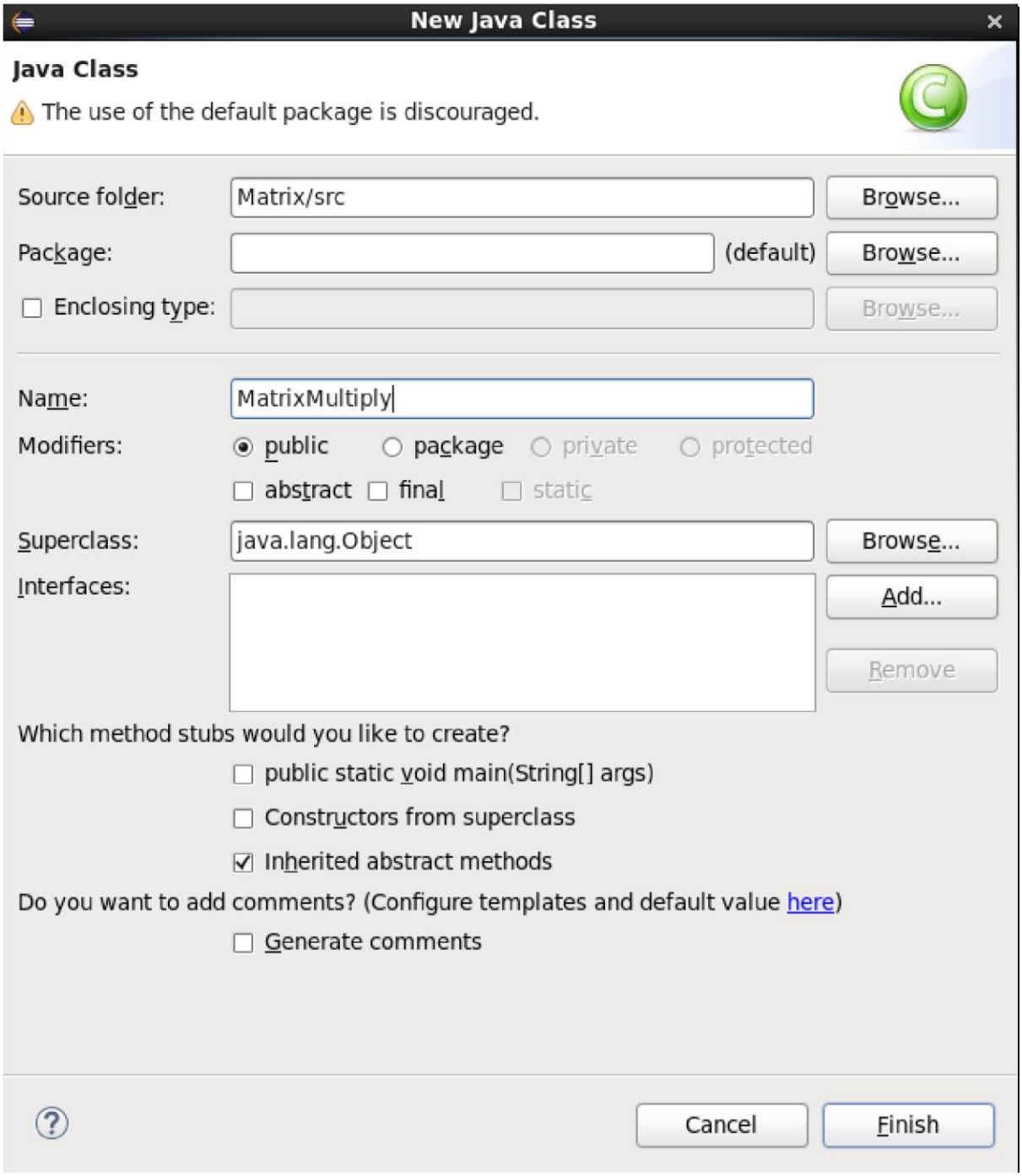

Source Code:

```
import java.io.IOException;
import java.util.HashMap;

import org.apache.hadoop.conf.*;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.*;
import org.apache.hadoop.mapreduce.*;
import org.apache.hadoop.mapreduce.Mapper.Context;
```

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Roll No:

```
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.input.TextInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
import org.apache.hadoop.mapreduce.lib.output.TextOutputFormat;
import org.apache.hadoop.conf.*;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;

import java.io.IOException;
import java.util.HashMap;

      public class MatrixMultiply {

            public static void main(String[] args) throws Exception {
            if (args.length != 2) {
               System.err.println("Usage: MatrixMultiply <in_dir> <out_dir>");
               System.exit(2);
            }
            Configuration conf = new Configuration();
            // M is an m-by-n matrix; N is an n-by-p matrix.
            conf.set("m", "1000");
            conf.set("n", "100");
            conf.set("p", "1000");
            @SuppressWarnings("deprecation")
                  Job job = new Job(conf, "MatrixMultiply");
            job.setJarByClass(MatrixMultiply.class);
            job.setOutputKeyClass(Text.class);
            job.setOutputValueClass(Text.class);

            job.setMapperClass(Map.class);
            job.setReducerClass(Reduce.class);

            job.setInputFormatClass(TextInputFormat.class);
            job.setOutputFormatClass(TextOutputFormat.class);

            FileInputFormat.addInputPath(job, new Path(args[0]));
            FileOutputFormat.setOutputPath(job, new Path(args[1]));

            job.waitForCompletion(true);
            }
            public class Map
              extends org.apache.hadoop.mapreduce.Mapper<LongWritable, Text,
Text, Text> {
                  @Override
                  public void map(LongWritable key, Text value, Context context)
                              throws IOException, InterruptedException {
                        Configuration conf = context.getConfiguration();
                        int m = Integer.parseInt(conf.get("m"));
                        int p = Integer.parseInt(conf.get("p"));
                        String line = value.toString();
                        // (M, i, j, Mij);
                        String[] indicesAndValue = line.split(",");
```

```
            Text outputKey = new Text();
            Text outputValue = new Text();
            if (indicesAndValue[0].equals("M")) {
                for (int k = 0; k < p; k++) {
                    outputKey.set(indicesAndValue[1] + "," + k);
                    // outputKey.set(i,k);
                    outputValue.set(indicesAndValue[0] + "," + indicesAndValue[2]
                            + "," + indicesAndValue[3]);
                    // outputValue.set(M,j,Mij);
                    context.write(outputKey, outputValue);
                }
            } else {
                // (N, j, k, Njk);
                for (int i = 0; i < m; i++) {
                    outputKey.set(i + "," + indicesAndValue[2]);
                    outputValue.set("N," + indicesAndValue[1] + ","
                            + indicesAndValue[3]);
                    context.write(outputKey, outputValue);
                }
            }
        }
    }
        public class Reduce
     extends org.apache.hadoop.mapreduce.Reducer<Text, Text, Text, Text> {
        @Override
        public void reduce(Text key, Iterable<Text> values, Context context)
                throws IOException, InterruptedException {
            String[] value;
            //key=(i,k),
            //Values = [(M/N,j,V/W),..]
            HashMap<Integer, Float> hashA = new HashMap<Integer, Float>();
            HashMap<Integer, Float> hashB = new HashMap<Integer, Float>();
            for (Text val : values) {
                value = val.toString().split(",");
                if (value[0].equals("M")) {
                    hashA.put(Integer.parseInt(value[1]), Float.parseFloat(value[2]));
                } else {
                    hashB.put(Integer.parseInt(value[1]), Float.parseFloat(value[2]));
                }
            }
            int n = Integer.parseInt(context.getConfiguration().get("n"));
            float result = 0.0f;
            float m_ij;
            float n_jk;
            for (int j = 0; j < n; j++) {
                m_ij = hashA.containsKey(j) ? hashA.get(j) : 0.0f;
                n_jk = hashB.containsKey(j) ? hashB.get(j) : 0.0f;
                result += m_ij * n_jk;
            }
            if (result != 0.0f) {
                context.write(null,
                        new Text(key.toString() + "," + Float.toString(result)));
            }
        }
```

```
}
}
```

StubDriver.java | WordCount.java | MaxTemp.java | MatrixMul.java

```java
import org.apache.hadoop.conf.*;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.*;
import org.apache.hadoop.mapreduce.*;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.input.TextInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
import org.apache.hadoop.mapreduce.lib.output.TextOutputFormat;
import org.apache.hadoop.conf.*;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Reducer;

import java.io.IOException;
import java.util.HashMap;


import java.io.IOException;


public class MatrixMul {

    public static void main(String[] args) throws Exception {
        if (args.length != 2) {
            System.err.println("Usage: MatrixMul <in_dir> <out_dir>");
            System.exit(2);
        }
        Configuration conf = new Configuration();
        // M is an m-by-n matrix; N is an n-by-p matrix.
        conf.set("m", "1000");
        conf.set("n", "100");
        conf.set("p", "1000");
        @SuppressWarnings("deprecation")
        Job job = new Job(conf, "MatrixMul");
        job.setJarByClass(MatrixMul.class);
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(Text.class);

        job.setMapperClass(Map.class);
        job.setReducerClass(Reduce.class);

        job.setInputFormatClass(TextInputFormat.class);
        job.setOutputFormatClass(TextOutputFormat.class);

```

Name:
Roll No:

```
87        public class Reduce
88          extends org.apache.hadoop.mapreduce.Reducer<Text, Text, Text, Text> {
89            @Override
90            public void reduce(Text key, Iterable<Text> values, Context context)
91                    throws IOException, InterruptedException {
92                String[] value;
93                //key=(i,k),
94                //Values = [(M/N,j,V/W),..]
95                HashMap<Integer, Float> hashA = new HashMap<Integer, Float>();
96                HashMap<Integer, Float> hashB = new HashMap<Integer, Float>();
97                for (Text val : values) {
98                    value = val.toString().split(",");
99                    if (value[0].equals("M")) {
100                       hashA.put(Integer.parseInt(value[1]), Float.parseFloat(value[2]));
101                   } else {
102                       hashB.put(Integer.parseInt(value[1]), Float.parseFloat(value[2]));
103                   }
104               }
105               int n = Integer.parseInt(context.getConfiguration().get("n"));
106               float result = 0.0f;
107               float m_ij;
108               float n_jk;
109               for (int j = 0; j < n; j++) {
110                   m_ij = hashA.containsKey(j) ? hashA.get(j) : 0.0f;
111                   n_jk = hashB.containsKey(j) ? hashB.get(j) : 0.0f;
112                   result += m_ij * n_jk;
113               }
114               if (result != 0.0f) {
115                   context.write(null,
116                           new Text(key.toString() + "," + Float.toString(result)));
117               }
118           }
119       }
120   }
```

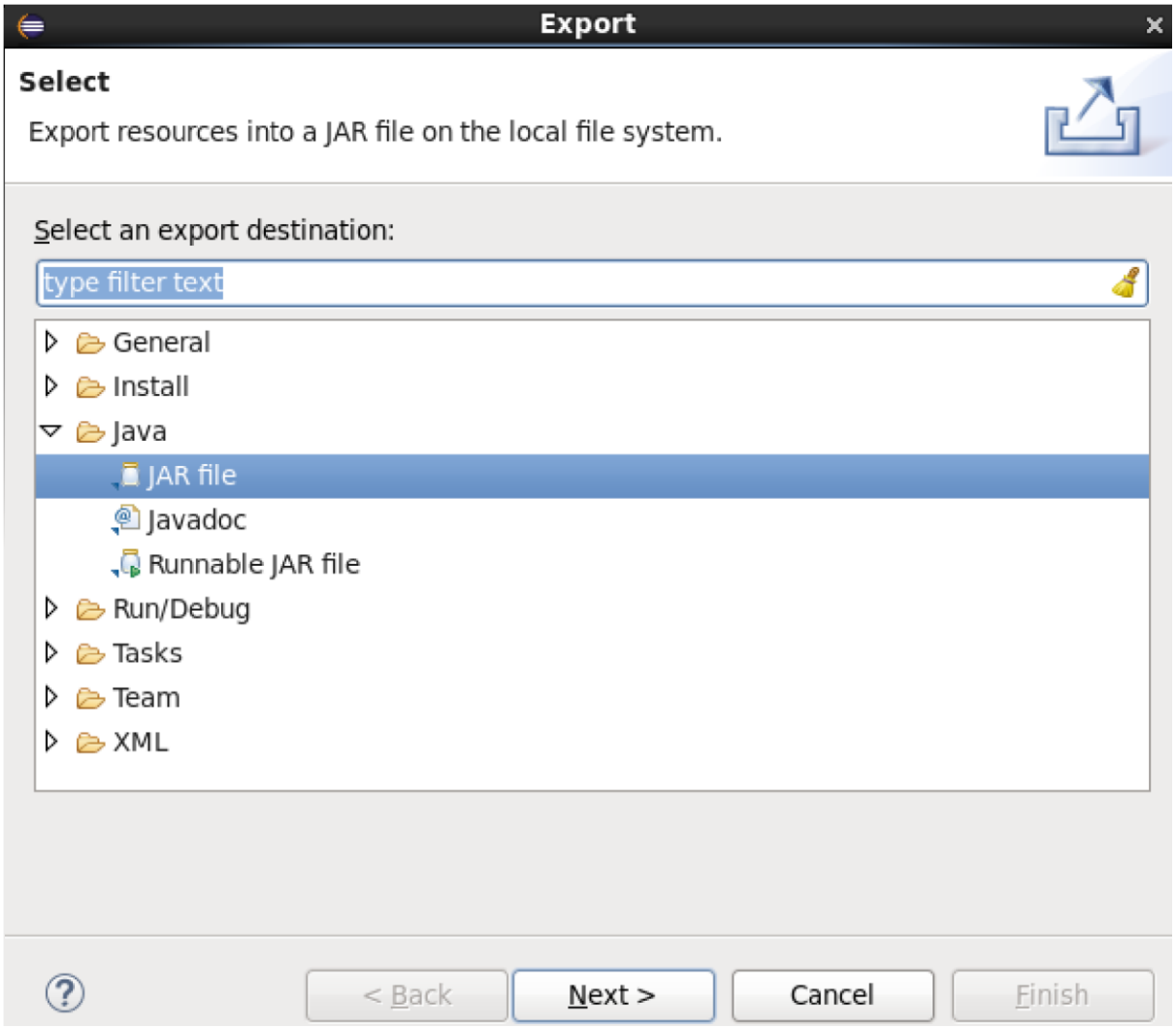
Name:
Roll No:

StubDriver.java | WordCount.java | MaxTemp.java | MatrixMul.java

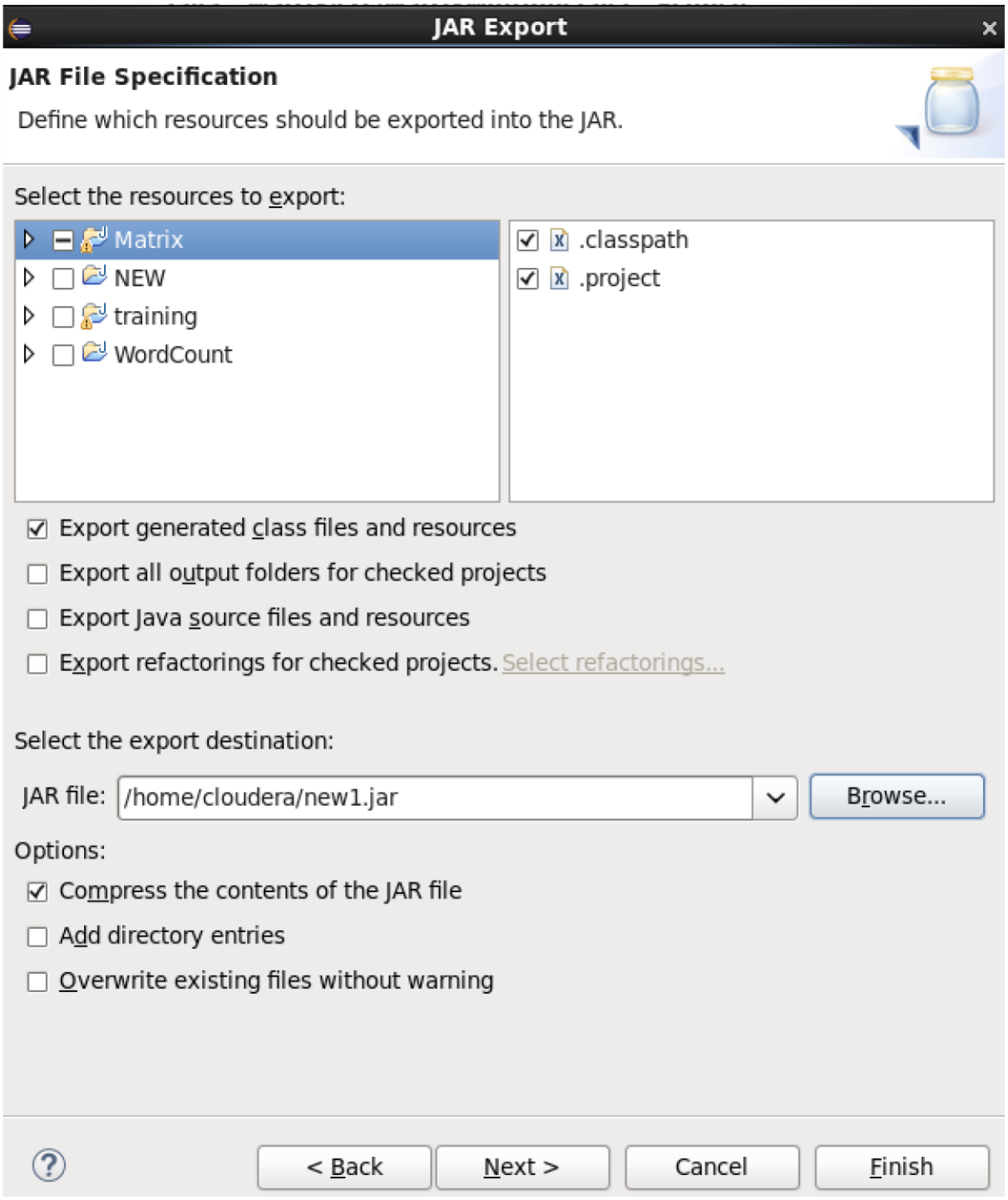
```
45            job.setOutputFormatClass(TextOutputFormat.class);
46
47            FileInputFormat.addInputPath(job, new Path(args[0]));
48            FileOutputFormat.setOutputPath(job, new Path(args[1]));
49
50            job.waitForCompletion(true);
51        }
52
53        public class Map
54          extends org.apache.hadoop.mapreduce.Mapper<LongWritable, Text, Text, Text> {
55            @Override
56            public void map(LongWritable key, Text value, Context context)
57                    throws IOException, InterruptedException {
58                Configuration conf = context.getConfiguration();
59                int m = Integer.parseInt(conf.get("m"));
60                int p = Integer.parseInt(conf.get("p"));
61                String line = value.toString();
62                // (M, i, j, Mij);
63                String[] indicesAndValue = line.split(",");
64                Text outputKey = new Text();
65                Text outputValue = new Text();
66                if (indicesAndValue[0].equals("M")) {
67                    for (int k = 0; k < p; k++) {
68                        outputKey.set(indicesAndValue[1] + "," + k);
69                        // outputKey.set(i,k);
70                        outputValue.set(indicesAndValue[0] + "," + indicesAndValue[2]
71                                + "," + indicesAndValue[3]);
72                        // outputValue.set(M,j,Mij);
73                        context.write(outputKey, outputValue);
74                    }
75                } else {
76                    // (N, j, k, Njk);
77                    for (int i = 0; i < m; i++) {
78                        outputKey.set(i + "," + indicesAndValue[2]);
79                        outputValue.set("N," + indicesAndValue[1] + ","
80                                + indicesAndValue[3]);
81                        context.write(outputKey, outputValue);
82                    }
83                }
84            }
85        }
86
87        public class Reduce
88          extends org.apache.hadoop.mapreduce.Reducer<Text, Text, Text, Text> {
89            @Override
90            public void reduce(Text key, Iterable<Text> values, Context context)
```

6) Right Click on the project name Matrix -> Export -> Java -> JAR File -> Next -> for select the export destination for JAR file: browse -> Name : Matrix1.jar -> save in folder -> cloudera -> Finish -> OK

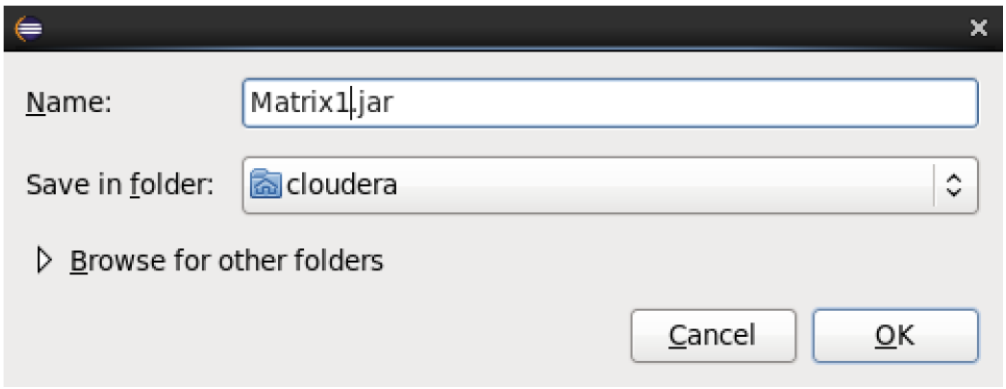
Name:
Roll No:

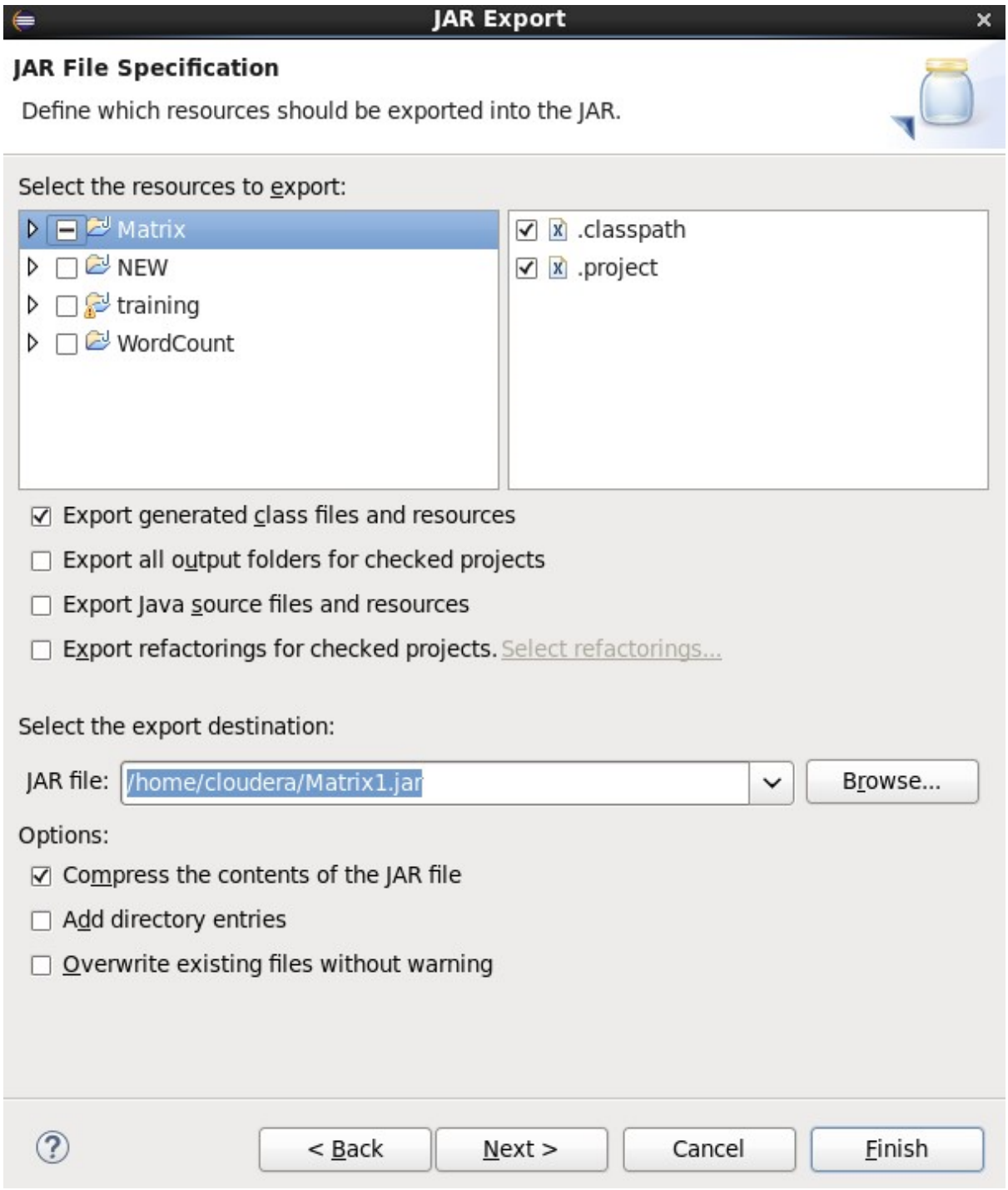

Export
Select
Export resources into a JAR file on the local file system.
Select an export destination:
type filter text
General
Install
Java
JAR file
Javadoc
Runnable JAR file
Run/Debug
Tasks
Team
XML
< Back
Next >
Cancel
Finish

Name:
Roll No:


JAR Export
JAR File Specification
Define which resources should be exported into the JAR.
Select the resources to export:
Matrix
NEW
training
WordCount
.classpath
.project
Export generated class files and resources
Export all output folders for checked projects
Export Java source files and resources
Export refactorings for checked projects. Select refactorings...
Select the export destination:
JAR file: /home/cloudera/new1.jar
Browse...
Options:
Compress the contents of the JAR file
Add directory entries
Overwrite existing files without warning
< Back
Next >
Cancel
Finish

Name:
Roll No:

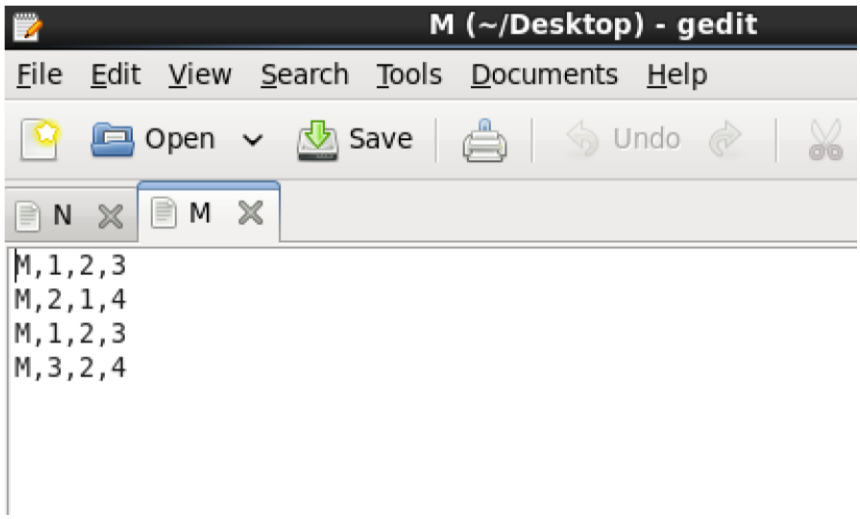

Name:
Matrix1.jar
Save in folder:
cloudera
Browse for other folders
Cancel
OK

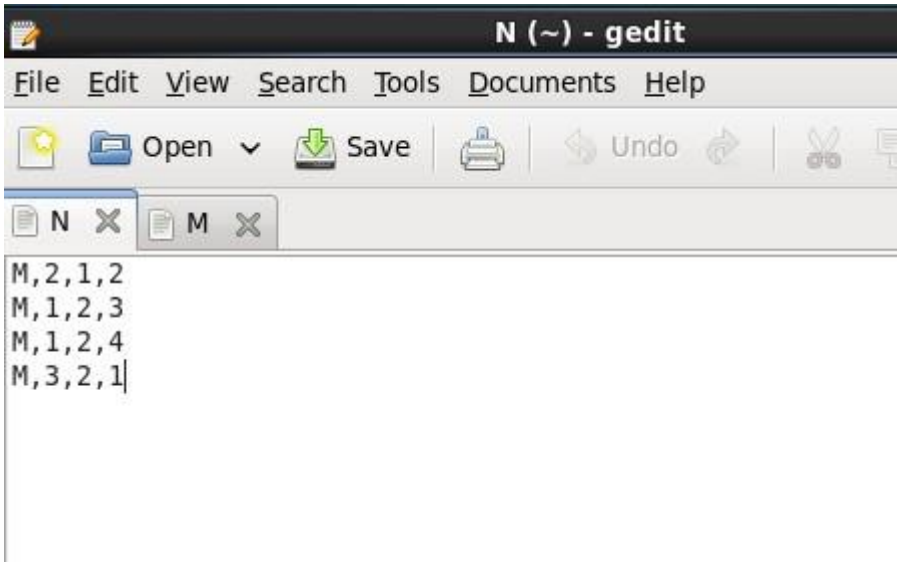

JAR Export
JAR File Specification
Define which resources should be exported into the JAR.
Select the resources to export:
Matrix
NEW
training
WordCount
.classpath
.project
Export generated class files and resources
Export all output folders for checked projects
Export Java source files and resources
Export refactorings for checked projects. Select refactorings...
Select the export destination:
JAR file:
/home/cloudera/Matrix1.jar
Browse...
Options:
Compress the contents of the JAR file
Add directory entries
Overwrite existing files without warning
< Back
Next >
Cancel
Finish

Name:
Roll No:

7) We need to create an input file in local file system

Creating an input file named as “M” and “N”





8) Open Terminal
Now we have to move this input file to **hdfs**. For this we create a direcory on **hdfs** using command **hdfs dfs -mkdir /testip**.

9) Here listing all the directory present in **hdfs** using **hdfs dfs -ls /** command

Then we can verify whether this directory is created or not using ls command **hdfs dfs -ls /**

Name:
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```
[cloudera@quickstart ~]$ hdfs dfs -mkdir /testip
[cloudera@quickstart ~]$ hdfs dfs -ls /
Found 12 items
drwxr-xr-x   - hbase    supergroup          0 2022-04-20 22:20 /hbase
drwxr-xr-x   - cloudera supergroup          0 2022-02-17 20:07 /inputdir
drwxr-xr-x   - cloudera supergroup          0 2022-02-17 20:24 /outputdir
drwxr-xr-x   - cloudera supergroup          0 2022-02-21 19:10 /rjc2122
drwxr-xr-x   - cloudera supergroup          0 2022-02-14 20:28 /rjcnew
drwxr-xr-x   - cloudera supergroup          0 2022-02-14 20:14 /rjcnew2
-rw-r--r--   4 cloudera supergroup         43 2022-02-14 19:03 /rjsuraj
drwxr-xr-x   - solr     solr                0 2015-06-09 03:38 /solr
drwxr-xr-x   - cloudera supergroup          0 2022-04-20 23:22 /testip
drwxrwxrwx   - hdfs     supergroup          0 2022-03-29 20:52 /tmp
drwxr-xr-x   - hdfs     supergroup          0 2022-03-14 21:22 /user
drwxr-xr-x   - hdfs     supergroup          0 2015-06-09 03:36 /var
```

10) Move the input file to this directory created in **hdfs** by using either put command or **copyFromLocal** command.

```
[cloudera@quickstart ~]$ hdfs dfs -put /home/cloudera/M /testip
[cloudera@quickstart ~]$ hdfs dfs -put /home/cloudera/N /testip
```

11) Now checking whether the “M” and “N” present in **/testip** directory of **hdfs** or not using **hdfs dfs -ls /testip** command.

```
[cloudera@quickstart ~]$ hdfs dfs -ls /testip
Found 2 items
-rw-r--r--   1 cloudera supergroup         32 2022-04-20 23:22 /testip/M
-rw-r--r--   1 cloudera supergroup         32 2022-04-20 23:23 /testip/N
[cloudera@quickstart ~]$
```

12) As we can see “M” and “N” file is present in /testip directory of hdfs. Now we will see the content of this file using **hdfs dfs –cat /testip/M** command

```
[cloudera@quickstart ~]$ hdfs dfs -cat /testip/M
M,1,2,3
M,2,1,4
M,1,2,3
M,3,2,4
[cloudera@quickstart ~]$ hdfs dfs -cat /testip/N
M,2,1,2
M,1,2,3
M,1,2,4
M,3,2,1
```

13) Running Mapreduce Program on Hadoop, syntax is hadoop jar jarFileName.jar ClassName/InputFileAddress /outputdir.

i.e. **hadoop jar /home/cloudera/Matrix1.jar MatrixMultiply /testip/* /testip_out**

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```
[cloudera@quickstart ~]$ hadoop jar /home/cloudera/MatrixMultiply.jar MatrixMultiply /tempip  /tempop2
22/02/24 19:56:29 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
22/02/24 19:56:30 WARN mapreduce.JobSubmitter: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your applicati
22/02/24 19:56:30 INFO input.FileInputFormat: Total input paths to process : 2
22/02/24 19:56:30 INFO mapreduce.JobSubmitter: number of splits:2
22/02/24 19:56:30 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1645544927537_0006
22/02/24 19:56:30 INFO impl.YarnClientImpl: Submitted application application_1645544927537_0006
22/02/24 19:56:30 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1645544927537_0006/
22/02/24 19:56:30 INFO mapreduce.Job: Running job: job_1645544927537_0006
22/02/24 19:56:37 INFO mapreduce.Job: Job job_1645544927537_0006 running in uber mode : false
22/02/24 19:56:37 INFO mapreduce.Job:  map 0% reduce 0%
22/02/24 19:56:47 INFO mapreduce.Job:  map 50% reduce 0%
22/02/24 19:56:48 INFO mapreduce.Job:  map 100% reduce 0%
22/02/24 19:56:54 INFO mapreduce.Job:  map 100% reduce 100%
22/02/24 19:56:54 INFO mapreduce.Job: Job job_1645544927537_0006 completed successfully
22/02/24 19:56:54 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=111126
                FILE: Number of bytes written=554795
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=274
                HDFS: Number of bytes written=36
                HDFS: Number of read operations=9
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Launched map tasks=2
                Launched reduce tasks=1
                Data-local map tasks=2
                Total time spent by all maps in occupied slots (ms)=14429
                Total time spent by all reduces in occupied slots (ms)=4356
                Total time spent by all map tasks (ms)=14429
                Total time spent by all reduce tasks (ms)=4356
                Total vcore-seconds taken by all map tasks=14429
                Total vcore-seconds taken by all reduce tasks=4356
                Total megabyte-seconds taken by all map tasks=14775296
                Total megabyte-seconds taken by all reduce tasks=4460544
        Map-Reduce Framework
                Map input records=8
                Map output records=8000
                Map output bytes=95120
                Map output materialized bytes=111132
                Input split bytes=210
                Combine input records=0
                Combine output records=0
                Reduce input groups=3996
                Reduce shuffle bytes=111132
```

Map Reduce Framework

```
                Launched map tasks=2
                Launched reduce tasks=1
                Data-local map tasks=2
                Total time spent by all maps in occupied slots (ms)=14429
                Total time spent by all reduces in occupied slots (ms)=4356
                Total time spent by all map tasks (ms)=14429
                Total time spent by all reduce tasks (ms)=4356
                Total vcore-seconds taken by all map tasks=14429
                Total vcore-seconds taken by all reduce tasks=4356
                Total megabyte-seconds taken by all map tasks=14775296
                Total megabyte-seconds taken by all reduce tasks=4460544
        Map-Reduce Framework
                Map input records=8
                Map output records=8000
                Map output bytes=95120
                Map output materialized bytes=111132
                Input split bytes=210
                Combine input records=0
                Combine output records=0
                Reduce input groups=3996
                Reduce shuffle bytes=111132
                Reduce input records=8000
                Reduce output records=4
                Spilled Records=16000
                Shuffled Maps =2
                Failed Shuffles=0
                Merged Map outputs=2
                GC time elapsed (ms)=170
                CPU time spent (ms)=1970
                Physical memory (bytes) snapshot=561012736
                Virtual memory (bytes) snapshot=4507758592
                Total committed heap usage (bytes)=391979008
        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=64
        File Output Format Counters
                Bytes Written=36
```

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14) Now we can check what we have inside this **tempop2** directory using command as **hdfs dfs -ls /tempop2.**

```
[cloudera@quickstart ~]$ hdfs dfs -cat /tempop2/part-r-00000
1,1,36.0
1,2,41.0
2,1,64.0
2,2,73.0
```