
Lab 01: A Gentle Introduction to Hadoop

CSC14118 Introduction to Big Data 20KHMT1

SmallData

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1 Lab 01: A Gentle Introduction to Hadoop

1.1 List of team members

ID	Full Name
20120366	Pham Phu Hoang Son
20120391	Ha Xuan Truong
20120393	Huynh Minh Tu
20120468	Nguyen Van Hai

1.2 Team's result

Section	Complete
Setting up SNC	100%
Introduction to MapReduce	100%
Running a warm-up problem: Word Count	100%
Bonus - Extended Word Count: Unhealthy relationships	100%
Bonus - Setting up Fully Distributed Mode	0%

1.3 Team reflection

Does your journey to the deadline have any bugs? How have you overcome it?

During the journey towards the deadline, we encountered several bugs that were related to Ubuntu, Hadoop installation, and errors while running Hadoop MapReduce jobs. In order to overcome these

challenges, we had to invest more time and effort. We also conducted research by reading documentation and watching tutorial videos. These resources provided us with useful insights and ideas for troubleshooting the issues. Additionally, we scheduled some online meetings to discuss and solve the problems together. Through these efforts, we were able to solve most of the problems we encountered and successfully complete the project.

What have you learned after this process?

Firstly, we learned the importance of clear communication among team members to ensure that everyone is on the same page and that tasks are completed efficiently. We also learned the importance of testing and debugging to ensure that any errors are caught and resolved early on in the process.

Secondly, we learned the importance of time management and task prioritization, as we encountered some unexpected challenges during the installation and setup process. This made it necessary for us to adjust our timeline and focus on the most critical tasks first.

Lastly, we learned the importance of continuous learning and self-improvement. We encountered some roadblocks that required us to do additional research and seek out new solutions, which allowed us to expand our knowledge and skills in Hadoop and MapReduce.

1.4 Setting up Single-node Hadoop Cluster

1.4.1 Step 1: Download java

1. The default Ubuntu repositories contain Java 8 and Java 11 both. Use the following command to install it.

```
sudo apt update && sudo apt install openjdk-8-jdk
```

2. Once you have successfully installed it, check the current Java version:

```
java -version
```

```
nvhai@20120468:~$ java -version
openjdk version "1.8.0_362"
OpenJDK Runtime Environment (build 1.8.0_362-8u362-ga-0ubuntu1~18.04.1-b09)
OpenJDK 64-Bit Server VM (build 25.362-b09, mixed mode)
nvhai@20120468:~$ dirname $(dirname $(readlink -f $(which java)))
/usr/lib/jvm/java-8-openjdk-amd64/jre
nvhai@20120468:~$
```

Figure 1.1: Download java

1.4.2 Step 2: Create User for Hadoop and install openSSH

1. Run the following command to create a new user with the name “hadoop”:

```
sudo adduser hadoop
```

```
nvhai@20120468:~$ sudo adduser hadoop
[sudo] password for nvhai:
Adding user `hadoop' ...
Adding new group `hadoop' (1001) ...
Adding new user `hadoop' (1001) with group `hadoop' ...
Creating home directory `/home/hadoop' ...
Copying files from `/etc/skel' ...
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Changing the user information for hadoop
Enter the new value, or press ENTER for the default
    Full Name []:
    Room Number []:
    Work Phone []:
    Home Phone []:
    Other []: \
Is the information correct? [Y/n] Y
nvhai@20120468:~$ sudo adduser hadoop
```

Figure 1.2: Create new user

2. Switch to the newly created hadoop user:

```
su - hadoop
```

```
nvhai@20120468:~$ su - hadoop
Password:
hadoop@20120468:~$
```

Figure 1.3: Change to hadoop user

- Now configure password-less SSH access for the newly created hadoop user. Generate an SSH keypair first:

```
ssh-keygen -t rsa
```

```
hadoop@20120468:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/hadoop/.ssh/id_rsa):
Created directory '/home/hadoop/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/hadoop/.ssh/id_rsa.
Your public key has been saved in /home/hadoop/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:MIi3W0szIszw2xfoIEz1d0IOE550ik2LPGiZhUbzN5s hadoop@20120468
The key's randomart image is:
+---[RSA 2048]-----+
| o o o .             |
| . *. *. o           |
| .+oOo=o            |
| BOBo=o+o           |
| =00.+E* S          |
| ...* = =           |
| . + o              |
| .                  |
+---[SHA256]-----+
hadoop@20120468:~$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
hadoop@20120468:~$ chmod 640 ~/.ssh/authorized_keys
hadoop@20120468:~$ ssh localhost
ssh: connect to host localhost port 22: Connection refused
hadoop@20120468:~$ S
```

Figure 1.4: OpenSSH

- Copy the generated public key to the authorized key file and set the proper permissions:

```
cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
chmod 640 ~/.ssh/authorized_keys
```

5. Now try to SSH to the localhost

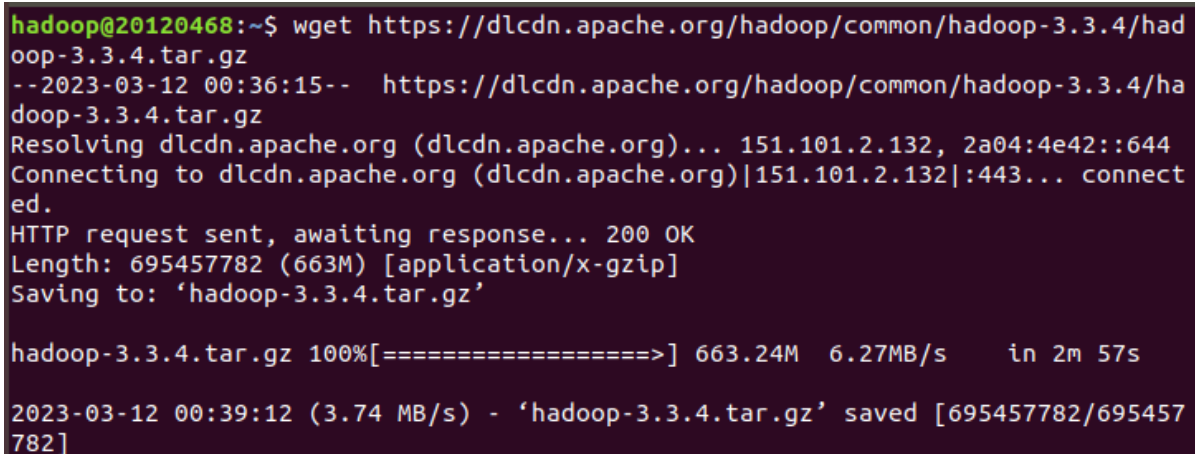
```
ssh localhost
```

You will be asked to authenticate hosts by adding RSA keys to known hosts. Type yes and hit Enter to authenticate the localhost.

1.4.3 Step 3: Install Hadoop on Ubuntu

1. Use the following command to download Hadoop 3.3.4

```
wget https://dlcdn.apache.org/hadoop/common/hadoop-3.3.4/hadoop-3.3.4.tar.gz
```



```
hadoop@20120468:~$ wget https://dlcdn.apache.org/hadoop/common/hadoop-3.3.4/hadoop-3.3.4.tar.gz
--2023-03-12 00:36:15-- https://dlcdn.apache.org/hadoop/common/hadoop-3.3.4/hadoop-3.3.4.tar.gz
Resolving dlcdn.apache.org (dlcdn.apache.org)... 151.101.2.132, 2a04:4e42::644
Connecting to dlcdn.apache.org (dlcdn.apache.org)|151.101.2.132|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 695457782 (663M) [application/x-gzip]
Saving to: 'hadoop-3.3.4.tar.gz'

hadoop-3.3.4.tar.gz 100%[=====>] 663.24M  6.27MB/s   in 2m 57s

2023-03-12 00:39:12 (3.74 MB/s) - 'hadoop-3.3.4.tar.gz' saved [695457782/695457782]
```

Figure 1.5: download hadoop

2. Once you've downloaded the file, you can unzip it to a folder on your hard drive

```
tar xzf hadoop-3.3.4.tar.gz
```

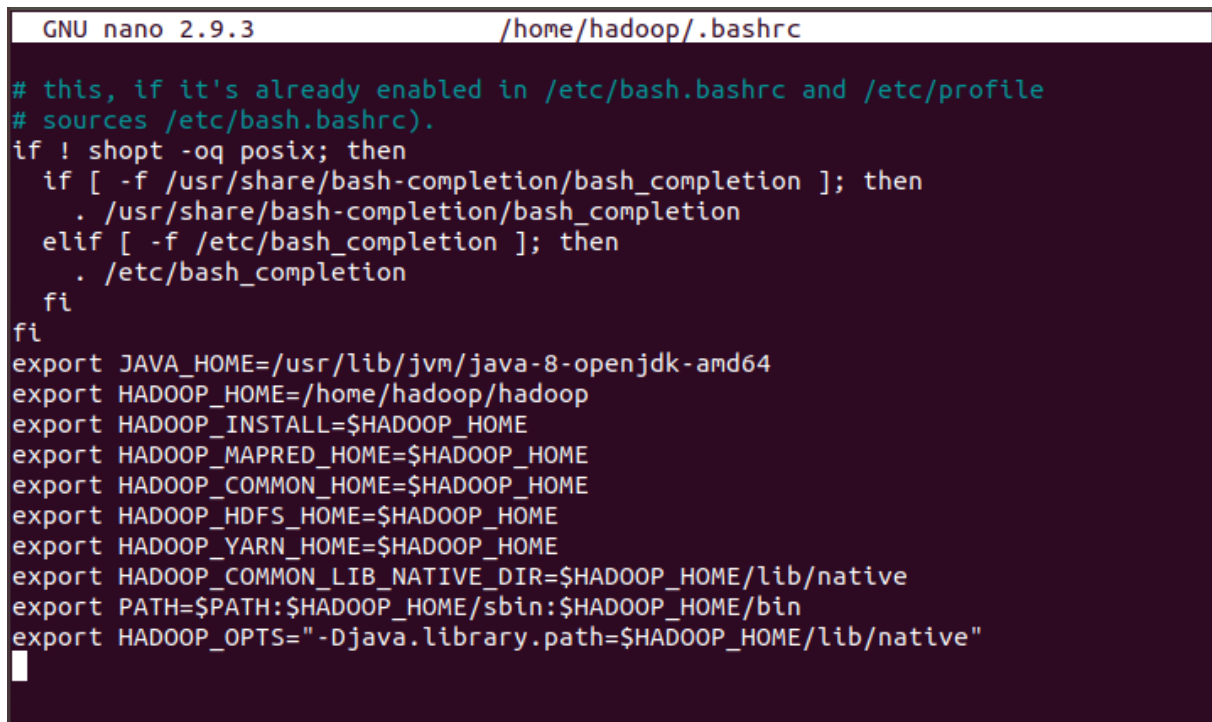
3. Rename the extracted folder to remove version information. This is an optional step, but if you don't want to rename, then adjust the remaining configuration paths.

```
mv hadoop-3.3.4 hadoop
```

4. Next, you will need to configure Hadoop and Java Environment Variables on your system. Open the ~/.bashrc file in your favorite text editor:

```
nano ~/.bashrc
```

Append the below lines to the file. You can find the JAVA_HOME location by running `dirname $(dirname $(readlink -f $(which java)))` command on the terminal.



```
GNU nano 2.9.3 /home/hadoop/.bashrc

# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
  if [ -f /usr/share/bash-completion/bash_completion ]; then
    . /usr/share/bash-completion/bash_completion
  elif [ -f /etc/bash_completion ]; then
    . /etc/bash_completion
  fi
fi

export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
export HADOOP_HOME=/home/hadoop/hadoop
export HADOOP_INSTALL=$HADOOP_HOME
export HADOOP_MAPRED_HOME=$HADOOP_HOME
export HADOOP_COMMON_HOME=$HADOOP_HOME
export HADOOP_HDFS_HOME=$HADOOP_HOME
export HADOOP_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/native"
```

Figure 1.6: setup environment

Save the file and close it.

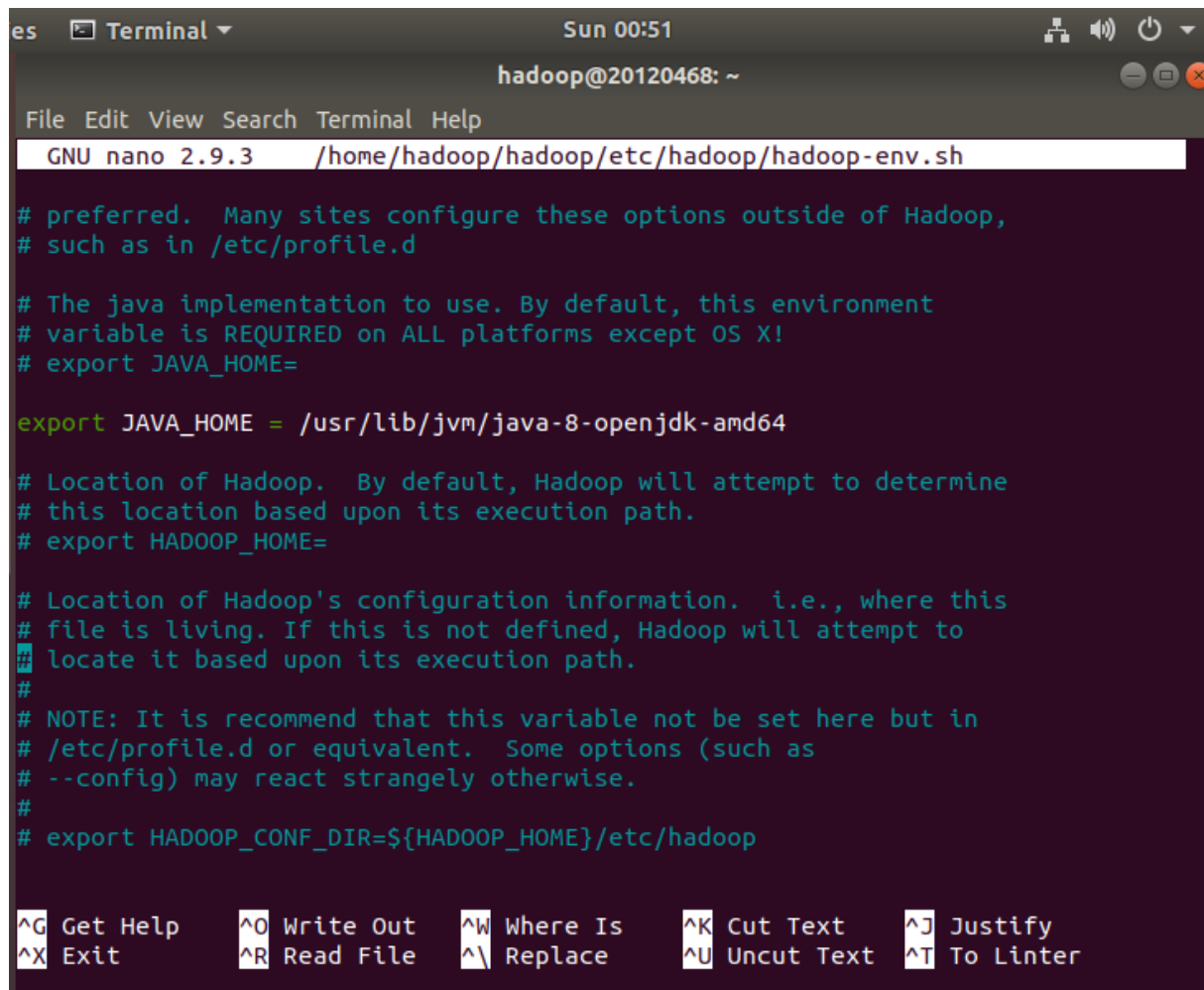
5. Load the above configuration in the current environment

```
source ~/.bashrc
```

6. You also need to configure JAVA_HOME in `hadoop-env.sh` file. Edit the Hadoop environment variable file in the text editor:

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

Search for the “`export JAVA_HOME`” and configure it with the value found in step 1. See the below screenshot:



```
es Terminal Sun 00:51
hadoop@20120468: ~
File Edit View Search Terminal Help
GNU nano 2.9.3 /home/hadoop/hadoop/etc/hadoop/hadoop-env.sh

# preferred.  Many sites configure these options outside of Hadoop,
# such as in /etc/profile.d

# The java implementation to use.  By default, this environment
# variable is REQUIRED on ALL platforms except OS X!
# export JAVA_HOME=

export JAVA_HOME = /usr/lib/jvm/java-8-openjdk-amd64

# Location of Hadoop.  By default, Hadoop will attempt to determine
# this location based upon its execution path.
# export HADOOP_HOME=

# Location of Hadoop's configuration information.  i.e., where this
# file is living.  If this is not defined, Hadoop will attempt to
# locate it based upon its execution path.
#
# NOTE: It is recommend that this variable not be set here but in
# /etc/profile.d or equivalent.  Some options (such as
# --config) may react strangely otherwise.
#
# export HADOOP_CONF_DIR=${HADOOP_HOME}/etc/hadoop

^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify
^X Exit      ^R Read File  ^_ Replace   ^U Uncut Text ^T To Linter
```

Figure 1.7: setup hadoop-env

Save the file and close it.

1.4.4 Step 4: Configuring Hadoop

Next is to configure Hadoop configuration files available under etc directory.

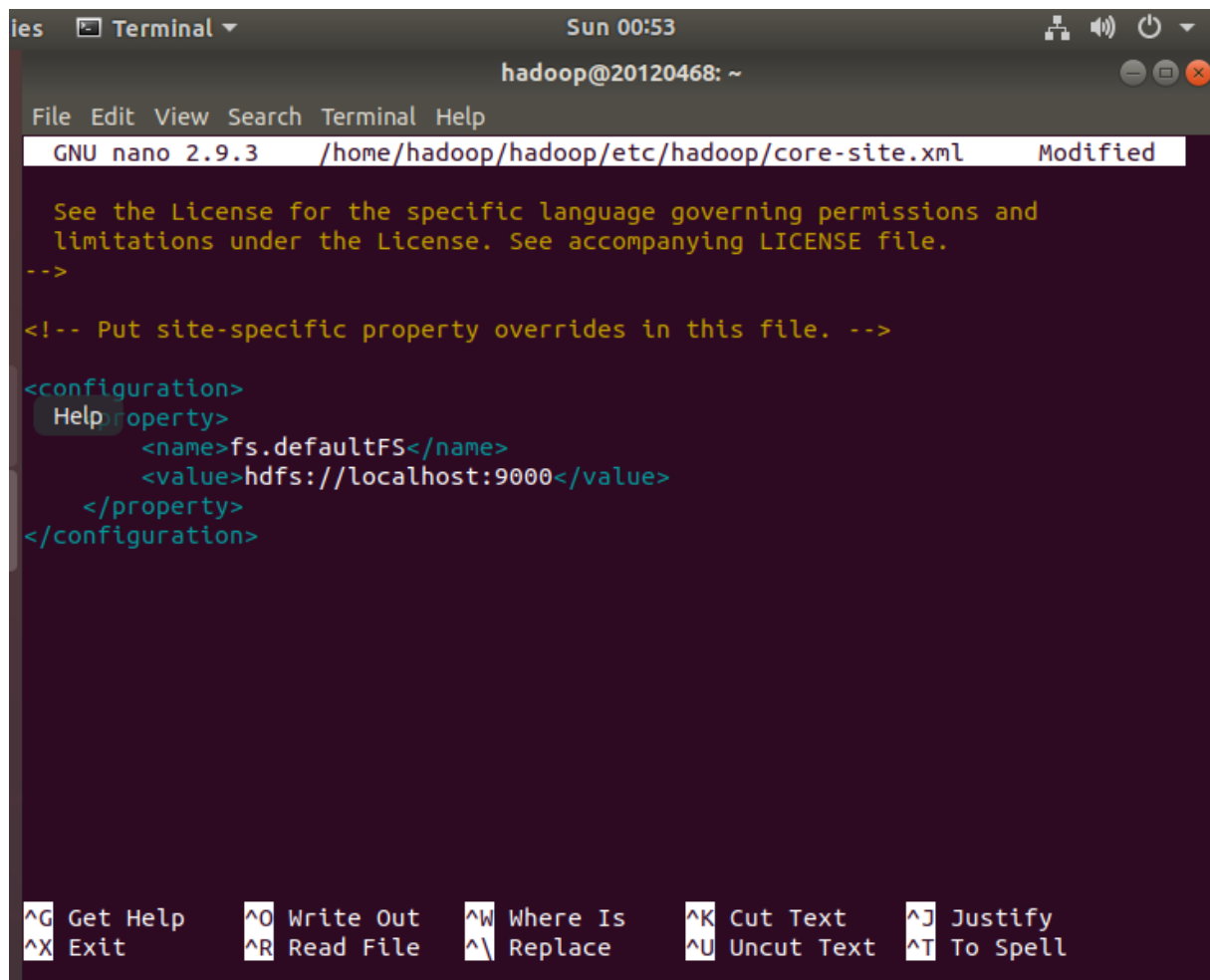
1. First, you will need to create the namenode and datanode directories inside the Hadoop user home directory. Run the following command to create both directories:

```
mkdir -p ~/hadoopdata/hdfs/{namenode,datanode}
```

- Next, edit the core-site.xml file and update with your system hostname:

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

Change the following name as per your system hostname:



```
hadoop@20120468: ~
File Edit View Search Terminal Help
GNU nano 2.9.3 /home/hadoop/hadoop/etc/hadoop/core-site.xml Modified

See the License for the specific language governing permissions and
limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

<configuration>
  <property>
    <name>fs.defaultFS</name>
    <value>hdfs://localhost:9000</value>
  </property>
</configuration>
```

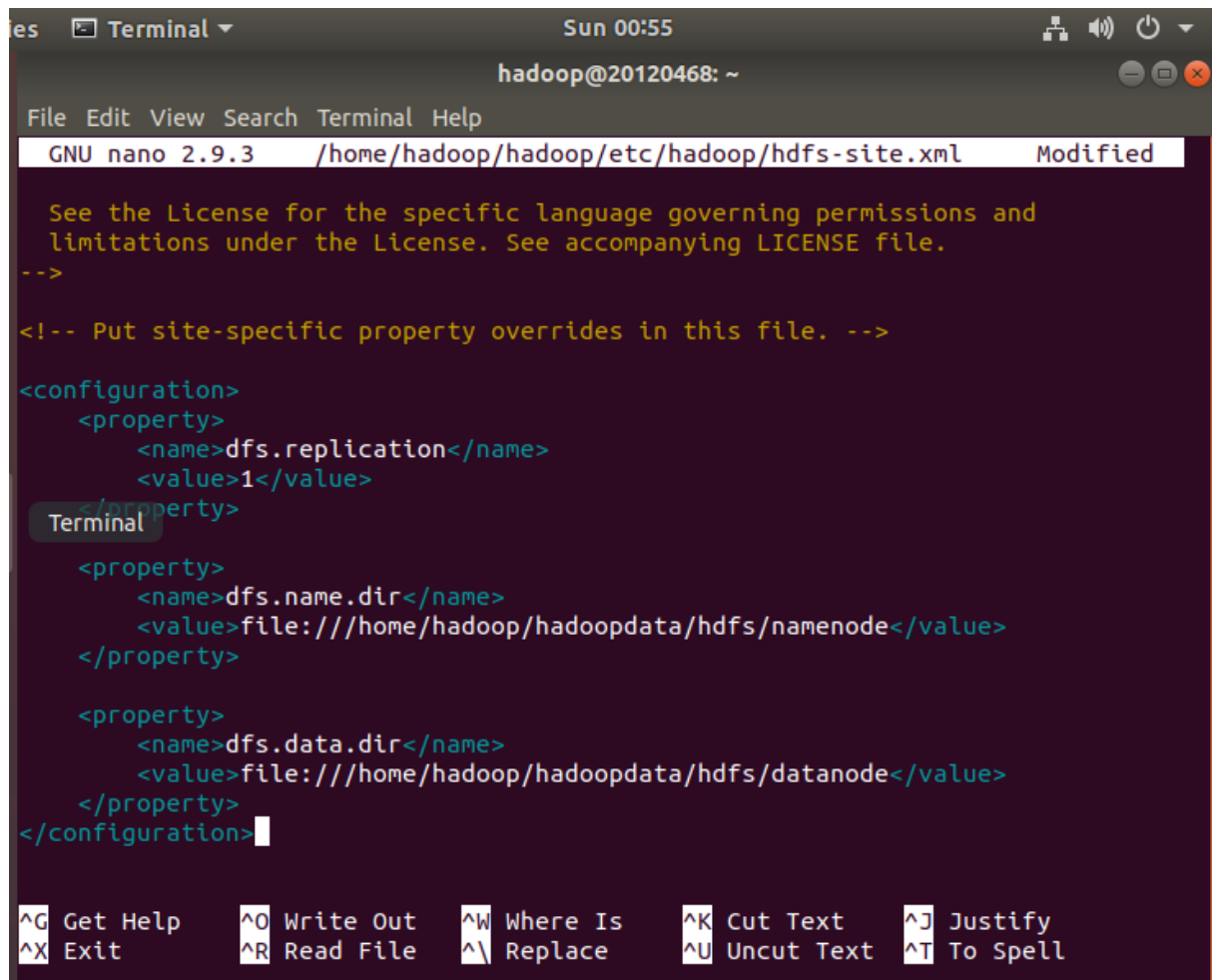
Figure 1.8: setup core-site

Save and close the file.

- Then, edit the hdfs-site.xml file

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

Change the NameNode and DataNode directory paths as shown below:



```
hadoop@20120468: ~
File Edit View Search Terminal Help
GNU nano 2.9.3 /home/hadoop/hadoop/etc/hadoop/hdfs-site.xml Modified

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limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

<configuration>
  <property>
    <name>dfs.replication</name>
    <value>1</value>
  </property>
  <property>
    <name>dfs.name.dir</name>
    <value>file:///home/hadoop/hadoopdata/hdfs/namenode</value>
  </property>
  <property>
    <name>dfs.data.dir</name>
    <value>file:///home/hadoop/hadoopdata/hdfs/datanode</value>
  </property>
</configuration>
```

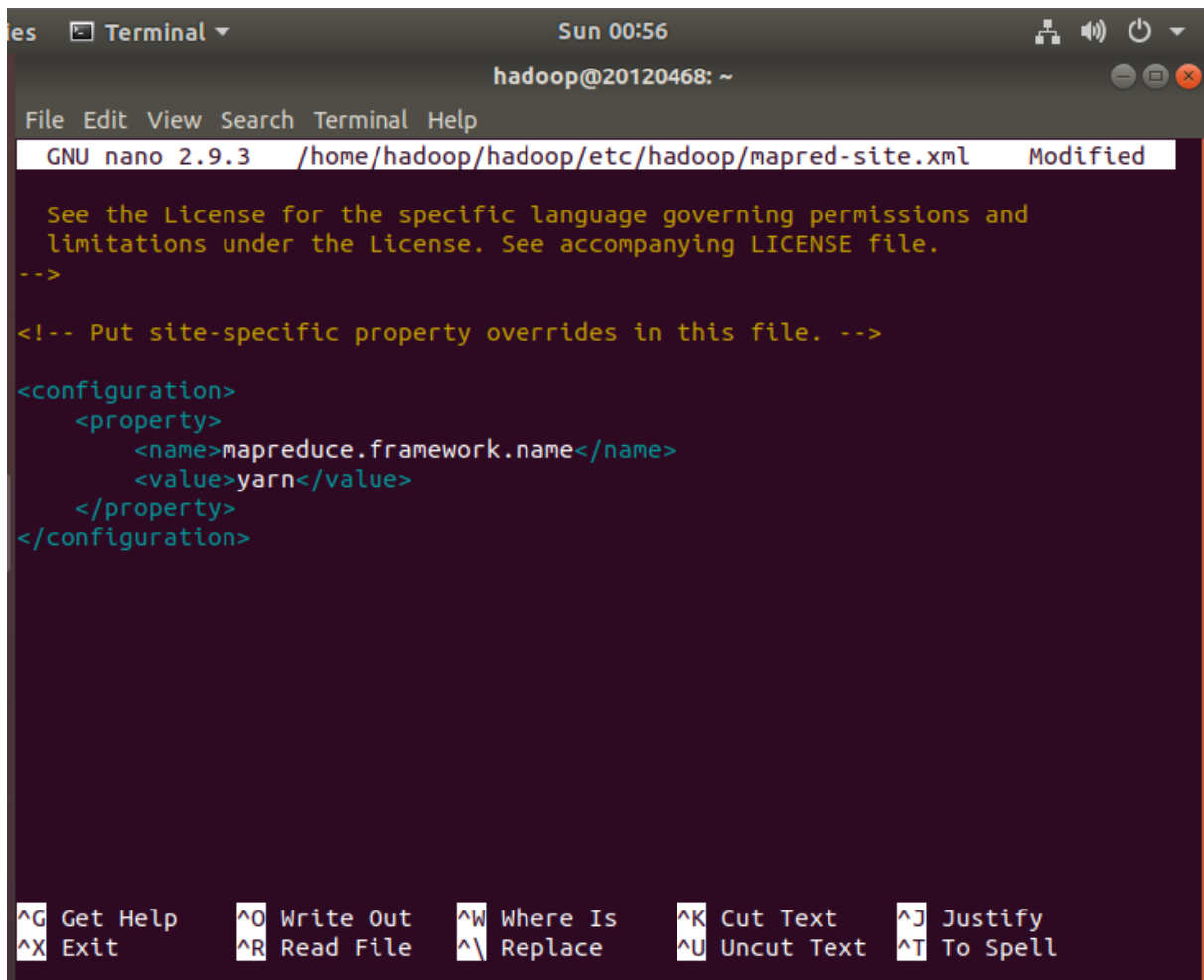
Figure 1.9: setup hdfs-site

Save and close the file.

4. Then, edit the mapred-site.xml file

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

Make the following changes:



```
es  Terminal ▾                               Sun 00:56
                                           hadoop@20120468: ~
File Edit View Search Terminal Help
GNU nano 2.9.3 /home/hadoop/hadoop/etc/hadoop/mapred-site.xml Modified

See the License for the specific language governing permissions and
limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

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

^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify
^X Exit ^R Read File ^\ Replace ^U Uncut Text ^T To Spell

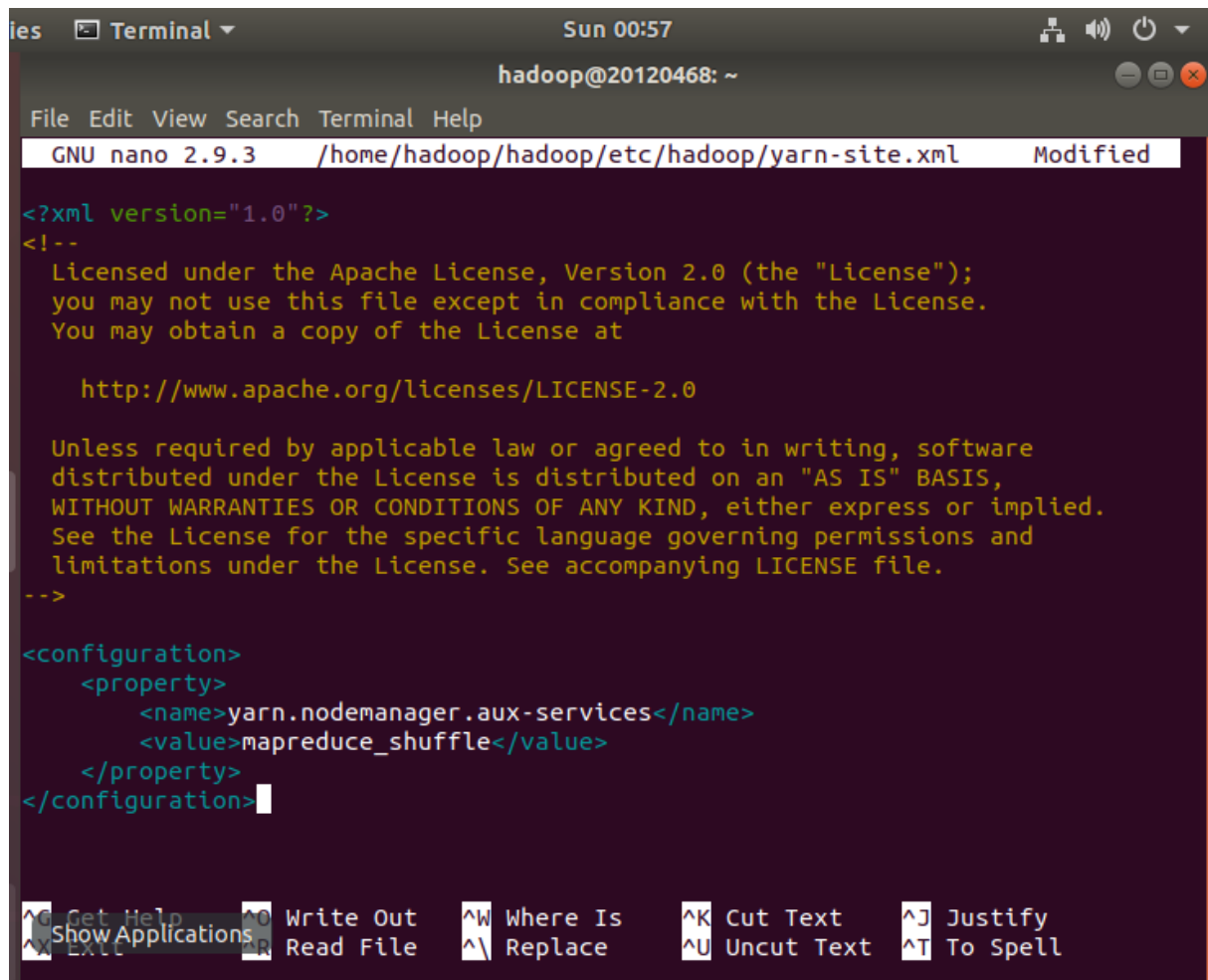
Figure 1.10: setup mapred-site

Save and close the file.

5. Then, edit the yarn-site.xml file

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

Make the following changes:



```
ies  Terminal ▾                               Sun 00:57
                                             hadoop@20120468: ~
File Edit View Search Terminal Help
GNU nano 2.9.3 /home/hadoop/hadoop/etc/hadoop/yarn-site.xml Modified

<?xml version="1.0"?>
<!--
  Licensed under the Apache License, Version 2.0 (the "License");
  you may not use this file except in compliance with the License.
  You may obtain a copy of the License at

      http://www.apache.org/licenses/LICENSE-2.0

  Unless required by applicable law or agreed to in writing, software
  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License. See accompanying LICENSE file.
-->

<configuration>
  <property>
    <name>yarn.nodemanager.aux-services</name>
    <value>mapreduce_shuffle</value>
  </property>
</configuration>
```

Figure 1.11: setup yarn-site

Save and close the file.

1.4.5 Step 5: Start Hadoop Cluster

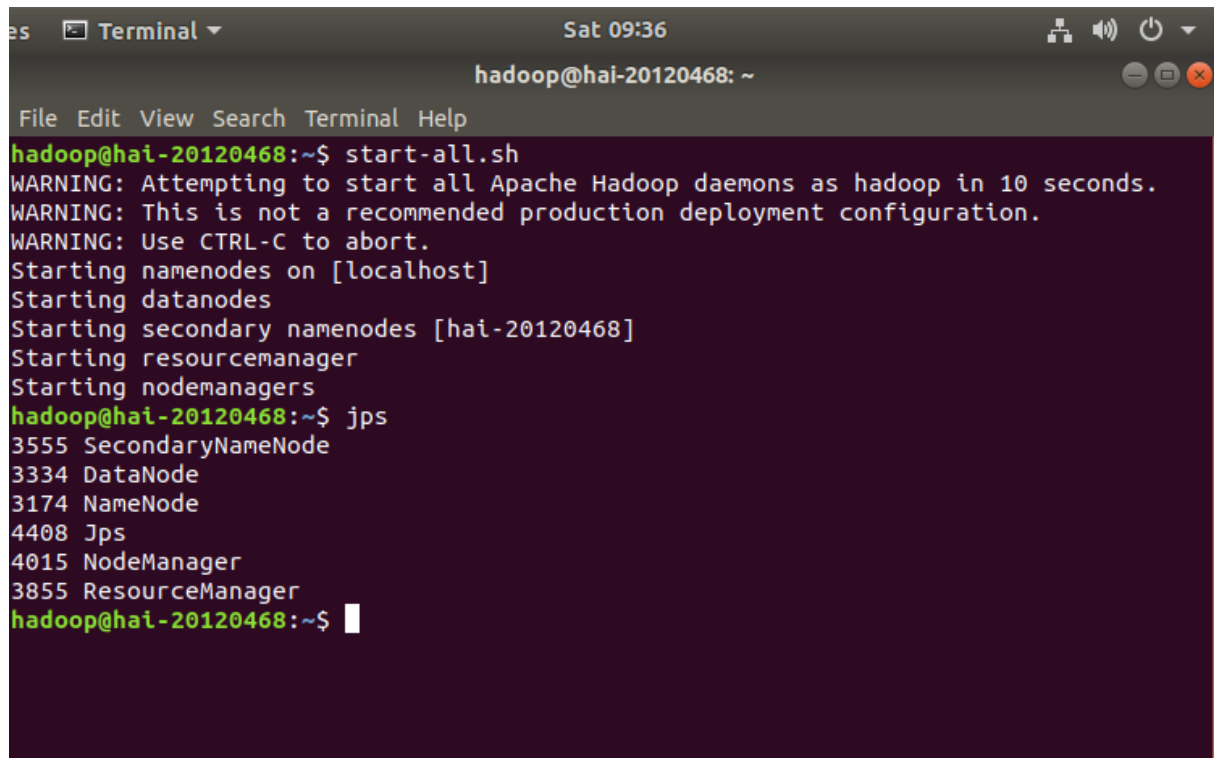
Then start the Hadoop cluster with the following command

```
start-all.sh
```

Check jps

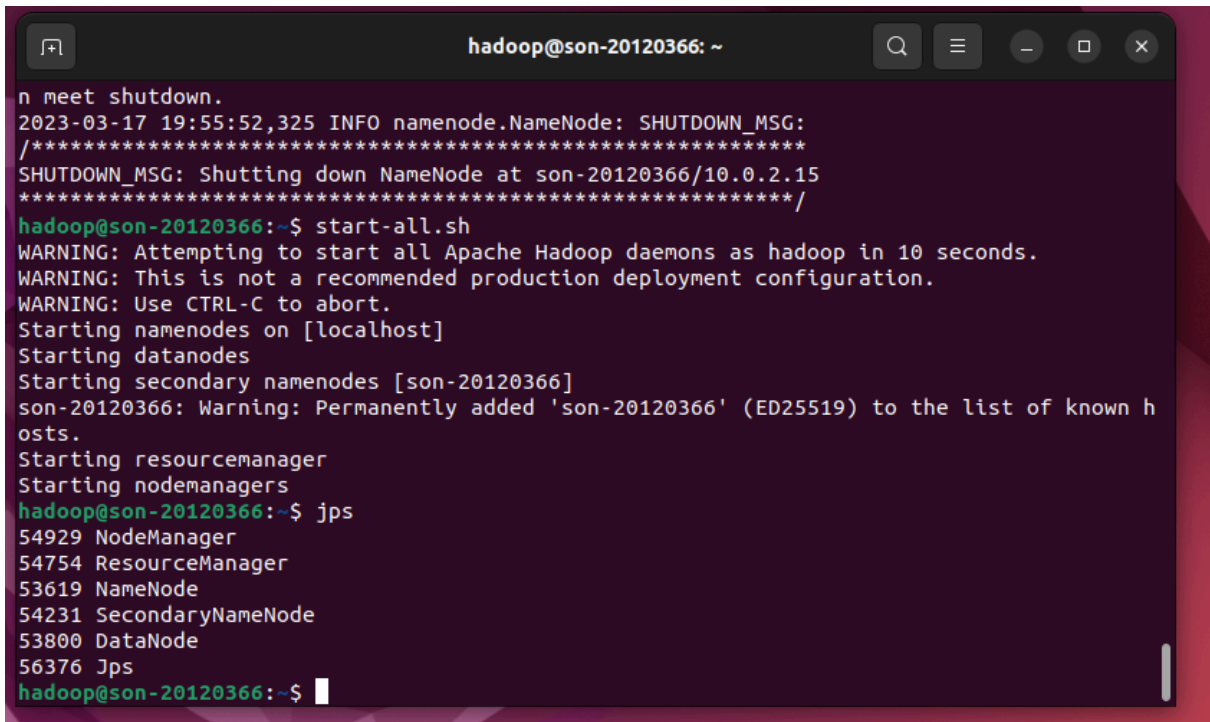
jps

Completed screenshots of the members:

A terminal window titled 'Terminal' with a dark background. The prompt is 'hadoop@hai-20120468: ~'. The user has entered 'start-all.sh', which outputs several warnings and then lists the starting of various Hadoop daemons: namenodes on [localhost], datanodes, secondary namenodes [hai-20120468], resourcemanager, and nodemanagers. The user then enters 'jps', which outputs a list of running processes with their PIDs: 3555 SecondaryNameNode, 3334 DataNode, 3174 NameNode, 4408 Jps, 4015 NodeManager, and 3855 ResourceManager.

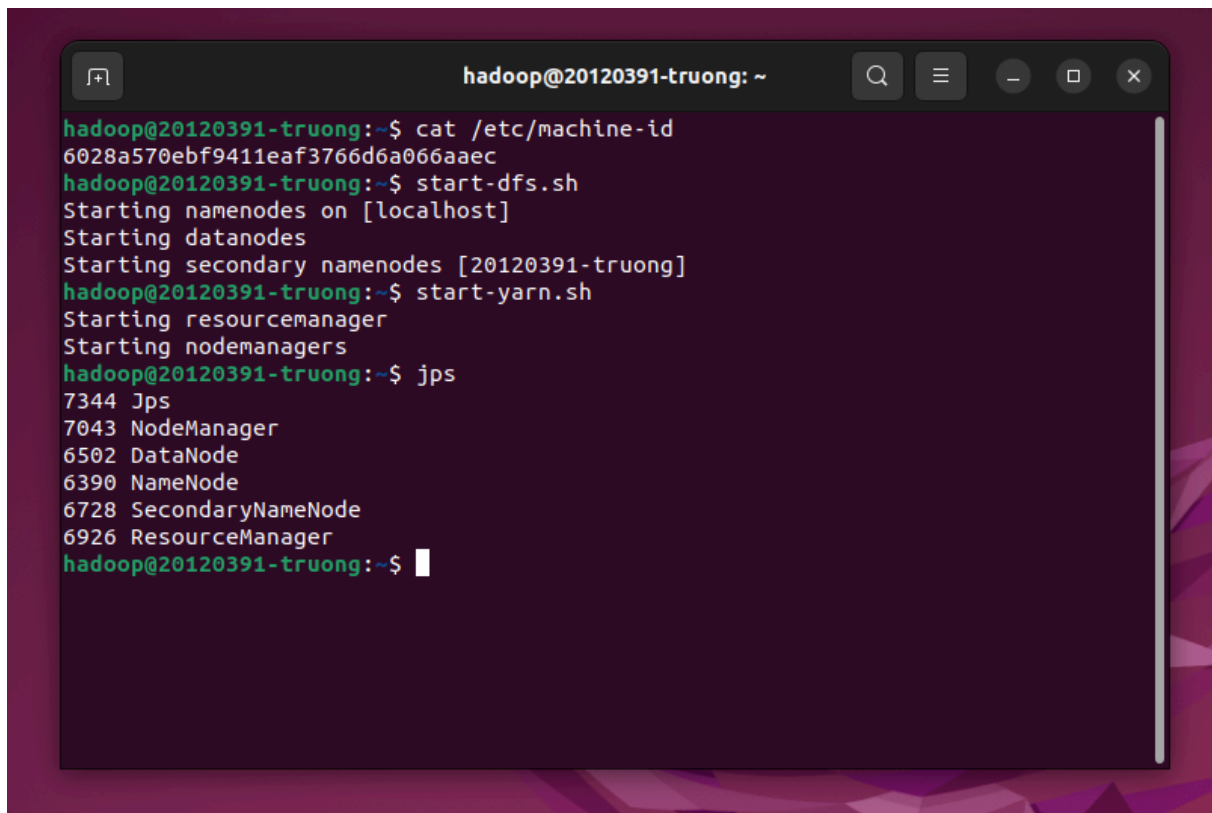
```
es Terminal ▾ Sat 09:36
hadoop@hai-20120468: ~
File Edit View Search Terminal Help
hadoop@hai-20120468:~$ start-all.sh
WARNING: Attempting to start all Apache Hadoop daemons as hadoop in 10 seconds.
WARNING: This is not a recommended production deployment configuration.
WARNING: Use CTRL-C to abort.
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [hai-20120468]
Starting resourcemanager
Starting nodemanagers
hadoop@hai-20120468:~$ jps
3555 SecondaryNameNode
3334 DataNode
3174 NameNode
4408 Jps
4015 NodeManager
3855 ResourceManager
hadoop@hai-20120468:~$
```

Figure 1.12: 20120468 - Nguyen Van Hai

A terminal window titled 'hadoop@son-20120366: ~' with standard window controls. The terminal shows a sequence of events: a shutdown message from a previous session, the execution of 'start-all.sh' which triggers several warnings and starts the Hadoop daemons (namenodes, datanodes, resourcemanager, nodemanagers), and finally the execution of 'jps' which lists the running processes with their PIDs.

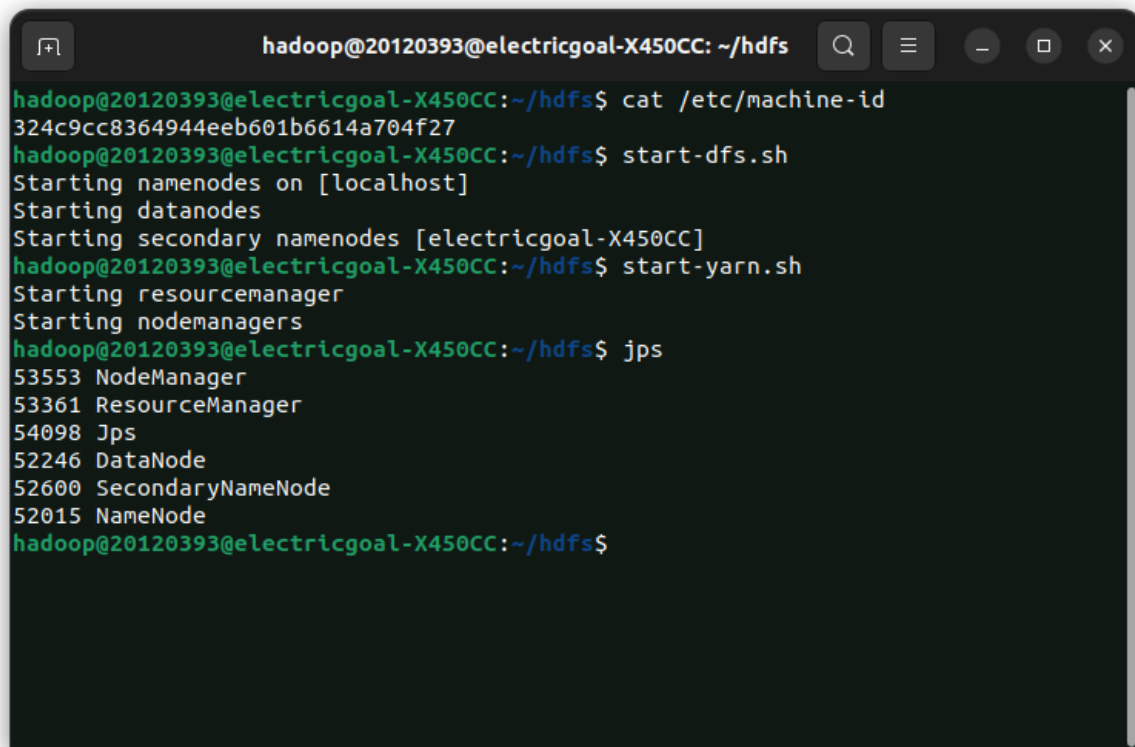
```
hadoop@son-20120366: ~  
n meet shutdown.  
2023-03-17 19:55:52,325 INFO namenode.NameNode: SHUTDOWN_MSG:  
/*****  
SHUTDOWN_MSG: Shutting down NameNode at son-20120366/10.0.2.15  
*****/  
hadoop@son-20120366:~$ start-all.sh  
WARNING: Attempting to start all Apache Hadoop daemons as hadoop in 10 seconds.  
WARNING: This is not a recommended production deployment configuration.  
WARNING: Use CTRL-C to abort.  
Starting namenodes on [localhost]  
Starting datanodes  
Starting secondary namenodes [son-20120366]  
son-20120366: Warning: Permanently added 'son-20120366' (ED25519) to the list of known h  
osts.  
Starting resourcemanager  
Starting nodemanagers  
hadoop@son-20120366:~$ jps  
54929 NodeManager  
54754 ResourceManager  
53619 NameNode  
54231 SecondaryNameNode  
53800 DataNode  
56376 Jps  
hadoop@son-20120366:~$
```

Figure 1.13: 20120366 - Pham Phu Hoang Son

A terminal window titled 'hadoop@20120391-truong: ~' with standard window controls. The terminal shows the execution of several Hadoop-related commands. First, 'cat /etc/machine-id' is run, displaying a long hexadecimal string. Then, 'start-dfs.sh' is executed, showing messages for starting namenodes on localhost and datanodes, and starting secondary namenodes on the current machine. Next, 'start-yarn.sh' is run, showing messages for starting the resource manager and node managers. Finally, 'jps' is run, displaying a list of running Java processes with their IDs and names. The prompt returns to the shell after each command.

```
hadoop@20120391-truong:~$ cat /etc/machine-id
6028a570ebf9411eaf3766d6a066aaec
hadoop@20120391-truong:~$ start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [20120391-truong]
hadoop@20120391-truong:~$ start-yarn.sh
Starting resource manager
Starting node managers
hadoop@20120391-truong:~$ jps
7344 Jps
7043 NodeManager
6502 DataNode
6390 NameNode
6728 SecondaryNameNode
6926 ResourceManager
hadoop@20120391-truong:~$
```

Figure 1.14: 20120391 - Ha Xuan Truong

A terminal window with a dark background and light green text. The window title is 'hadoop@20120393@electricgoal-X450CC: ~/hdfs'. The terminal shows the following commands and output:

```
hadoop@20120393@electricgoal-X450CC:~/hdfs$ cat /etc/machine-id
324c9cc8364944eeb601b6614a704f27
hadoop@20120393@electricgoal-X450CC:~/hdfs$ start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [electricgoal-X450CC]
hadoop@20120393@electricgoal-X450CC:~/hdfs$ start-yarn.sh
Starting resourcemanager
Starting nodemanagers
hadoop@20120393@electricgoal-X450CC:~/hdfs$ jps
53553 NodeManager
53361 ResourceManager
54098 Jps
52246 DataNode
52600 SecondaryNameNode
52015 NameNode
hadoop@20120393@electricgoal-X450CC:~/hdfs$
```

Figure 1.15: 20120393 - Huynh Minh Tu

1.5 Introduction to MapReduce

1. How do the input keys-values, the intermediate keys-values, and the output keys-values relate?

Answer :

- Input keys-values: The input data is divided into splits and represented as key-value pairs. Each input key-value is read into the MapReduce job using a RecordReader, which is responsible for reading the input data and converting it into key-value pairs.
- Intermediate keys-values: The map function processes the input keys-values and generates intermediate key-value pairs. The intermediate keys and values may be different from the input keys-values, depending on how the map function processes the data. The intermediate key-value pairs are sorted and grouped by key before being passed to the reduce function.
- Output keys-values: The reduce function generates the final output keys-values based on the intermediate key-value pairs that are passed to it. The output keys-values may be different from the intermediate keys-values, depending on how the reduce function processes the data.

The output keys-values are typically written to a distributed file system, such as HDFS, or to a database. The output of the MapReduce job can be used as input to other MapReduce jobs or as input to other applications.

2. How does MapReduce deal with node failures?

Answer :

Worker failure: The master node send heartbeat to each worker node. If a worker node fails, the master reschedule the tasks handled by the worker.

Master failure: The whole MapReduce job gets restarted through a different master based on check-pointed state of the failed master.

3. What is the meaning and implication of locality? What does it use?

Answer :

The concept of locality in the MapReduce refers to the idea that it is beneficial to process data on the same node where the data is stored, rather than moving it across the network to another node for processing. This is known as data locality.

MapReduce uses the concept of data locality to optimize the processing of data. The MapReduce framework is designed to distribute processing tasks to the nodes where the data is stored, in order to maximize data locality. When processing a large dataset, the framework splits the data into smaller chunks and distributes them across the cluster. Then, the Map tasks are scheduled on the same node where the data is stored, so that the data can be processed locally. Finally, the Reduce tasks are scheduled to aggregate the intermediate results generated by the Map tasks, again with the goal of minimizing data movement across the network.

4. Which problem is addressed by introducing a combiner function to the MapReduce model?

Answer :

The problem that is addressed by introducing a combiner function is the excessive duplicate data transfer during the shuffling phase of the MapReduce job. Without a combiner function, all the intermediate key-value pairs generated by the map tasks are transferred over the network to the reduce tasks, resulting in high network traffic and increased processing time.

By introducing a combiner function, the amount of data that needs to be transferred over the network is reduced, resulting in faster processing times and reduced network traffic. The combiner function helps to group together intermediate key-value pairs with the same key and perform a local aggregation, reducing the number of key-value pairs that need to be transferred. This is particularly useful when the same intermediate key appears multiple times across the map outputs.

1.6 Running a warm-up problem: Word Count

Use Eclipse IDE to run MapReduce on Ubuntu

1.6.1 Step 0: Install Eclipse on Ubuntu (if you had installed, please go to next step)

```
sudo snap install --classic eclipse
```

1.6.2 Step 1: Create new Java project

Open Eclipse, select **File -> New -> Java project**

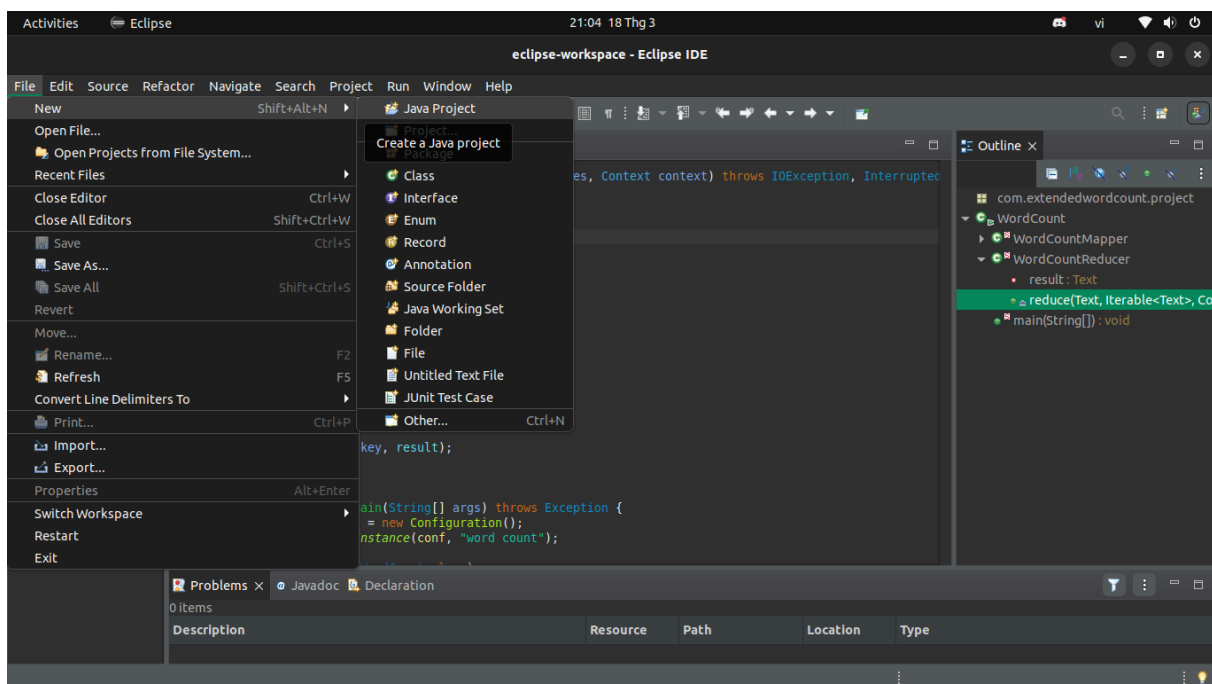


Figure 1.16: Create new Java project

Enter project name and click on **Next** button

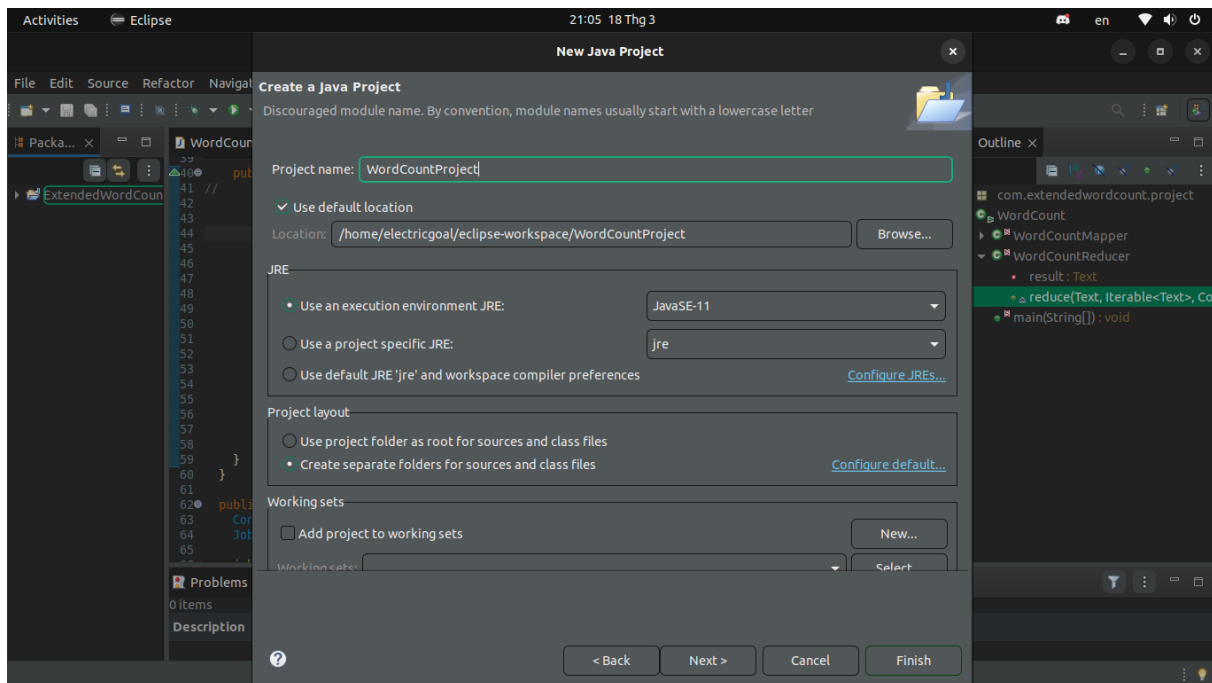


Figure 1.17: Click on Next button

Click on **Finish** button

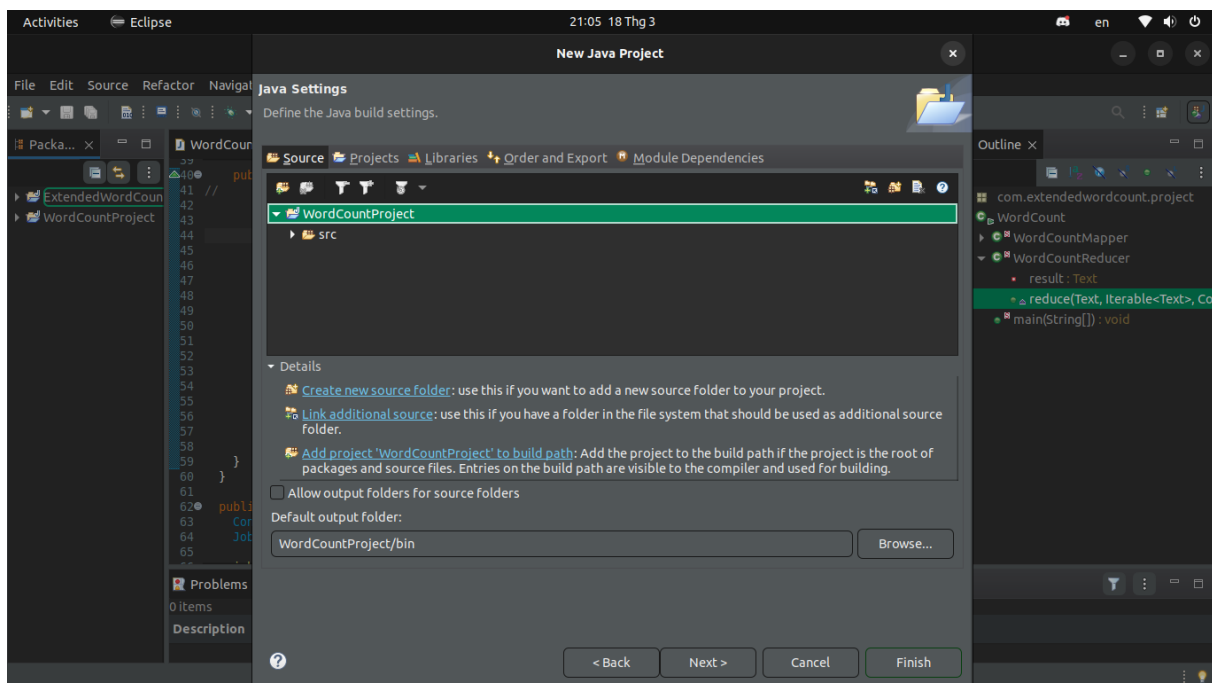


Figure 1.18: Click on Finish button

Result looks like this

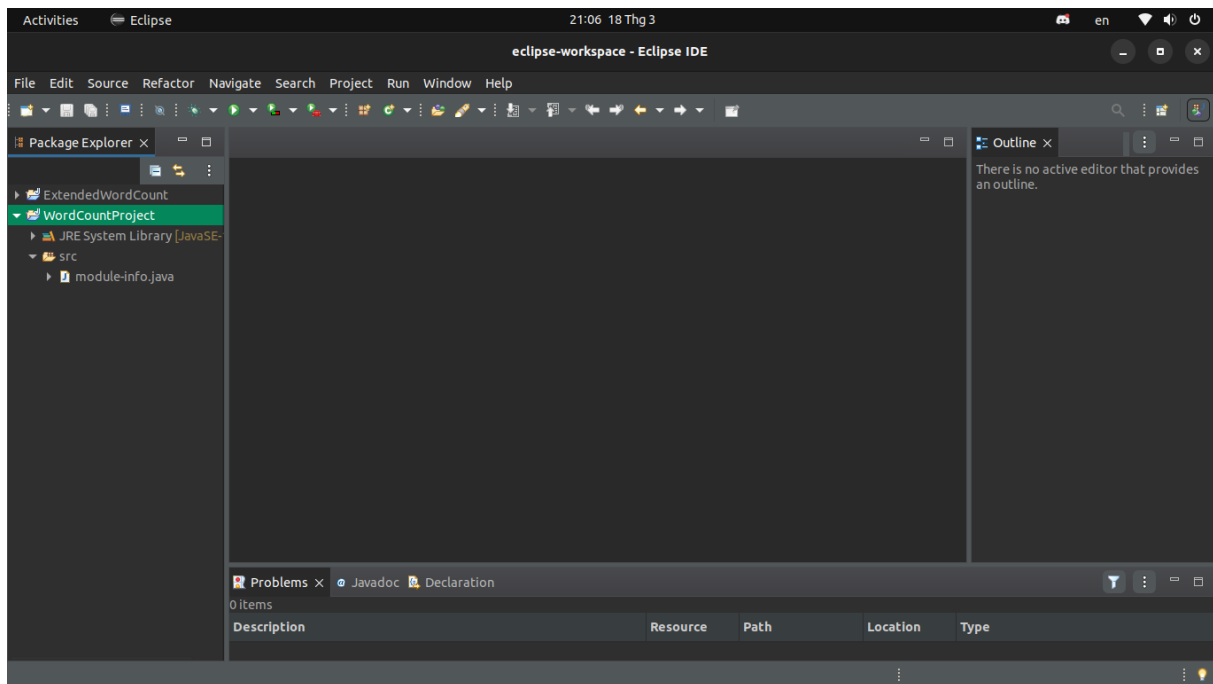


Figure 1.19: Result

1.6.3 Step 2: Delete file *module-info.java*

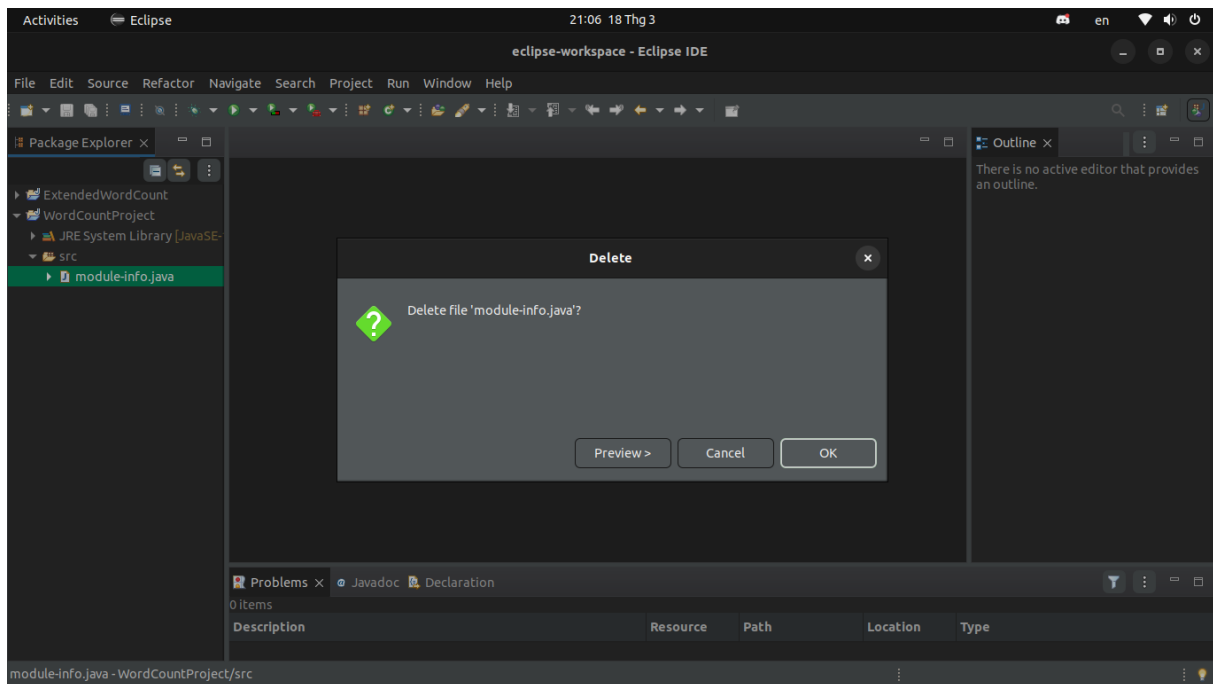
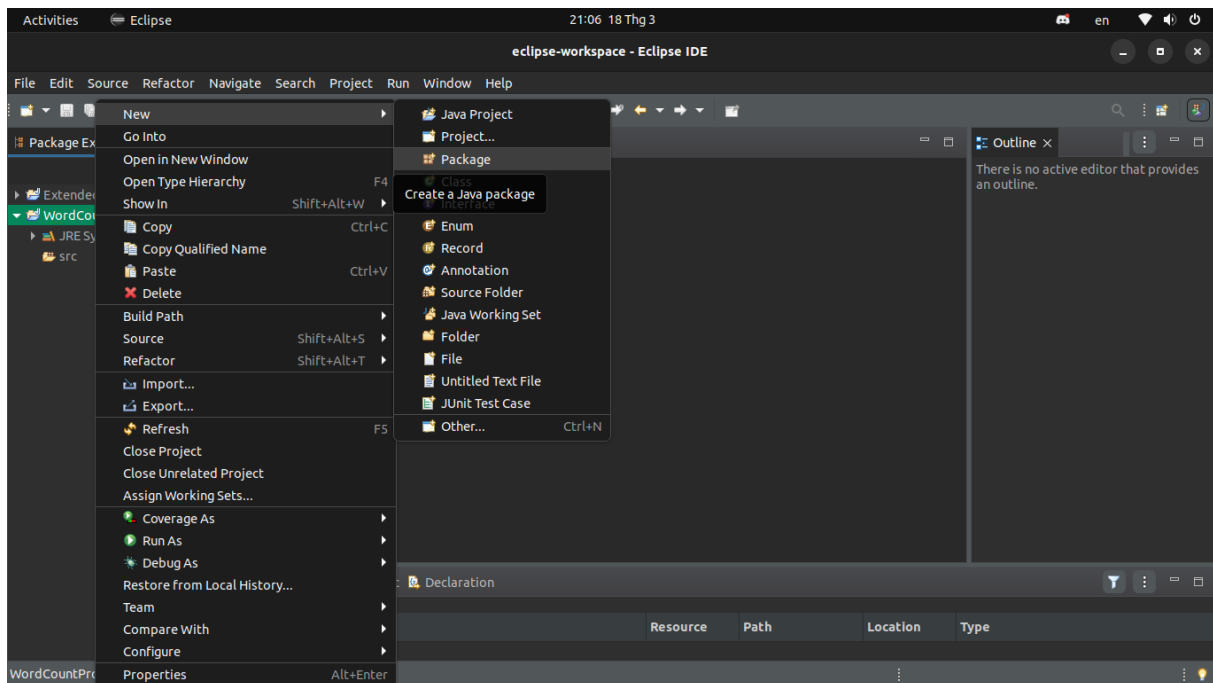


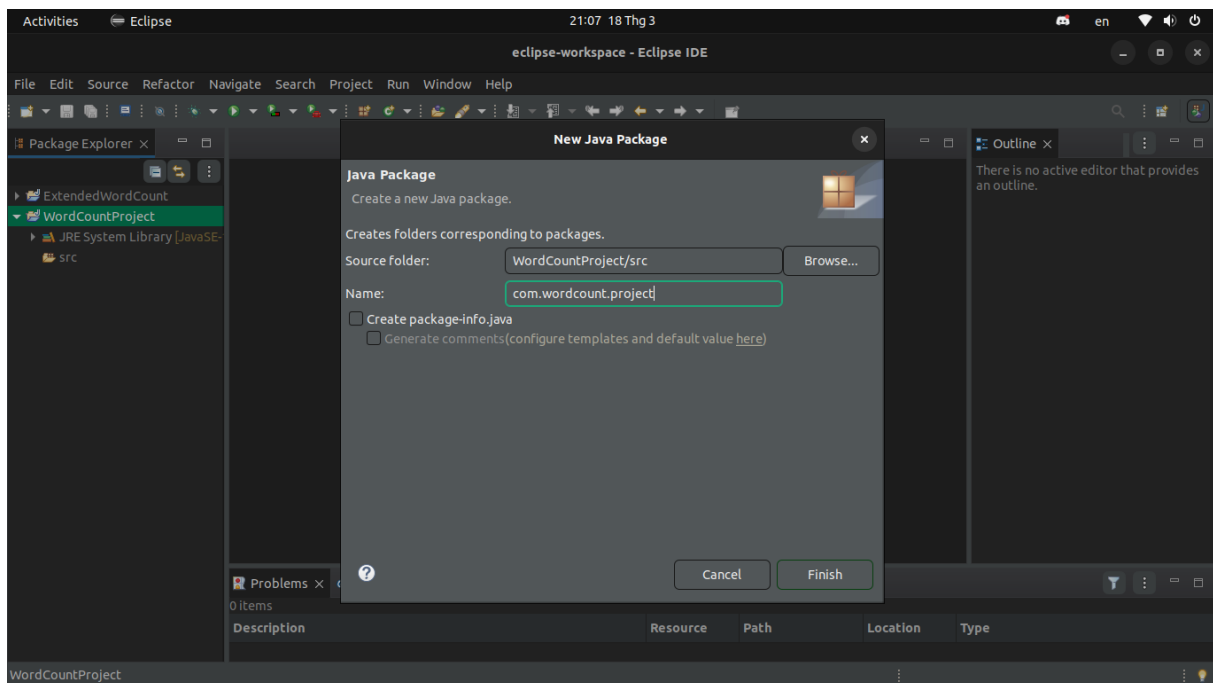
Figure 1.20: Delete module-info.java

1.6.4 Step 3: Create Java package

Right click on project name, select **New -> Package**

**Figure 1.21:** Create new Java package

Enter Package name and click on **Finish** button

**Figure 1.22:** Click on Finish button

1.6.5 Step 4: Create Java class

Right click on project name, select **New** -> **Class** to create a Java class

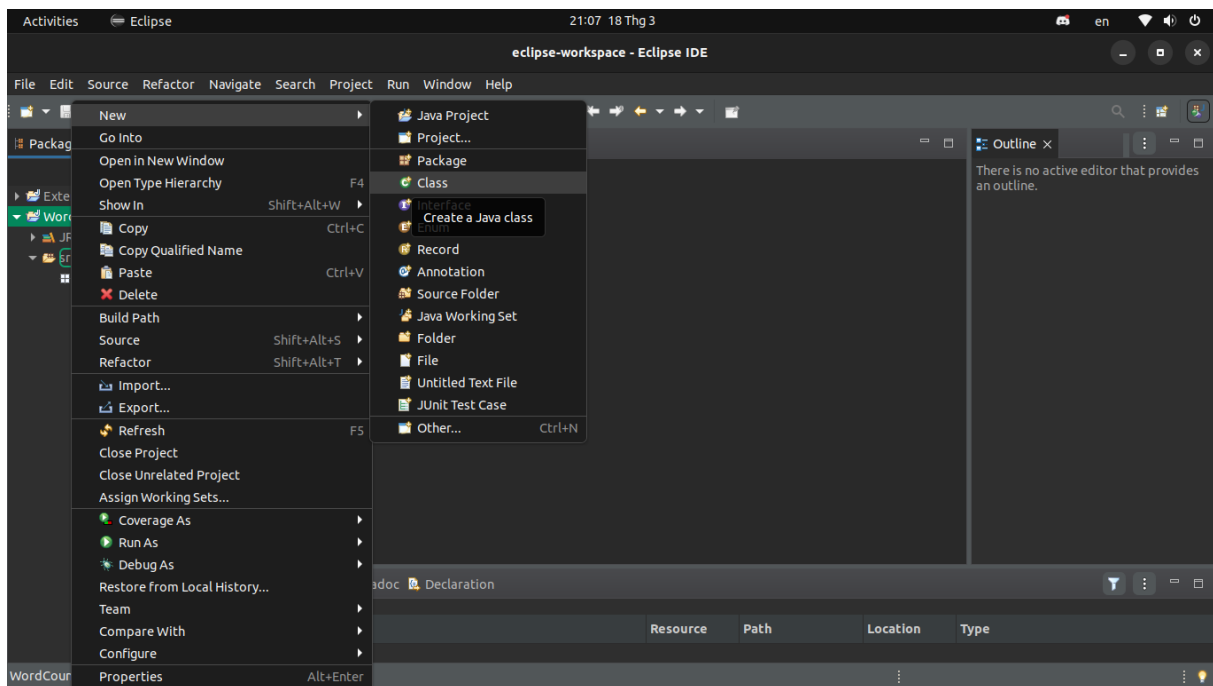


Figure 1.23: Create new Java class

Enter Class name and click on **Finish** button

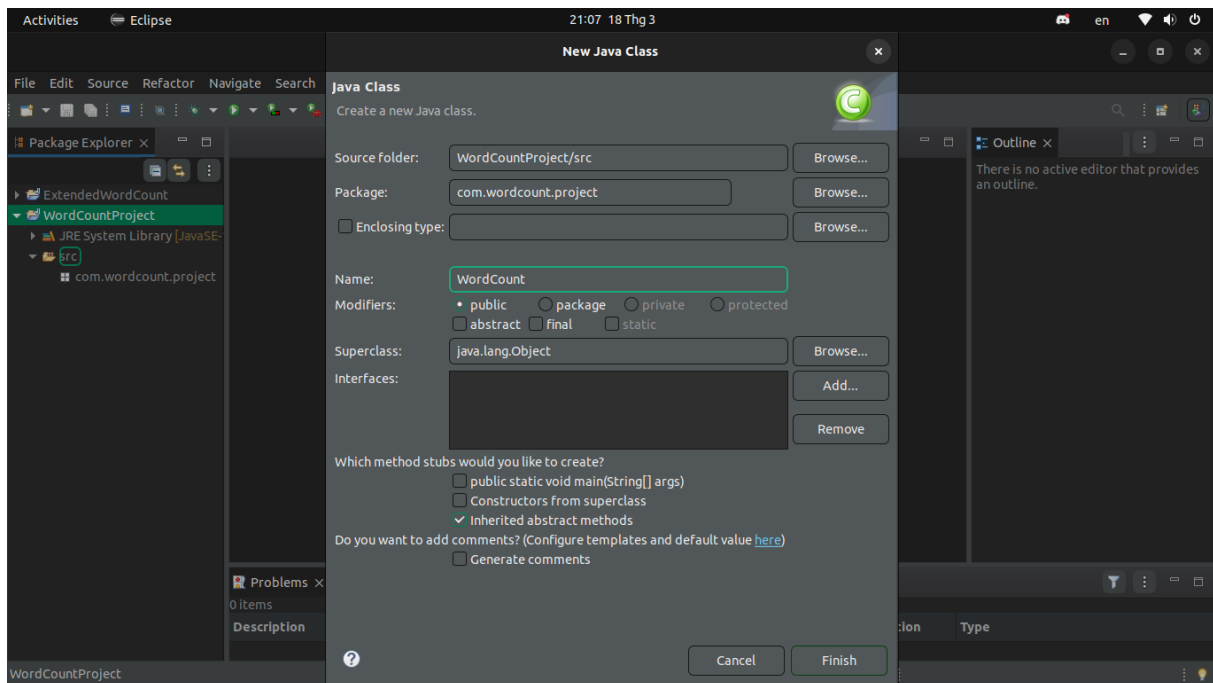
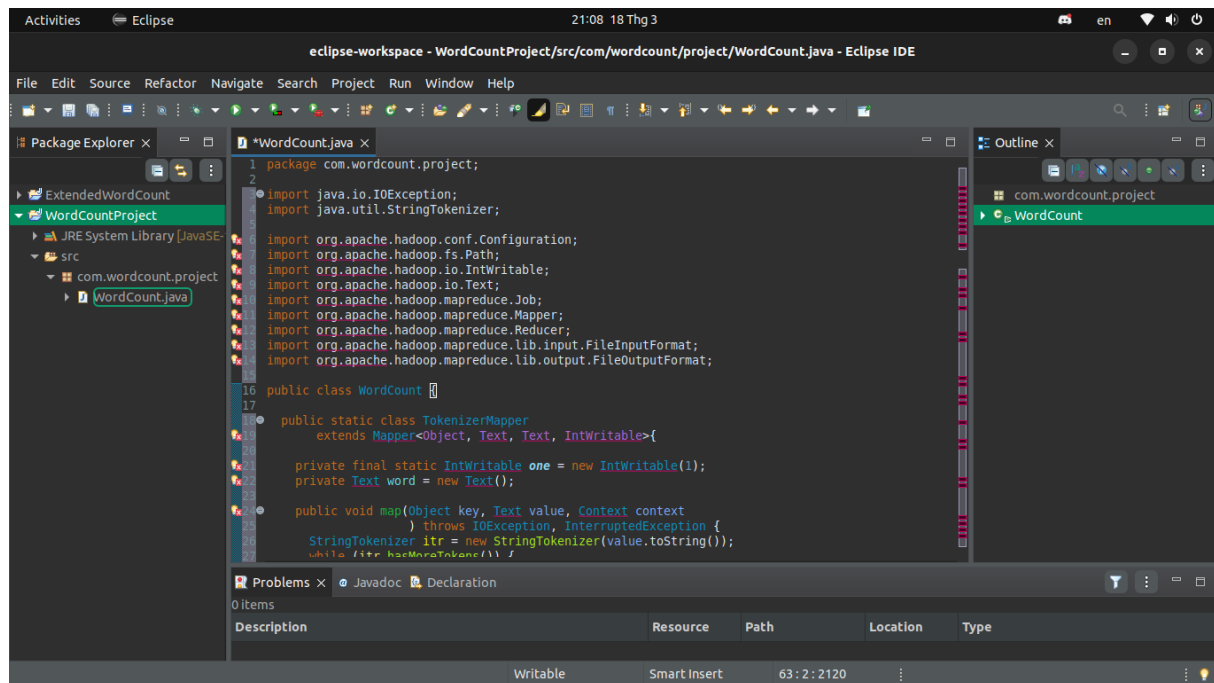


Figure 1.24: Click on Finish button

1.6.6 Step 5: Paste WordCount code to the *WordCount.java* file just created

You should see many errors

**Figure 1.25:** Create WordCount code

1.6.7 Step 6: Configure build path for the project

Right click on project name, select **New -> Build Path -> Configure Build Path**

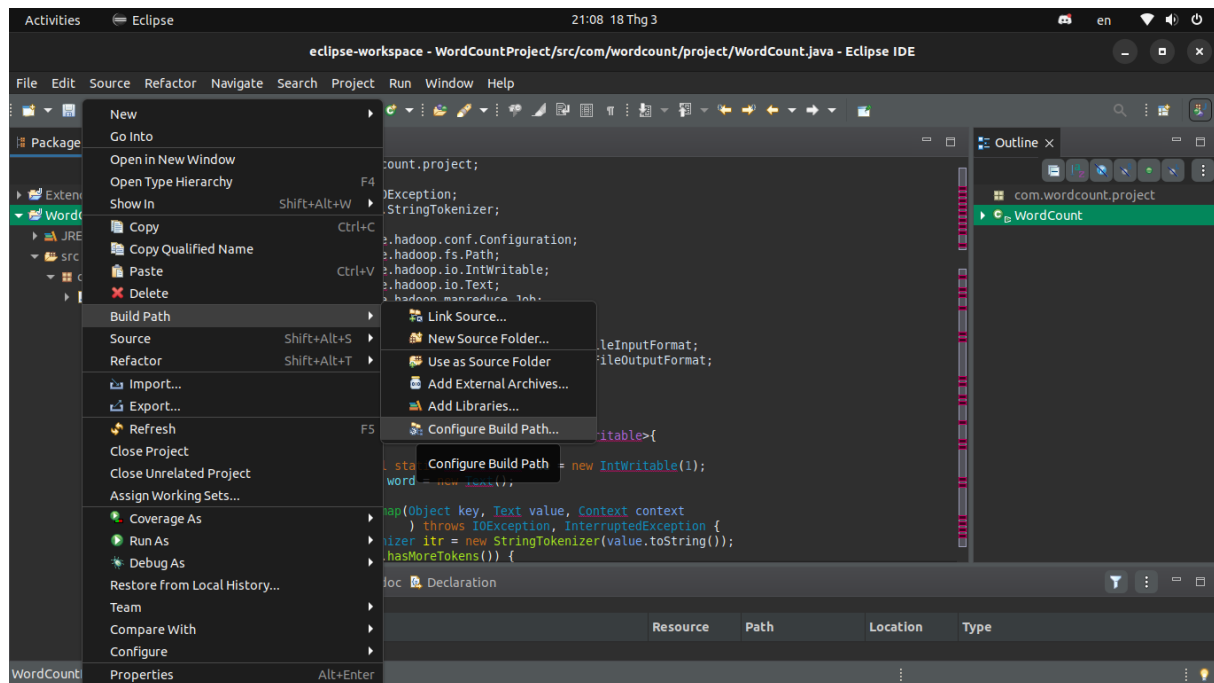


Figure 1.26: Configure Build Path

Click on the **Libraries** tab

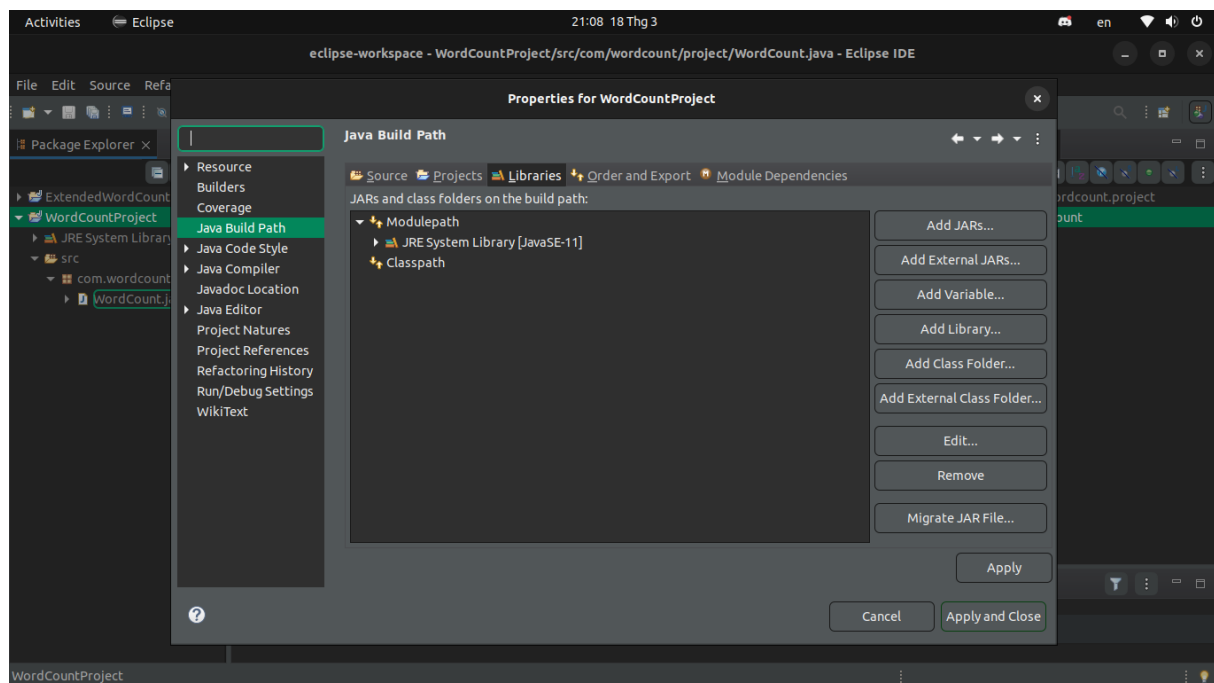


Figure 1.27: Libraries tab

Select **Classpath** section and click on the **Add External JARs** button

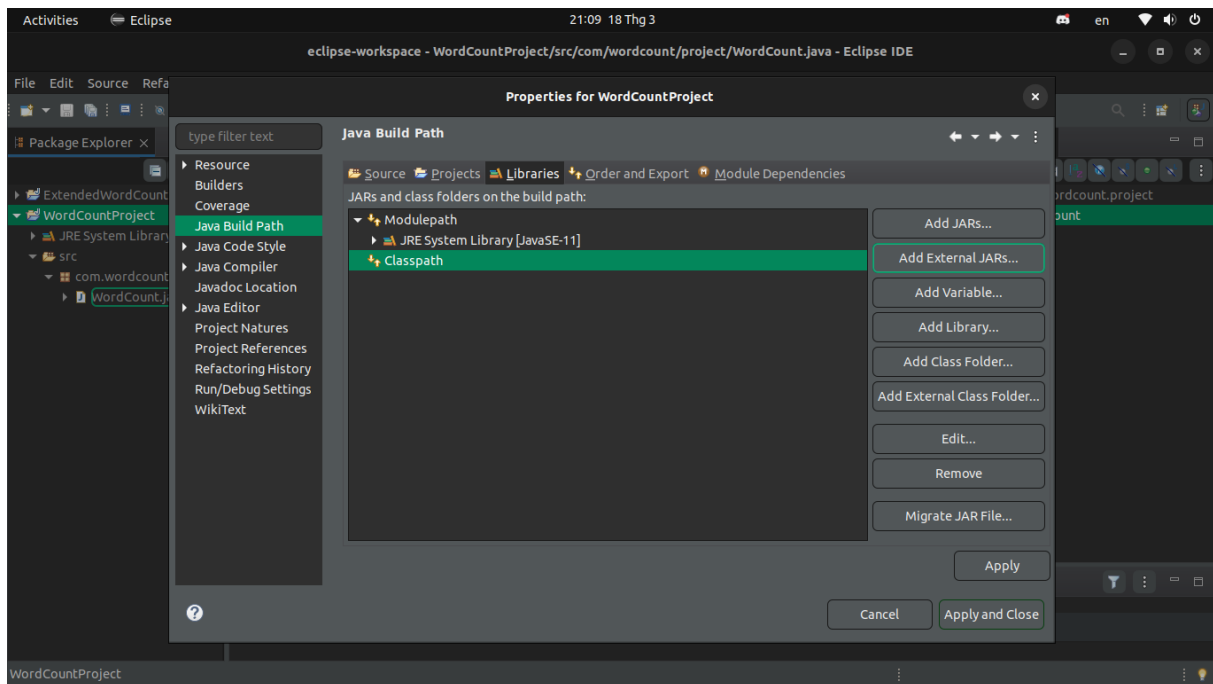


Figure 1.28: Add External JARs

Navigate to the Hadoop installation directory and select the following JAR files:

- hadoop-mapreduce-client-core-<version>.jar
- hadoop-mapreduce-client-common-<version>.jar
- hadoop-mapreduce-client-jobclient-<version>.jar
- hadoop-common-<version>.jar

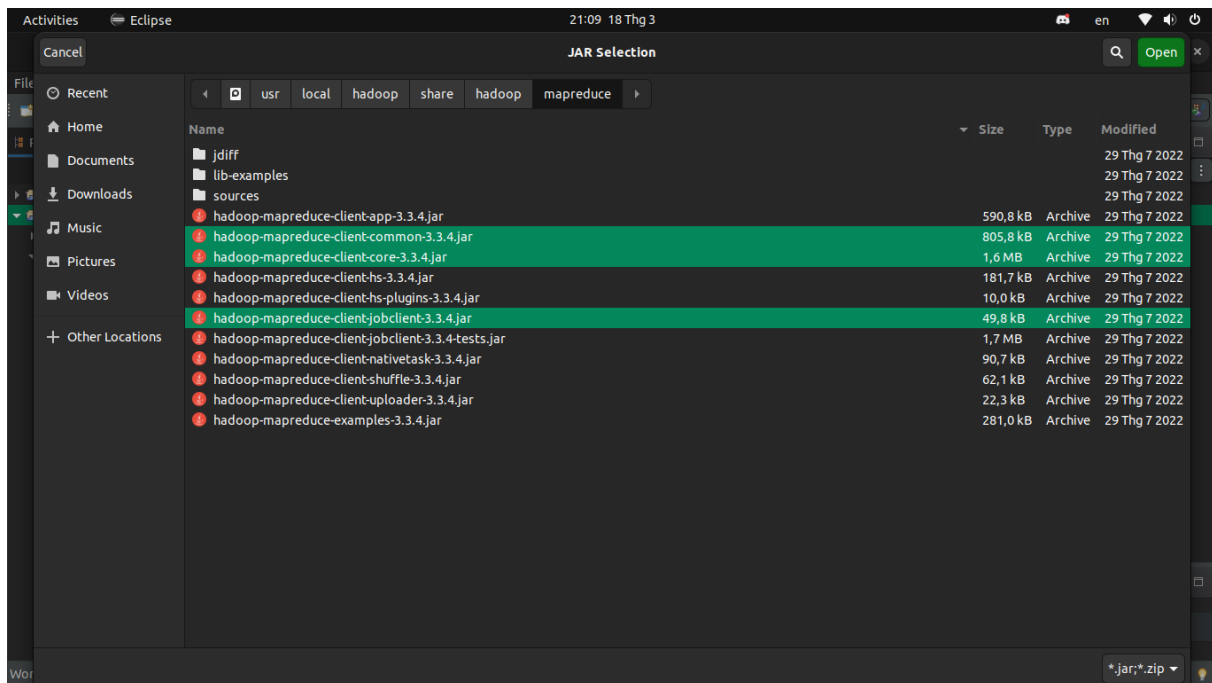


Figure 1.29: Select JAR files - 1

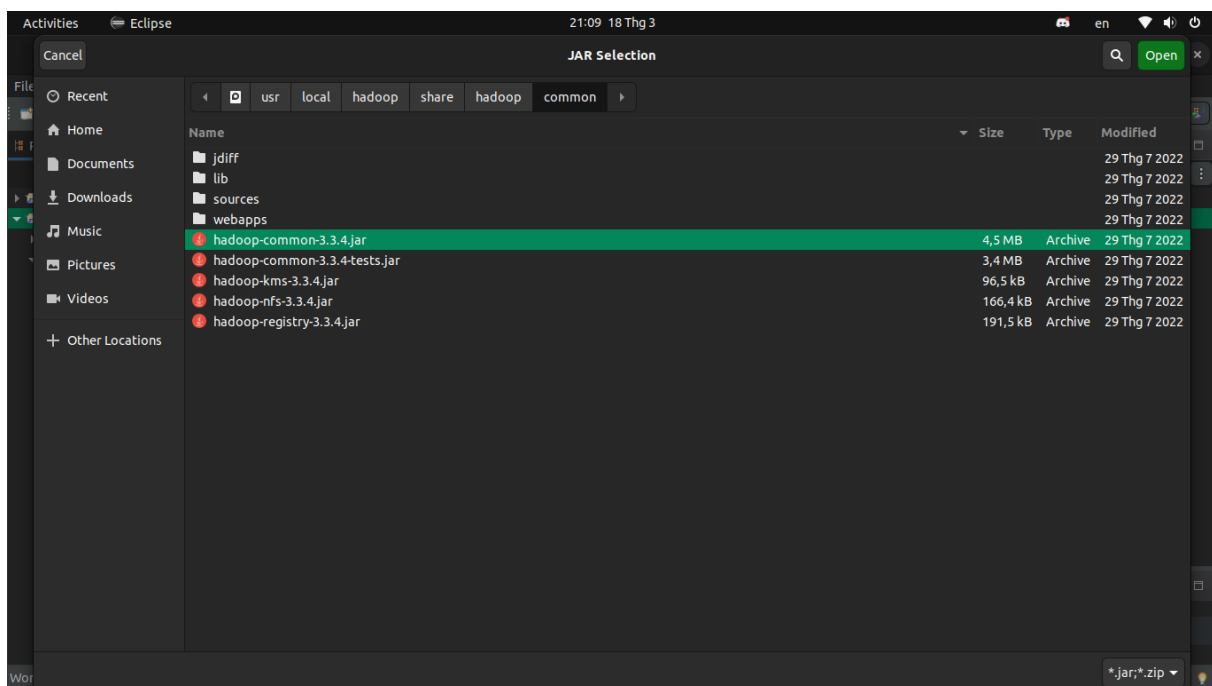


Figure 1.30: Select JAR files - 2

Click on the button **Apply and Close**

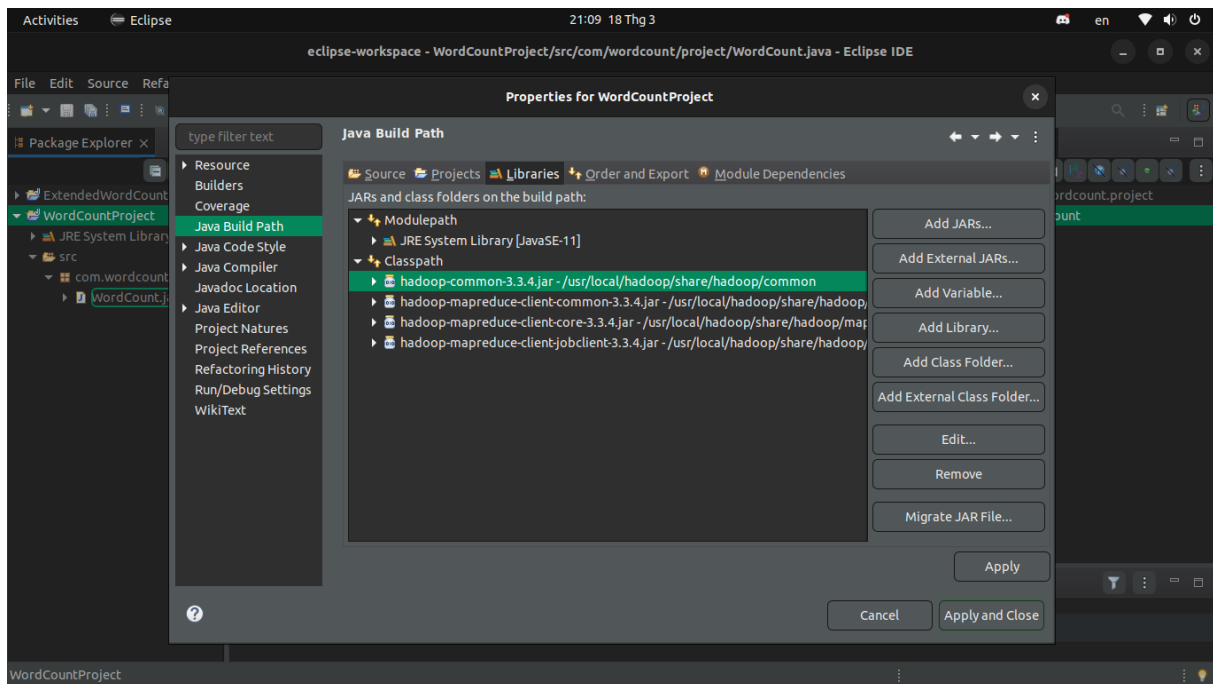


Figure 1.31: Apply and Close

After that, the errors should disappear

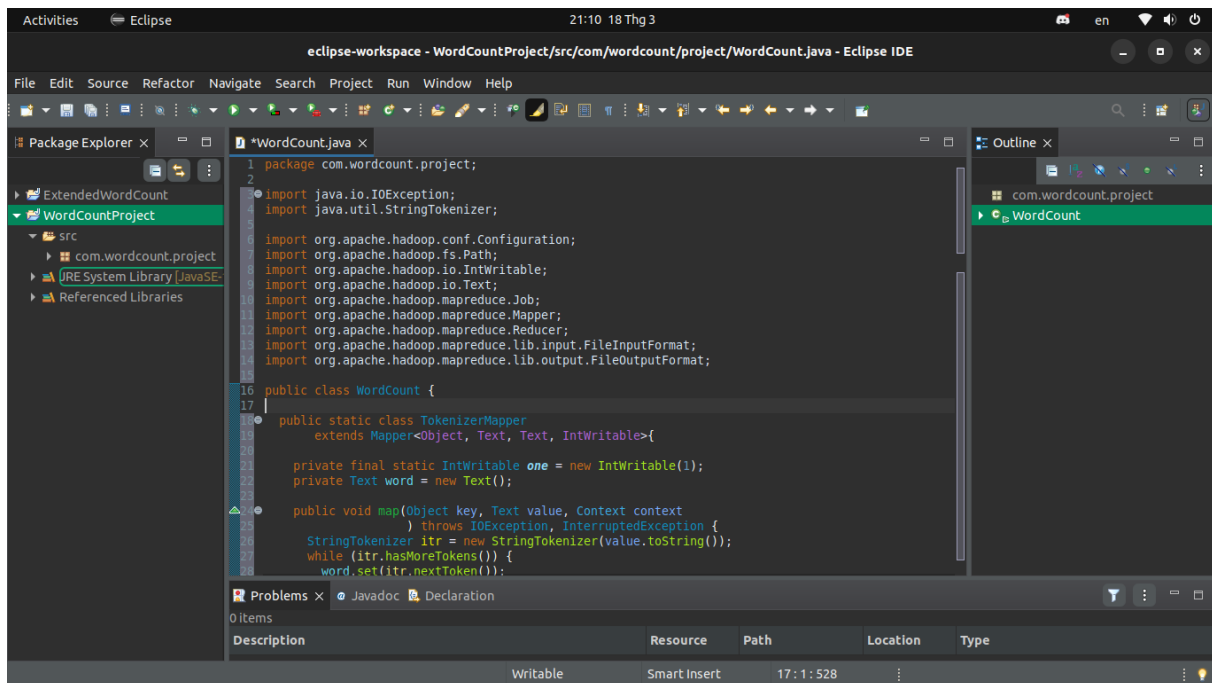
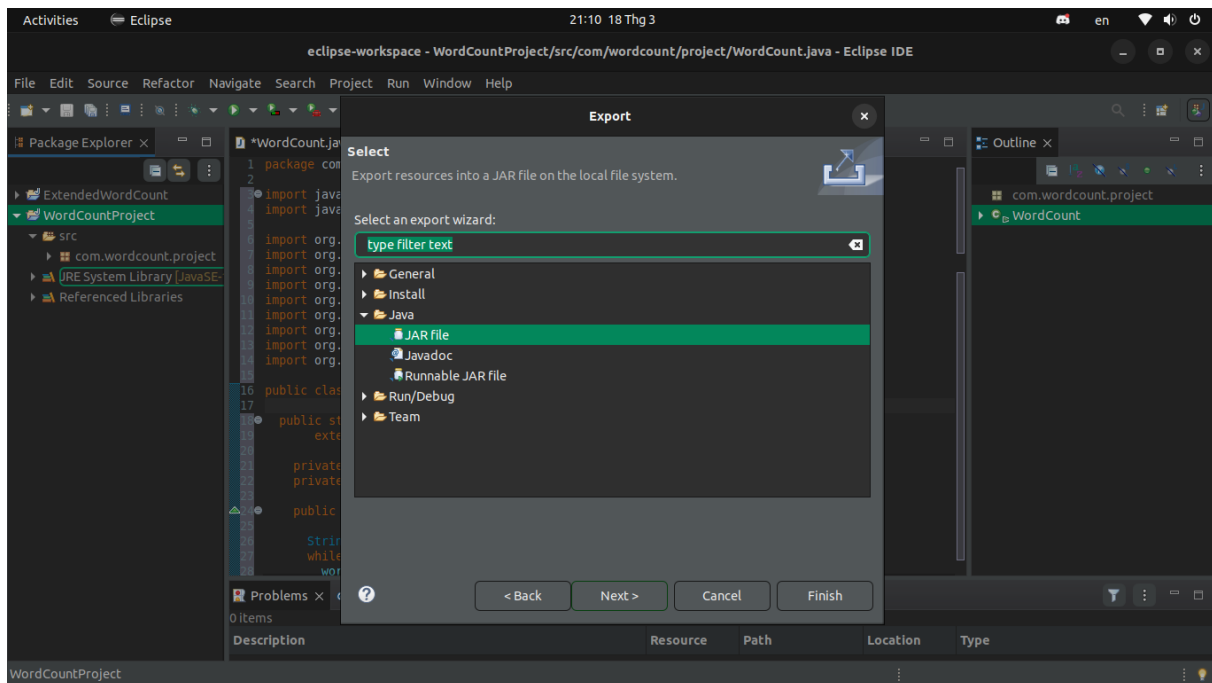


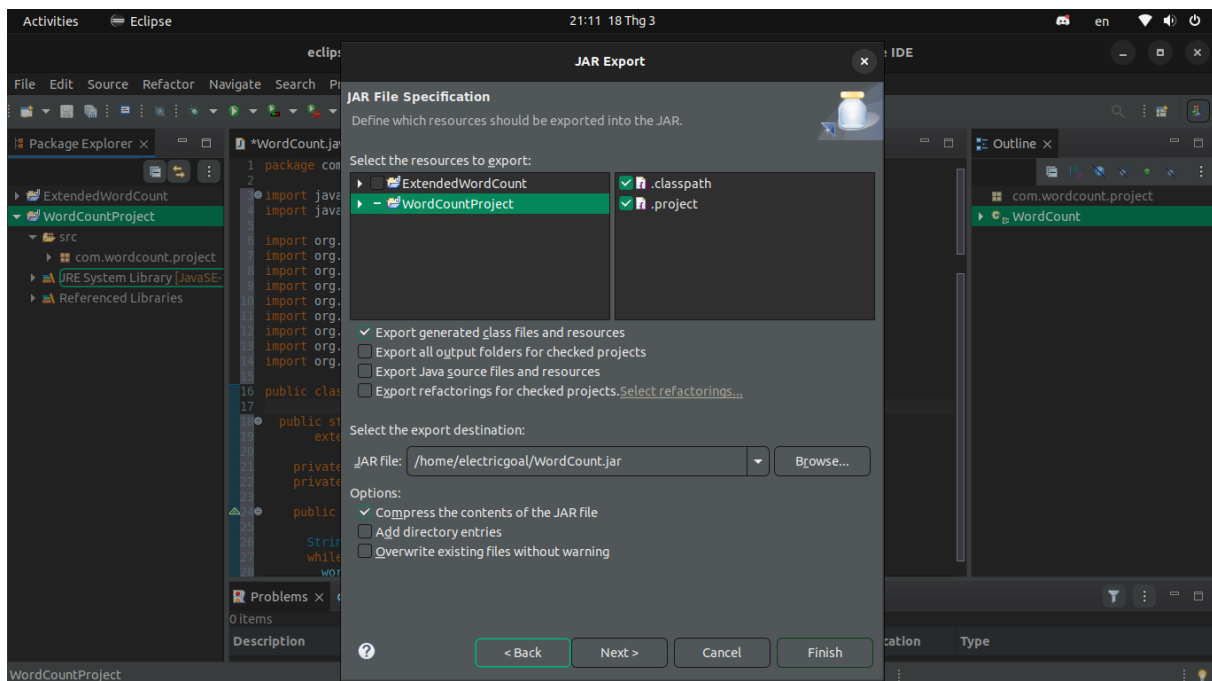
Figure 1.32: Result screen

1.6.8 Step 7: Export to JAR file

Right click to project name, select **Export**. You should see this screen, click on **JAR file** -> **Next**

**Figure 1.33:** Select JAR file

Enter name of jar file and path to save this jar file and. Once done, click on **Next** button

**Figure 1.34:** Click on Next button

Click on **Next** button until see this screen and browse the the package in this project. Once done, click on **Finish** button

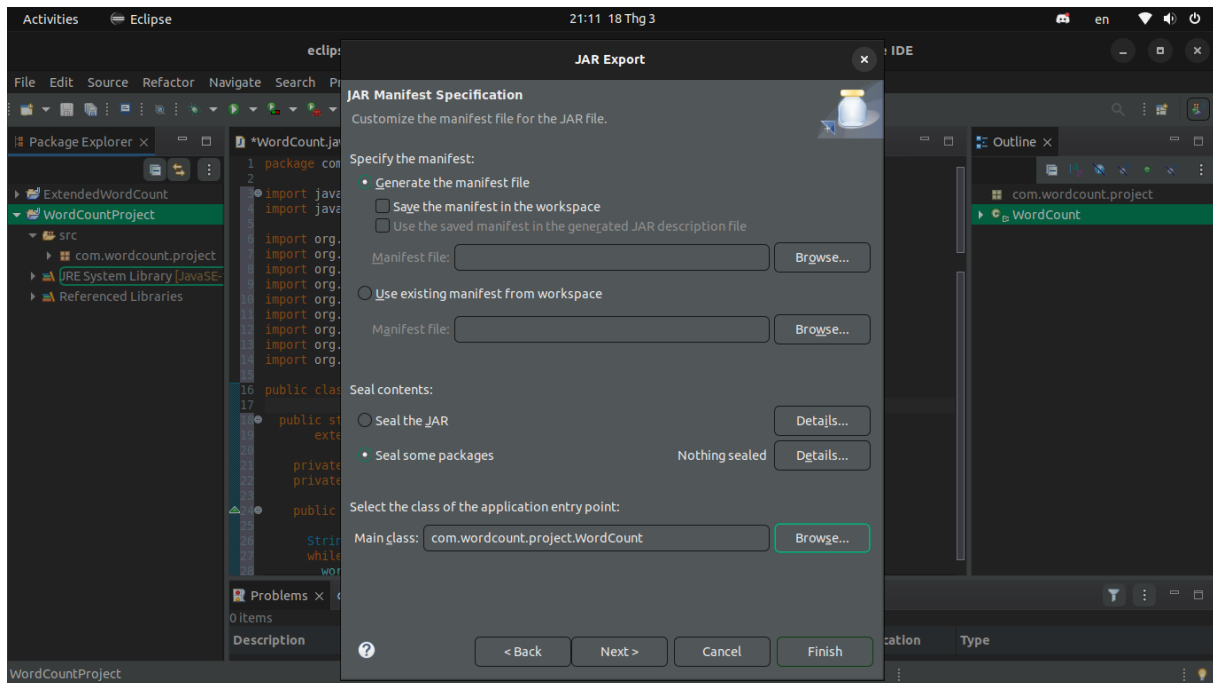


Figure 1.35: Click on Finish button

After all, you will get the Jar file

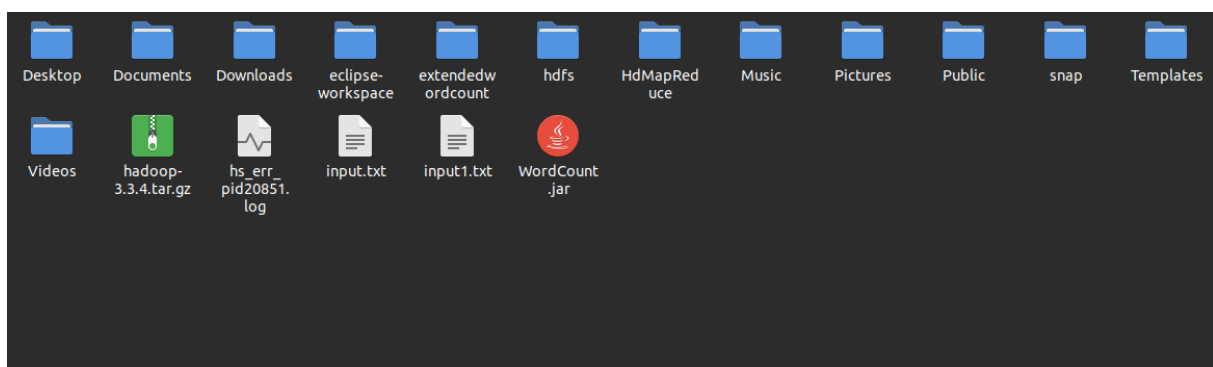


Figure 1.36: Result screen

1.6.9 Step 8: Prepare to run MapReduce

Create new folder name “wordcount” in HDFS

```
hadoop fs -mkdir -p /<your-favorite-path>/wordcount
```

Create “input” folder in “wordcount” folder to store input file

```
hadoop fs -mkdir -p /<your-favorite-path>/wordcount/input
```

Put *input.txt* file into “input” directory

```
hadoop fs -put /<local_file_path>/input.txt /<your-favorite-path>/wordcount/input
```

Open browser and enter <http://localhost:9870>, you should see the screen like this

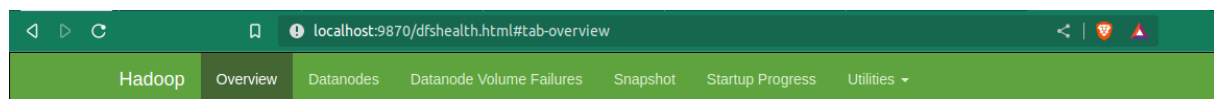


Figure 1.37: Open <http://localhost:9870>

Click on **Utilities** tab -> **Browse the file system**

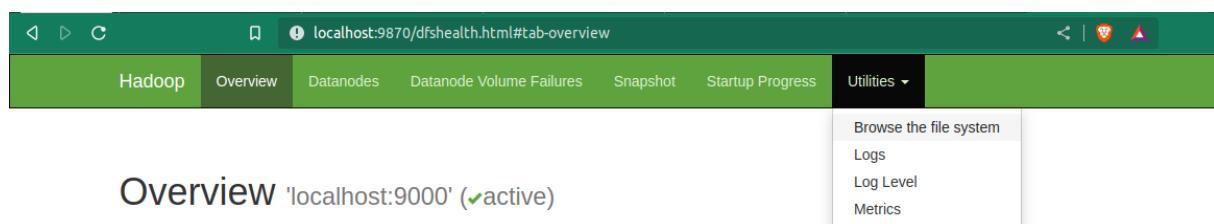


Figure 1.38: Browse the file system

Browse to your “wordcount” directory, you should see “input” folder. Click on it you will see **input.txt** file

Browse Directory

/user/hadoop/wordcount/input Go!

Show 25 entries Search:

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
-rw-r--r--	hadoop	supergroup	172 B	Mar 15 22:03	1	128 MB	input.txt
-rw-r--r--	hadoop	supergroup	53 B	Mar 15 22:03	1	128 MB	input1.txt

Showing 1 to 2 of 2 entries

Previous 1 Next

Hadoop, 2022.

Figure 1.39: Input folder

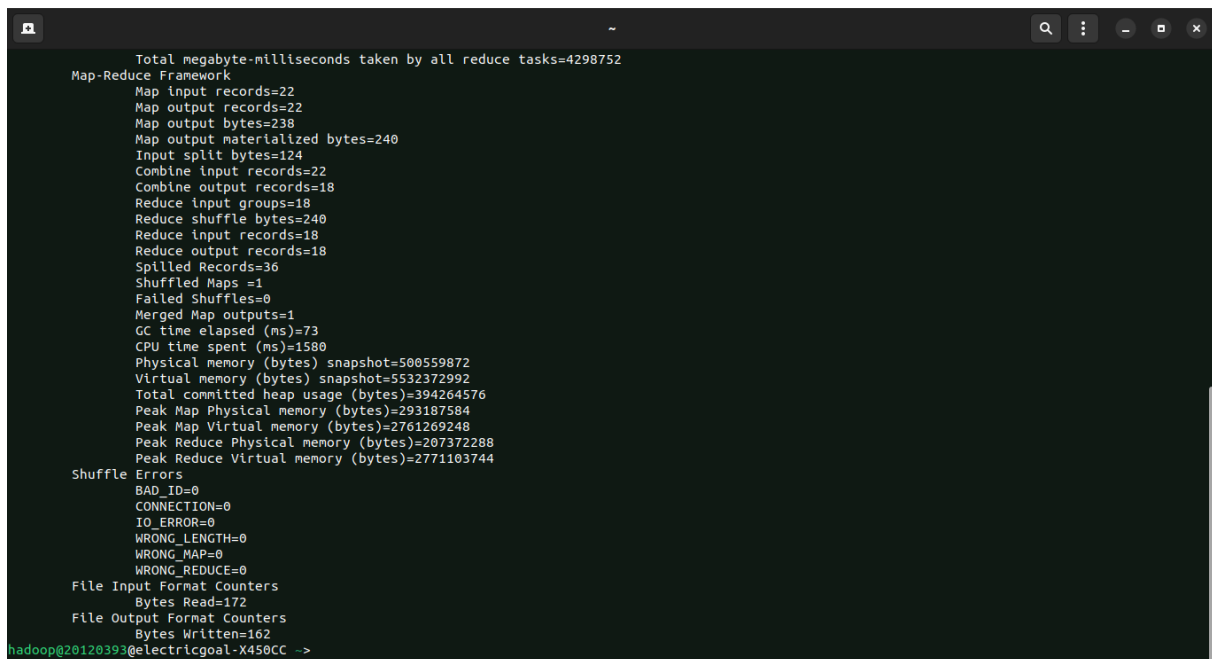
1.6.10 Step 9: Run MapReduce

```
hadoop jar WordCount.jar /<your-favorite-path>/wordcount/input/input.txt /<your-favorite-path>/wordcount/output
```

In my case, <your-favorite-path> is user/hadoop

```
hadoop jar WordCount.jar /user/hadoop/wordcount/input/input.txt /user/hadoop/wordcount/output
```

You should see something like this

A terminal window with a dark background and light green text. It displays the output of a Hadoop Map-Reduce job. The text is organized into sections: 'Total megabyte-milliseconds taken by all reduce tasks=4298752', 'Map-Reduce Framework' (with sub-statistics for Map and Reduce tasks), 'Shuffle Errors' (all showing 0), and 'File Input/Output Format Counters' (Bytes Read=172, Bytes Written=162). The prompt at the bottom is 'hadoop@20120393@electricgoal-X450CC ->'.

```
hadoop@20120393@electricgoal-X450CC ->
Total megabyte-milliseconds taken by all reduce tasks=4298752
Map-Reduce Framework
  Map input records=22
  Map output records=22
  Map output bytes=238
  Map output materialized bytes=240
  Input split bytes=124
  Combine input records=22
  Combine output records=18
  Reduce input groups=18
  Reduce shuffle bytes=240
  Reduce input records=18
  Reduce output records=18
  Spilled Records=36
  Shuffled Maps =1
  Failed Shuffles=0
  Merged Map outputs=1
  GC time elapsed (ms)=73
  CPU time spent (ms)=1580
  Physical memory (bytes) snapshot=500559072
  Virtual memory (bytes) snapshot=5532372992
  Total committed heap usage (bytes)=394264576
  Peak Map Physical memory (bytes)=293187584
  Peak Map Virtual memory (bytes)=2761269248
  Peak Reduce Physical memory (bytes)=207372288
  Peak Reduce Virtual memory (bytes)=2771103744
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=172
File Output Format Counters
  Bytes Written=162
hadoop@20120393@electricgoal-X450CC ->
```

Figure 1.40: Result screen

To see the result, enter this command

```
hadoop fs -cat /<your-favorite-path>/wordcount/output/part-r-00000
```

In my case

```
hadoop fs -cat /user/hadoop/wordcount/output/part-r-00000
```

Compare to the input

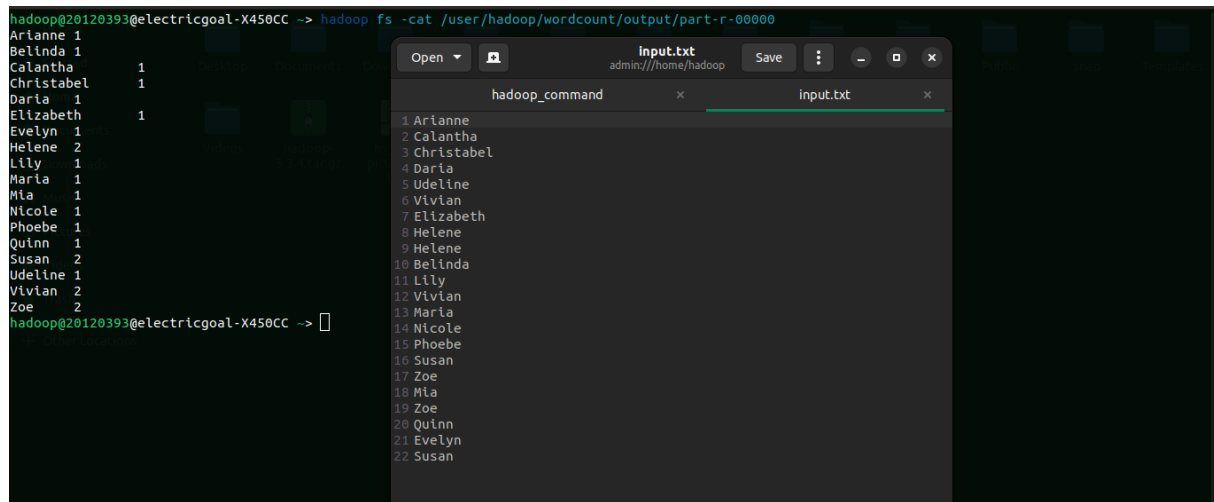


Figure 1.41: Compare to the input

1.7 Bonus

1.7.1 4.1 Extended Word Count: Unhealthy relationships

For more details, open folder `src`

Sample input:

```

faker showmaker
gumayusi deft
keria kellin
canyon oner
zeus canna
chovy faker
canyon peanut
oner peanut
zeus doran
gumayusi peyz
keria delight
deft peyz
delight kellin
chovy showmaker
doran canna

```

Expected output:

```
canna neg
canyon pos
chovy pos
deft eq
delight eq
doran eq
faker eq
gumayusi pos
kellin neg
keria pos
oner eq
peanut neg
peyz neg
showmaker neg
zeus pos
```

The result screen:



```
hadoop@20120393@gotcha ~-> hadoop fs -cat unhealthy_relationship/output/part-r-00000
canna neg
canyon pos
chovy pos
deft eq
delight eq
doran eq
faker eq
gumayusi pos
kellin neg
keria pos
oner eq
peanut neg
peyz neg
showmaker neg
zeus pos
The result screen:
### 4.2 Setting up Fully Distributed Mode
Uncomplete
```

Figure 1.42: Result screen

1.7.2 4.2 Setting up Fully Distributed Mode

Uncomplete

1.8 References

- Example: WordCount v1.0: https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html#Example:_WordCount_v1.0
- How to Install Apache Hadoop on Ubuntu 22.04: <https://www.howtoforge.com/how-to-install-apache-hadoop-on-ubuntu-22-04/>
- How to run Word Count example on Hadoop MapReduce (WordCount Tutorial): <https://www.youtube.com/watch?v=qgBu8Go1SyM>
- MapReduce Word Count Example using Hadoop and Java: <https://www.youtube.com/watch?v=qgBu8Go1SyM>
- Create and Execute your First Hadoop MapReduce Project in Eclipse: <https://medium.com/data-science-community-srm/create-execute-your-first-hadoop-mapreduce-project-with-eclipse-9ec03105e974>
- All of StackOverflow link related:
 - <https://stackoverflow.com/questions/11889261/datanode-process-not-running-in-hadoop>
 - <https://stackoverflow.com/questions/66182686/why-output-key-value-of-mapper-needs-to-be-same-as-that-of-output-key-value-ofco>