

Lab 01: A Gentle Introduction to Hadoop

Setting up Single-node Hadoop Cluster

Introduction to MapReduce

Running a warm-up problem: Word Count

Bonus

TEAM HugeData:

MSSV	FULLNAME	TASKS
20120560	Cao Đình Quý	1, 2.1.3, write report
20120089	Lê Xuân Hoàng	1, 2.1.1, 4
20120130	Đinh Thị Hoàng Linh	1, 2.1.4, 4
20120397	Bùi Quang Tùng	1, 2.1.2, 3

COMPLETION RATE:

SESSION	RATE
1	100%
2	100%
3	100%
4	50%

1. Setting up Single-node Hadoop Cluster

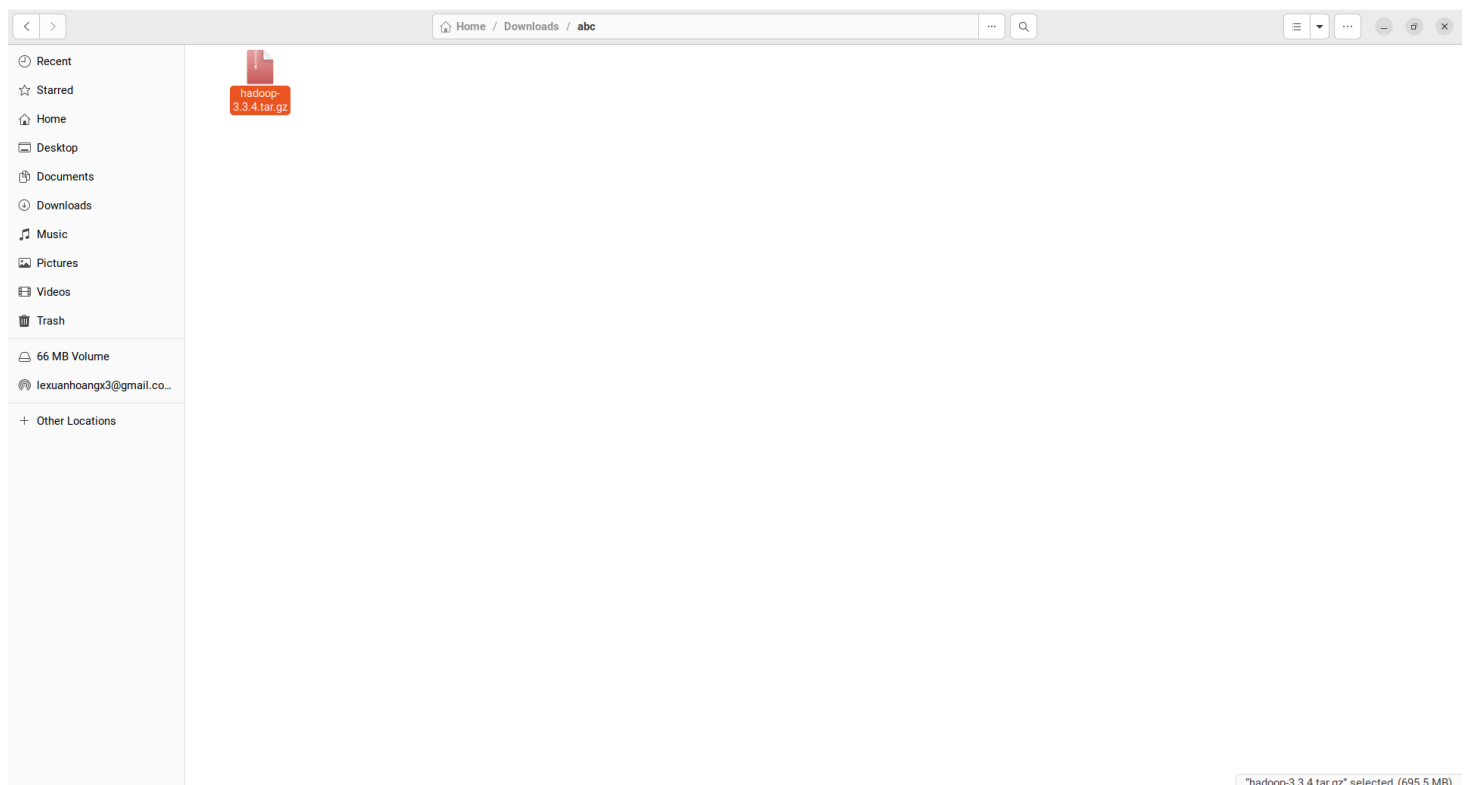
All members finished successfully.

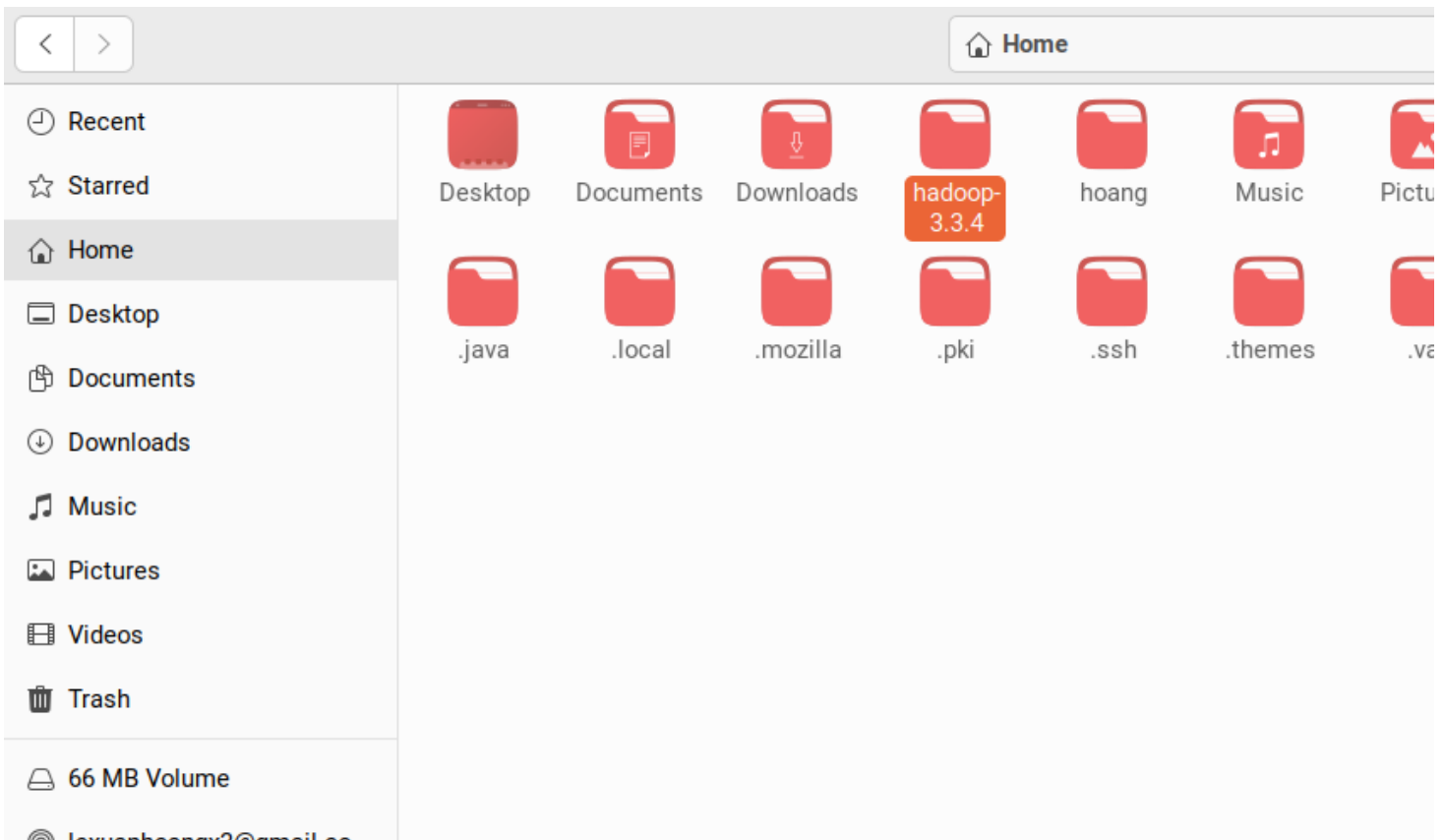
The process:

Step 1: Download hadoop-3.3.4.tar.gz

Download from link: <https://www.apache.org/dyn/closer.cgi/hadoop/common/hadoop-3.3.4/hadoop-3.3.4.tar.gz>

Then extract to Home.





Step 2: Install ssh

Type:

```
sudo apt-get install ssh
```

Then check:

```
ssh -V
```

```
hoang@hoangitus: ~  
20120089:~$ sudo apt-get install ssh  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
The following NEW packages will be installed:  
  ssh  
0 upgraded, 1 newly installed, 0 to remove and 7 not upgraded.  
Need to get 0 B/4,850 B of archives.  
After this operation, 133 kB of additional disk space will be used.  
Selecting previously unselected package ssh.  
(Reading database ... 219888 files and directories currently installed.)  
Preparing to unpack .../ssh_1%3a8.9p1-3ubuntu0.1_all.deb ...  
Unpacking ssh (1:8.9p1-3ubuntu0.1) ...  
Setting up ssh (1:8.9p1-3ubuntu0.1) ...  
20120089:~$ ssh -V  
OpenSSH_8.9p1 Ubuntu-3ubuntu0.1, OpenSSL 3.0.2 15 Mar 2022  
20120089:~$
```

Step 3: Install pdsh

Type:

```
sudo apt-get install pdsh
```

Then check:

```
pdsh -V
```



hoang@hoangitus: ~



```
20120089:~$ sudo apt-get install pdsh
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  genders libgenders0
Suggested packages:
  rdist
The following NEW packages will be installed:
  genders libgenders0 pdsh
0 upgraded, 3 newly installed, 0 to remove and 7 not upgraded.
Need to get 0 B/171 kB of archives.
After this operation, 527 kB of additional disk space will be used.
Do you want to continue? [Y/n] Y
```

```
hoang@hoangitus: ~  
Need to get 0 B/171 kB of archives.  
After this operation, 527 kB of additional disk space will be used.  
Do you want to continue? [Y/n] Y  
Preconfiguring packages ...  
Selecting previously unselected package libgenders0:amd64.  
(Reading database ... 219892 files and directories currently installed.)  
Preparing to unpack .../libgenders0_1.22-1build4_amd64.deb ...  
Unpacking libgenders0:amd64 (1.22-1build4) ...  
Selecting previously unselected package genders.  
Preparing to unpack .../genders_1.22-1build4_amd64.deb ...  
Unpacking genders (1.22-1build4) ...  
Selecting previously unselected package pdsh.  
Preparing to unpack .../pdsh_2.31-3build2_amd64.deb ...  
Unpacking pdsh (2.31-3build2) ...  
Setting up libgenders0:amd64 (1.22-1build4) ...  
Setting up genders (1.22-1build4) ...  
Setting up pdsh (2.31-3build2) ...  
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...  
Processing triggers for man-db (2.10.2-1) ...  
20120089:~$ pdsh -V  
pdsh-2.31 (+debug)  
rcmd modules: ssh,rsh,exec (default: rsh)  
misc modules: genders  
20120089:~$
```

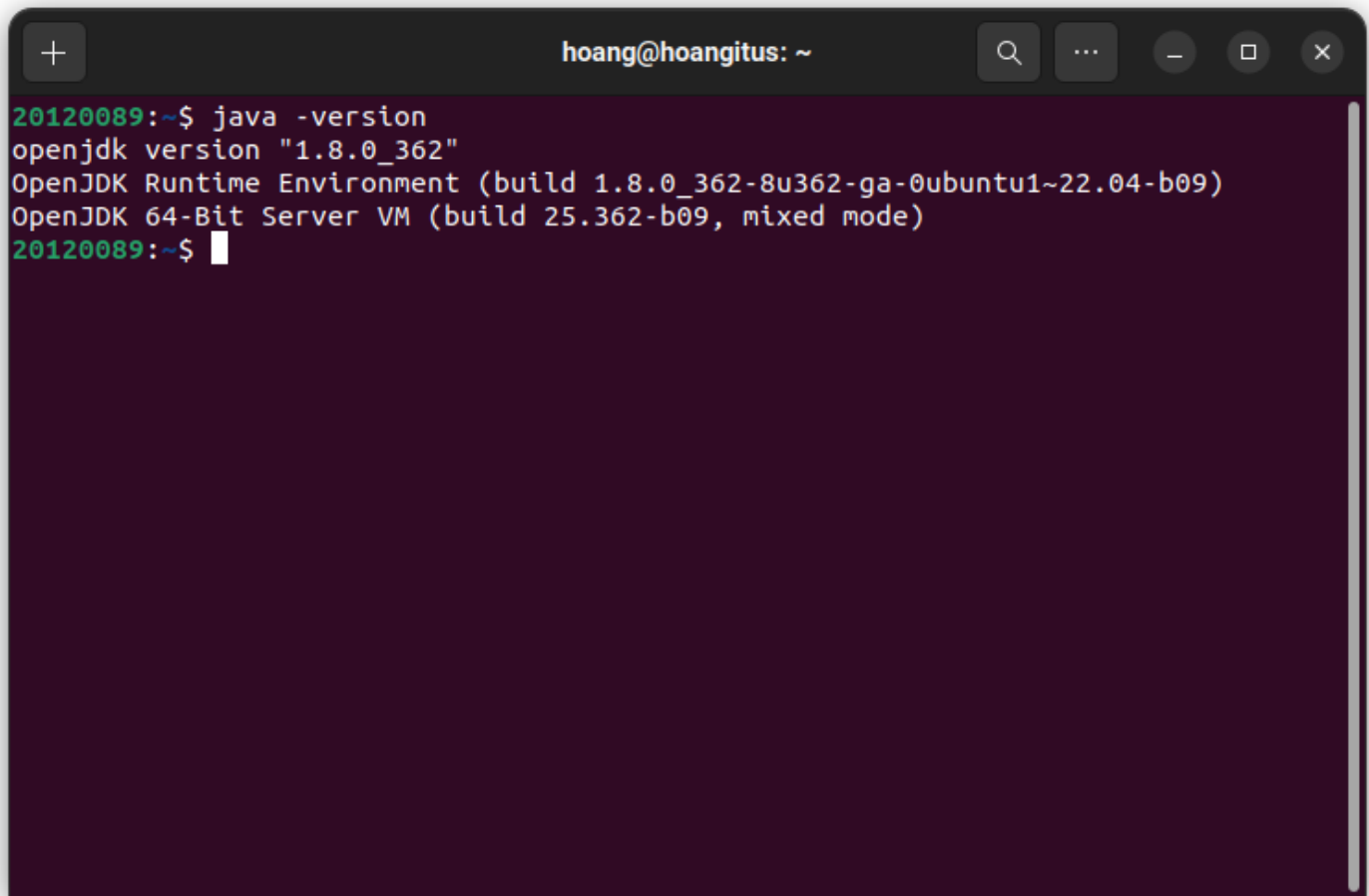
Step 4: Install Java

Check if your computer has java installed:

```
java --version
```

If Java is already installed, there is no need to reinstall it. But if you want to install Java then type:

```
sudo apt install openjdk-8-jdk -y
```

A terminal window with a dark background and light text. The window title bar shows 'hoang@hoangitus: ~' and standard window controls. The terminal output shows the command 'java -version' and its output: 'openjdk version "1.8.0_362"', 'OpenJDK Runtime Environment (build 1.8.0_362-8u362-ga-0ubuntu1~22.04-b09)', and 'OpenJDK 64-Bit Server VM (build 25.362-b09, mixed mode)'. The prompt '20120089:~\$' is visible at the end of the output.

```
hoang@hoangitus: ~  
20120089:~$ java -version  
openjdk version "1.8.0_362"  
OpenJDK Runtime Environment (build 1.8.0_362-8u362-ga-0ubuntu1~22.04-b09)  
OpenJDK 64-Bit Server VM (build 25.362-b09, mixed mode)  
20120089:~$
```

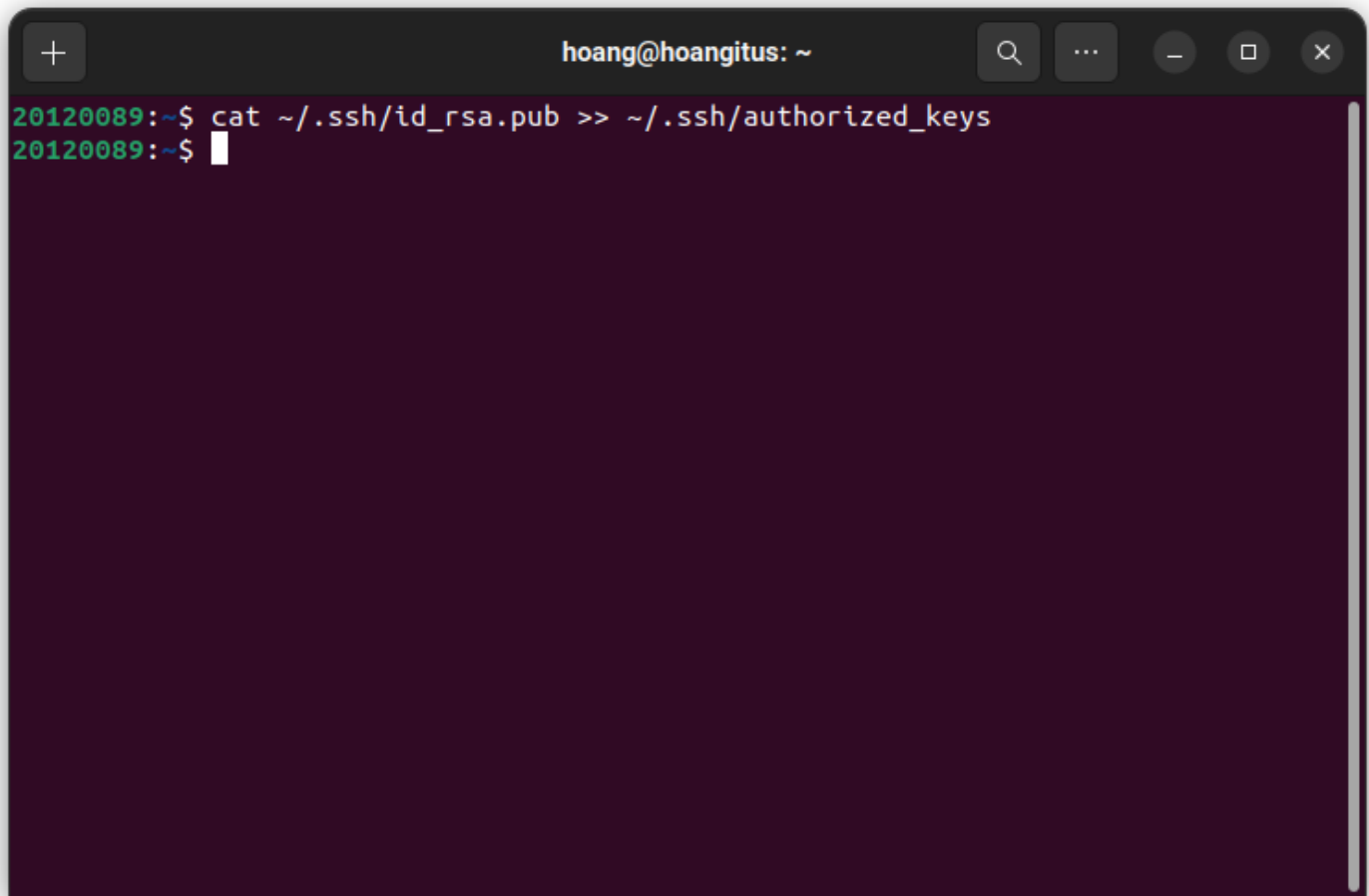
Step 5: Create and Install SSH Certificates

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

```
hoang@hoangitus: ~  
20120089:~$ ssh-keygen -t rsa -P '' -f ~/.ssh/id_rsa  
Generating public/private rsa key pair.  
/home/hoang/.ssh/id_rsa already exists.  
Overwrite (y/n)? y  
Your identification has been saved in /home/hoang/.ssh/id_rsa  
Your public key has been saved in /home/hoang/.ssh/id_rsa.pub  
The key fingerprint is:  
SHA256:fu37gbHinqzn2+NC6B4N9dl3L3RrPdEwh/15mvWftjQ hoang@hoangitus  
The key's randomart image is:  
+---[RSA 3072]-----+  
|  
|                o  |  
|               o= o |  
|              . .o=**|  
|             S .+o+E*@|  
|            .oX=.O% |  
|           .O.*=+= |  
|          ...+O. |  
|         .. .OO. |  
+-----[SHA256]-----+  
20120089:~$
```

Save information:

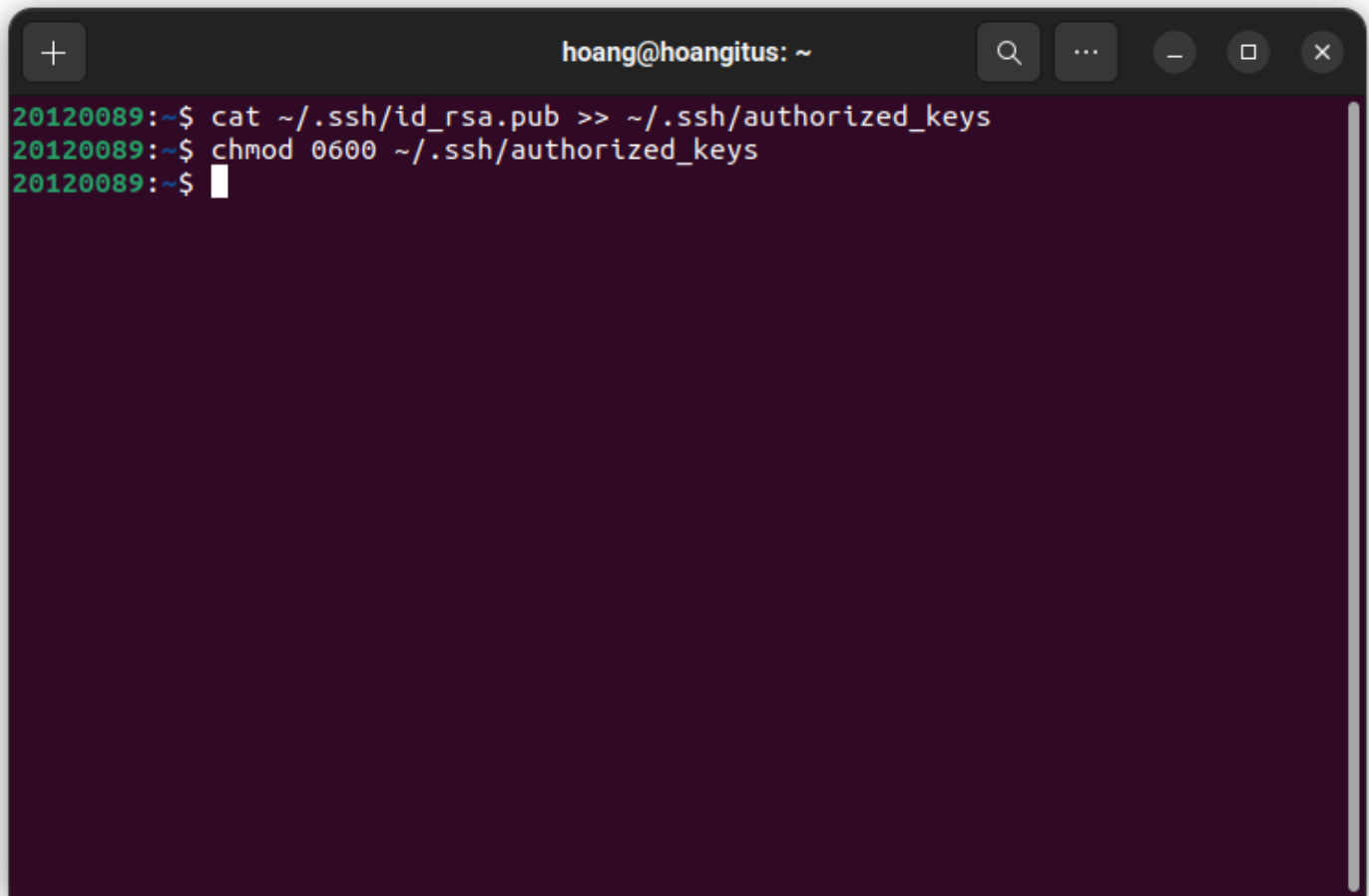
```
cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
```

```
hoang@hoangitus: ~  
20120089:~$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys  
20120089:~$
```

Grant permissions to the user:

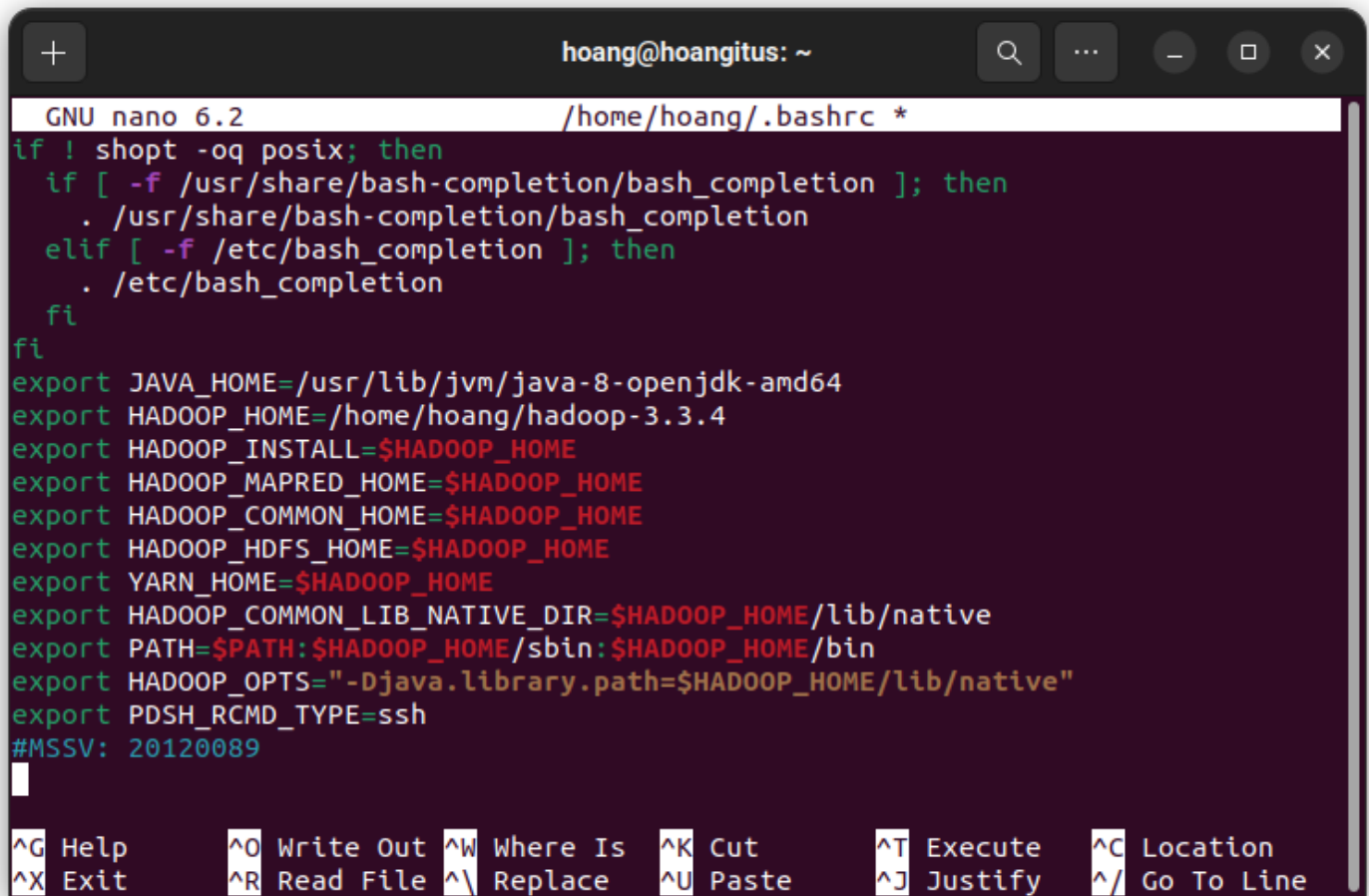
```
chmod 0600 ~/.ssh/authorized_keys
```

A terminal window with a dark background and a title bar. The title bar contains a plus icon on the left, the text 'hoang@hoangitus: ~' in the center, and search, menu, and window control icons on the right. The terminal shows three lines of commands and their prompts. The first line is '20120089:~\$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys'. The second line is '20120089:~\$ chmod 0600 ~/.ssh/authorized_keys'. The third line is '20120089:~\$' followed by a cursor. The terminal has a vertical scrollbar on the right side.

```
hoang@hoangitus: ~  
20120089:~$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys  
20120089:~$ chmod 0600 ~/.ssh/authorized_keys  
20120089:~$
```

Step 6: Edit bashrc file.

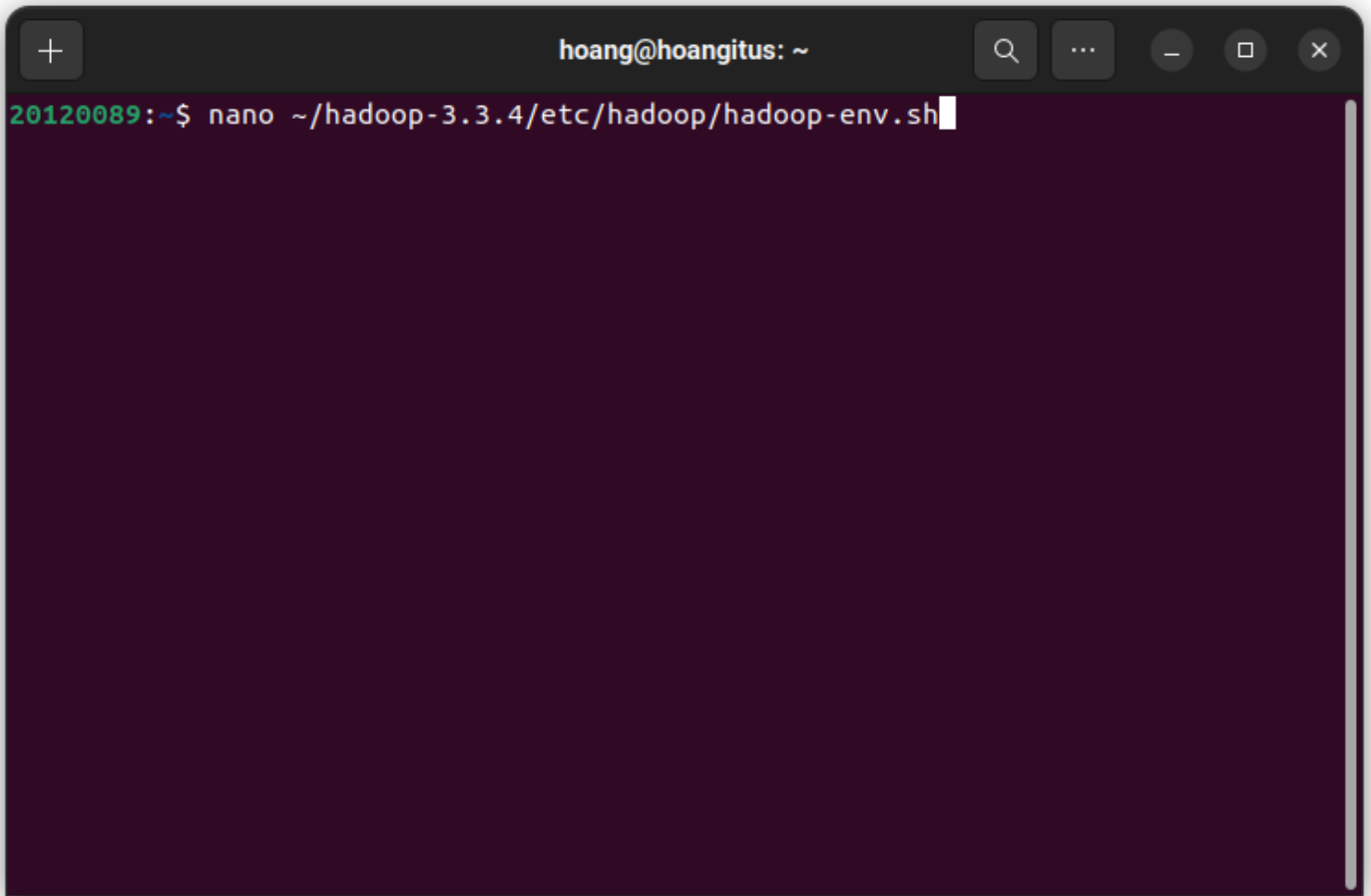
nano ~/.bashrc



```
hoang@hoangitus: ~
GNU nano 6.2 /home/hoang/.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/hoang/hadoop-3.3.4
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/native"
export PDSH_RCMD_TYPE=ssh
#MSSV: 20120089
^G Help      ^O Write Out ^W Where Is  ^K Cut       ^T Execute  ^C Location
^X Exit      ^R Read File ^\ Replace   ^U Paste     ^J Justify  ^_ Go To Line
```

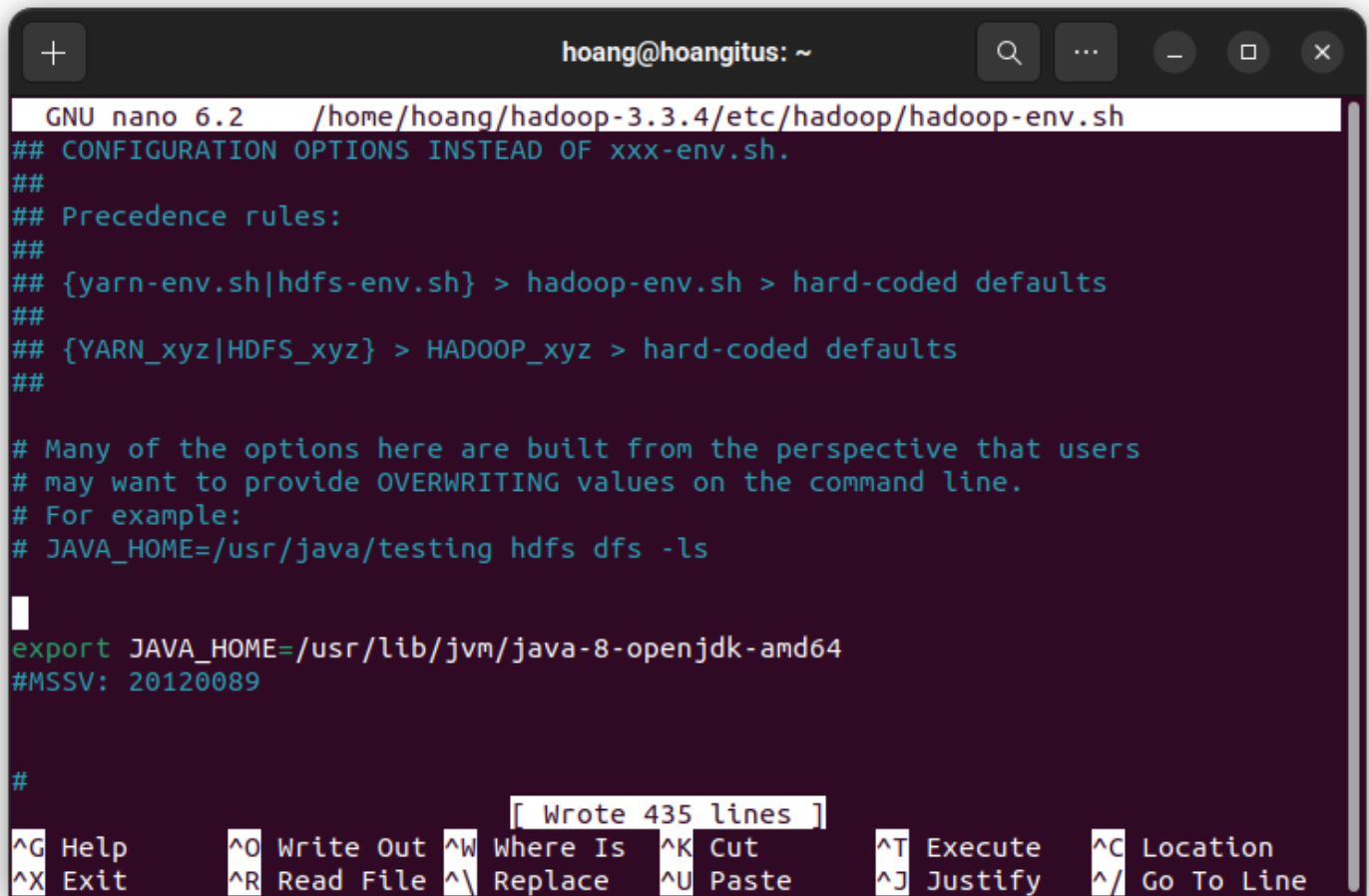
Step 7: Edit `hadoop-env.sh` file.

```
nano ~/hadoop-3.3.4/etc/hadoop/hadoop-env.sh
```



A terminal window with a dark theme. The title bar at the top shows a plus icon on the left, the text "hoang@hoangitus: ~" in the center, and search, menu, and window control icons on the right. The terminal content shows a green prompt "20120089:~\$" followed by the command "nano ~/hadoop-3.3.4/etc/hadoop/hadoop-env.sh". The command opens the nano text editor, which displays a dark purple background with a white cursor at the end of the command line. A vertical scrollbar is visible on the right side of the terminal window.

```
hoang@hoangitus: ~  
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/hadoop-env.sh
```

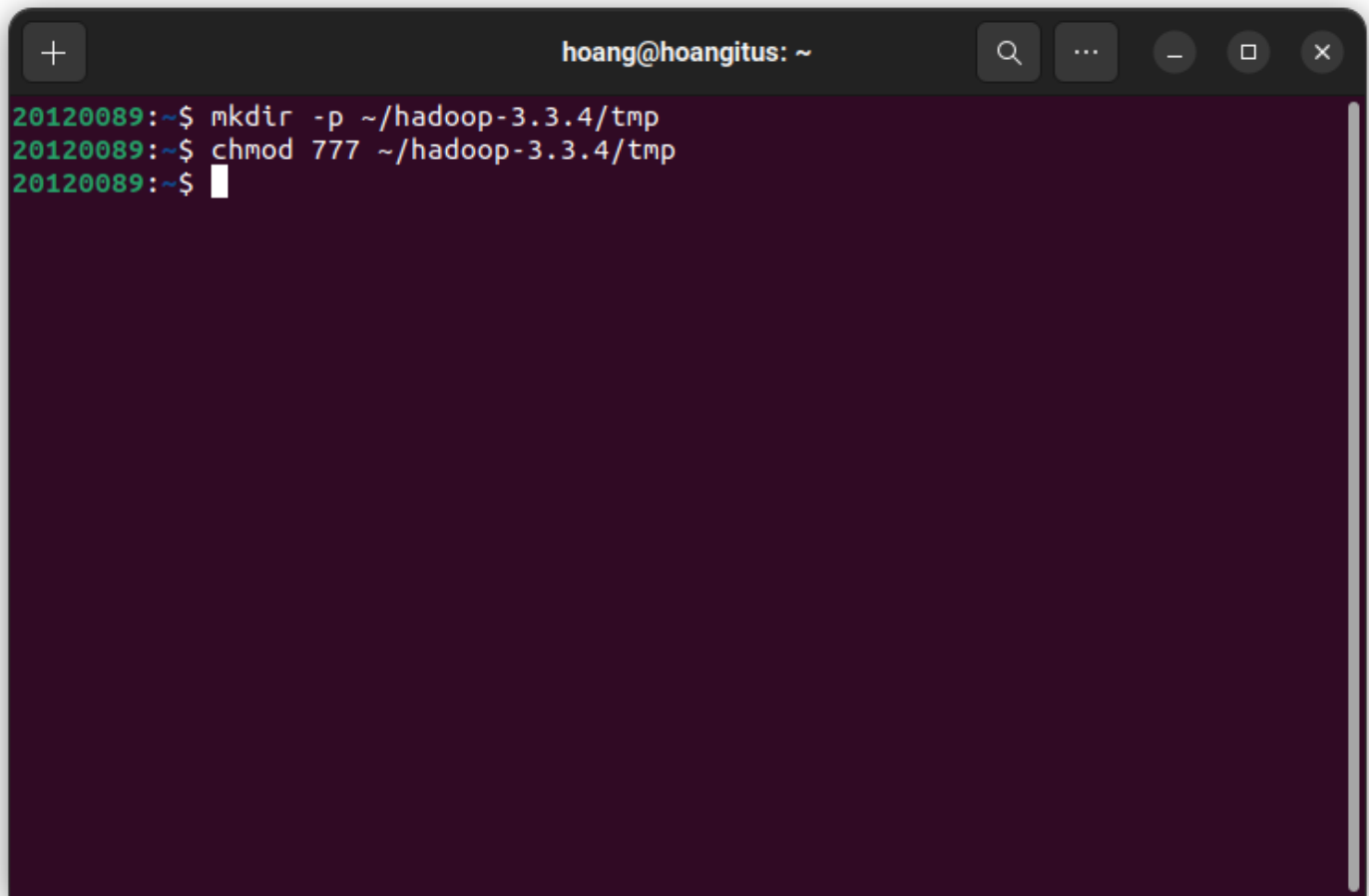


```
hoang@hoangitus: ~
GNU nano 6.2 /home/hoang/hadoop-3.3.4/etc/hadoop/hadoop-env.sh
## CONFIGURATION OPTIONS INSTEAD OF xxx-env.sh.
##
## Precedence rules:
##
## {yarn-env.sh|hdfs-env.sh} > hadoop-env.sh > hard-coded defaults
##
## {YARN_xyz|HDFS_xyz} > HADOOP_xyz > hard-coded defaults
##
# Many of the options here are built from the perspective that users
# may want to provide OVERWRITING values on the command line.
# For example:
# JAVA_HOME=/usr/java/testing hdfs dfs -ls
#
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
#MSSV: 20120089
#
[Wrote 435 lines]
^G Help      ^O Write Out ^W Where Is  ^K Cut      ^T Execute  ^C Location
^X Exit      ^R Read File ^\ Replace   ^U Paste     ^J Justify  ^_ Go To Line
```

Step 8: Edit core-site.xml

Create a tmp transit folder and grant all users access to it.

```
mkdir -p ~/hadoop-3.3.4/tmp
chmod 777 ~/hadoop-3.3.4/tmp
```



A terminal window titled 'hoang@hoangitus: ~' with standard window controls. It shows three lines of commands being executed in a shell:

```
20120089:~$ mkdir -p ~/hadoop-3.3.4/tmp
20120089:~$ chmod 777 ~/hadoop-3.3.4/tmp
20120089:~$
```

Edit core-site.xml:

```
nano ~/hadoop-3.3.4/etc/hadoop/core-site.xml
```



hoang@hoangitus: ~



```
20120089:~$ mkdir -p ~/hadoop-3.3.4/tmp
20120089:~$ chmod 777 ~/hadoop-3.3.4/tmp
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/core-site.xml
```

```
hoang@hoangitus: ~  
GNU nano 6.2 /home/hoang/hadoop-3.3.4/etc/hadoop/core-site.xml *  
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.  
-->  
  
<!-- Put site-specific property overrides in this file. -->  
<!--MSSV: 20120089 -->  
<configuration>  
<property>  
<name>hadoop.tmp.dir</name>  
<value>/home/hoang/hadoop-3.3.4/tmp</value>  
</property>  
<property>  
<name>fs.default.name</name> >  
<value>hdfs://localhost:9000</value>  
</property>  
</configuration>  
|  
  
^G Help      ^O Write Out ^W Where Is  ^K Cut       ^T Execute   ^C Location  
^X Exit      ^R Read File ^\ Replace   ^U Paste     ^J Justify   ^_ Go To Line
```

Step 9: Edit mapred-site.xml

```
nano ~/hadoop-3.3.4/etc/hadoop/mapred-site.xml
```



```
hoang@hoangitus: ~  
GNU nano 6.2 /home/hoang/hadoop-3.3.4/etc/hadoop/mapred-site.xml *  
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.  
-->  
  
<!-- Put site-specific property overrides in this file. -->  
<!-- MSSV: 20120089-->  
<configuration>  
<property>  
  <name>mapreduce.framework.name</name>  
  <value>yarn</value>  
</property>  
</configuration>  
|  
  
^G Help      ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location  
^X Exit      ^R Read File  ^\ Replace    ^U Paste      ^J Justify    ^_ Go To Line
```

Step 10: Edit hdfs-site.xml

Create two folder namenode and datanode

```
mkdir -p /home/hoang/hadoop-3.3.4/data/namenode  
mkdir -p /home/hoang/hadoop-3.3.4/data/datanode
```

```
hoang@hoangitus: ~  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/namenode  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/datanode  
20120089:~$
```

Edit hdfs-site.xml

```
nano ~/hadoop-3.3.4/etc/hadoop/hdfs-site.xml
```

```
hoang@hoangitus: ~  
GNU nano 6.2 /home/hoang/hadoop-3.3.4/etc/hadoop/hdfs-site.xml *  
limitations under the License. See accompanying LICENSE file.  
-->  
  
<!-- Put site-specific property overrides in this file. -->  
<!-- MSSV : 20120089 -->  
<configuration>  
<property>  
<name>dfs.replication</name>  
<value>1</value>  
</property>  
<property>  
<name>dfs.namenode.name.dir</name>  
<value>/home/hoang/hadoop-3.3.4/data/namenode</value>  
</property>  
<property>  
<name>dfs.datanode.data.dir</name>  
<value>/home/hoang/hadoop-3.3.4/data/datanode</value>  
</property>  
</configuration>  
  
^G Help      ^O Write Out ^W Where Is  ^K Cut       ^T Execute  ^C Location  
^X Exit      ^R Read File ^\ Replace  ^U Paste     ^J Justify  ^_ Go To Line
```

Step 11: Edit yarn-site.xml

nano ~/hadoop-3.3.4/etc/hadoop/hdfs-site.xml

```
hoang@hoangitus: ~  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/namenode  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/datanode  
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/hdfs-site.xml  
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/yarn-site.xml
```

```
GNU nano 6.2 /home/hoang/hadoop-3.3.4/etc/hadoop/yarn-site.xml  
limitations under the License. See accompanying LICENSE file.  
-->  
<configuration>  
  
<!-- Site specific YARN configuration properties -->  
<!-- MSSV: 20120089 -->  
<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>  
  
^G Help      ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location   M-U Undo      M-A Set Mark  M-] To Bracket  
^X Exit      ^R Read File  ^_ Replace    ^U Paste      ^J Justify    ^_ Go To Line M-E Redo      M-6 Copy      ^Q Where Was
```

Step 12: New Hadoop system file format

hdfs namenode -format

```
hoang@hoangitgus: ~  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/namenode  
20120089:~$ mkdir -p /home/hoang/hadoop-3.3.4/data/datanode  
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/hdfs-site.xml  
20120089:~$ nano ~/hadoop-3.3.4/etc/hadoop/yarn-site.xml  
20120089:~$ hdfs namenode -format  
2023-03-19 09:43:44,872 INFO namenode.NameNode: STARTUP_MSG:  
/*****  
STARTUP_MSG: Starting NameNode  
STARTUP_MSG: host = hoangitgus/127.0.1.1  
STARTUP_MSG: args = [-format]  
STARTUP_MSG: version = 3.3.4  
STARTUP_MSG: classpath = /home/hoang/hadoop-3.3.4/etc/hadoop:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/kerb-identity-1.0.1.jar:/home/hoang/hado  
op-3.3.4/share/hadoop/common/lib/jakarta.activation-api-1.2.1.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/nimbus-jose-jwt-9.8.1.jar:/home/hoang  
/hadoop-3.3.4/share/hadoop/common/lib/commons-compress-1.21.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/netty-3.10.6.Final.jar:/home/hoang/hado  
op-3.3.4/share/hadoop/common/lib/checker-qual-2.5.2.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/zookeeper-3.5.6.jar:/home/hoang/hadoop-3.3.4/sh  
are/hadoop/common/lib/slf4j-api-1.7.36.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jetty-security-9.4.43.v20210629.jar:/home/hoang/hadoop-3.3.4  
/share/hadoop/common/lib/httpcore-4.4.13.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/kerby-config-1.0.1.jar:/home/hoang/hadoop-3.3.4/share/hado  
op/common/lib/listenablefuture-9999.0-empty-to-avoid-conflict-with-guava.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jackson-mapper-asl-1.9.13.  
jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/kerb-admin-1.0.1.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jsch-0.1.55.jar:/home/hoang/h  
adoop-3.3.4/share/hadoop/common/lib/commons-text-1.4.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/zookeeper-jute-3.5.6.jar:/home/hoang/hadoop-3.  
3.4/share/hadoop/common/lib/kerb-server-1.0.1.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/hadoop-shaded-guava-1.1.1.jar:/home/hoang/hadoop-3.3.  
4/share/hadoop/common/lib/jul-to-slf4j-1.7.36.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/gson-2.8.9.jar:/home/hoang/hadoop-3.3.4/share/hadoop  
common/lib/jetty-servlet-9.4.43.v20210629.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jetty-webapp-9.4.43.v20210629.jar:/home/hoang/hadoop-3.3.  
4/share/hadoop/common/lib/javax.servlet-api-3.1.0.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/paranamer-2.3.jar:/home/hoang/hadoop-3.3.4/share/  
hadoop/common/lib/curator-recipes-4.2.0.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/asm-5.0.4.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/  
lib/failureaccess-1.0.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/animal-sniffer-annotations-1.17.jar:/home/hoang/hadoop-3.3.4/share/hadoop/com  
mon/lib/dnsjava-2.1.7.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/commons-codec-1.15.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jerse  
y-server-1.19.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/commons-net-3.6.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jackson-core-2.1  
2.7.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/commons-cli-1.2.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/json-smart-2.4.7.jar:/home  
/hoang/hadoop-3.3.4/share/hadoop/common/lib/kerb-common-1.0.1.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/protobuf-java-2.5.0.jar:/home/hoang/h  
adoop-3.3.4/share/hadoop/common/lib/jackson-databind-2.12.7.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jettison-1.1.jar:/home/hoang/hadoop-3.3  
.4/share/hadoop/common/lib/jsr-api-2.1.jar:/home/hoang/hadoop-3.3.4/share/hadoop/common/lib/jetty-io-9.4.43.v20210629.jar:/home/hoang/hadoop-3.3.4/share
```

Step 13: Start nodes

Run namenode,datanode, secondary namenode:

start-dfs.sh

```
hoang@hoangitgus: ~  
20120089:~$ start-dfs.sh  
Starting namenodes on [localhost]  
Starting datanodes  
Starting secondary namenodes [hoangitgus]  
20120089:~$
```

Run yarn:

start-yarn.sh

```
hoang@hoangitus: ~  
20120089:~$ start-dfs.sh  
Starting namenodes on [localhost]  
Starting datanodes  
Starting secondary namenodes [hoangitus]  
20120089:~$ start-yarn.sh  
Starting resourcemanager  
Starting nodemanagers  
20120089:~$
```

Step 14: Check result.

```
hoang@hoangitus: ~/hoang/big_data/Lab1  
20120089:~/hoang/big_data/Lab1$ jps  
5908 Jps  
3237 NameNode  
3690 SecondaryNameNode  
4059 NodeManager  
3931 ResourceManager  
3422 DataNode  
20120089:~/hoang/big_data/Lab1$ blkid | sort | grep -m1 /dev/sd | sha1sum | cut -d' ' -f1  
da39a3ee5e6b4b0d3255bfef95601890afd80709  
20120089:~/hoang/big_data/Lab1$
```



```
cdqui-20120560@MyUbuntu: ~  
cdqui-20120560@MyUbuntu: ~ 87x35  
cdqui-20120560@MyUbuntu:~$ stop-all.sh  
WARNING: Stopping all Apache Hadoop daemons as cdqui-20120560 in 10 seconds.  
WARNING: Use CTRL-C to abort.  
Stopping namenodes on [localhost]  
Stopping datanodes  
Stopping secondary namenodes [MyUbuntu]  
Stopping nodemanagers  
Stopping resourcemanager  
cdqui-20120560@MyUbuntu:~$ start-dfs.sh  
Starting namenodes on [localhost]  
Starting datanodes  
Starting secondary namenodes [MyUbuntu]  
cdqui-20120560@MyUbuntu:~$ start-yarn.sh  
Starting resourcemanager  
Starting nodemanagers  
cdqui-20120560@MyUbuntu:~$ jps  
13008 SecondaryNameNode  
13680 Jps  
13216 ResourceManager  
12690 NameNode  
13336 NodeManager  
12814 DataNode  
cdqui-20120560@MyUbuntu:~$ blkid | sort | grep -m1 /dev/sd  
/dev/sda3: UUID="e7b44525-6543-44b8-bf64-b9976a242812" BLOCK_SIZE="4096" TYPE="ext4" PARTUUID="20472396-4836-425e-80e9-117e2848a735"  
cdqui-20120560@MyUbuntu:~$ blkid | sort | grep -m1 /dev/sd ^C  
cdqui-20120560@MyUbuntu:~$ blkid | sort | grep -m1 /dev/sd | sha1sum | cut -d' ' -f1  
dc7e81f67c2224a51933db3c47aa78bdfa90b5cf  
cdqui-20120560@MyUbuntu:~$
```

20120397 - Bùi Quang Tùng:

```
t_20120397@tung:~$ start-all.sh  
WARNING: Attempting to start all Apache Hadoop daemons as t_20120397 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 [tung]  
Starting resourcemanager  
Starting nodemanagers  
t_20120397@tung:~$ jps  
4288 SecondaryNameNode  
4577 NodeManager  
4917 Jps  
4072 DataNode  
3947 NameNode  
4460 ResourceManager  
t_20120397@tung:~$ blkid | sort | grep -m1 /dev/sd | sha1sum | cut -d' ' -f1  
daea4b5d7826de0e2ac9b0a8eb93cf5a27c6cd81  
t_20120397@tung:~$
```


20120089 - Lê Xuân Hoàng:

```
hoang@hoangitus: ~/hoang/big_data/Lab1

20120089:~/hoang/big_data/Lab1$ jps
5908 Jps
3237 NameNode
3690 SecondaryNameNode
4059 NodeManager
3931 ResourceManager
3422 DataNode
20120089:~/hoang/big_data/Lab1$ blkid | sort | grep -m1 /dev/sd | sha1sum | cut -d' ' -f1
da39a3ee5e6b4b0d3255bfef95601890afd80709
20120089:~/hoang/big_data/Lab1$
```

20120130 - Đinh thị Hoàng Linh:

```
Ubuntu - VMware Workstation

File Edit View VM Tabs Help

Library
Type here to search...

My Computer
  Ubuntu

dhxnlc@ubuntu: ~
dhxnlc@ubuntu:~$ PS1="20120130"
20120130 start-all.sh
WARNING: Attempting to start all Apache Hadoop daemons as dhxnlc in 10 seconds.
WARNING: This is not a recommended production deployment configuration.
WARNING: Use CTRL-C to abort.
^C
20120130 start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [ubuntu]
OpenJDK Server VM warning: You have loaded library /home/dhxnlc/hadoop-3.3.4/lib
/native/libhadoop.so.1.0.0 which might have disabled stack guard. The VM will try
to fix the stack guard now.
It's highly recommended that you fix the library with 'execstack -c <libfile>',
or link it with '-z noexecstack'.
2023-03-21 04:48:57.040 WARN util.NativeCodeLoader: Unable to load native-hadoop
library for your platform... using builtin-java classes where applicable
20120130 start-yarn.sh
Starting resourcemanager
Starting nodemanagers
20120130 jps
3859 SecondaryNameNode
3732 NodeManager
3956 Jps
2698 NameNode
3579 ResourceManager
2843 DataNode
20120130 hadoop version
Hadoop 3.3.4
Source code repository https://github.com/apache/hadoop.git -r a585a73c3e02ac623
58c136643a5e7f6095a3dbb
Compiled by stevel on 2022-07-29T12:32Z
Compiled with protoc 3.7.1
From source with checksum fb9dd8010a7b8a5b430d61af858f6ec
This command was run using /home/dhxnlc/hadoop-3.3.4/share/hadoop/common/hadoop-
common-3.3.4.jar
20120130 blkid | sort | grep -m1 /dev/sd | sha1sum | cut -d' ' -f1
da39a3ee5e6b4b0d3255bfef95601890afd80709
20120130
```

2. Introduction to MapReduce

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

- Input keys-values: The initial data is divided into multiple input keys-values to be fed into MapReduce for processing.
- Intermediate keys-values: Generated from the input keys-values by the Map function. Its key is the result of the Map function's processing, and its value is information to be used in the Reduce function.
- Output keys-values: Generated from intermediate keys-values. The intermediate keys-values are sorted by key and partitioned across reducers. The reducers perform the Reduce function on the groups of intermediate keys-values and generate output keys-values.
- It can be said that input keys-values, intermediate keys-values, and output keys-values are interrelated as the output of one function serves as the input for the next function in the MapReduce process.

2.2 How does MapReduce deal with node failures?

- Redundant storage: MapReduce replicates data across multiple nodes in the cluster to ensure that if one node fails, the data can still be accessed and processed.
- Task tracking: MapReduce tracks completed tasks and tasks that are currently running. If a node fails while running a task, the task can be automatically restarted on another node.
- Job checkpointing: MapReduce periodically stores the intermediate output of a job on disk. If a node fails, the job can be restarted from the last checkpoint instead of starting from scratch, reducing processing time.
- Node monitoring: MapReduce continuously monitors the health of nodes in the cluster through heartbeat. If a node becomes unresponsive or fails, MapReduce can automatically remove it from the cluster and redistribute its tasks to other nodes.

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

- The meaning:
 - In MapReduce Hadoop, locality refers to processing data at or near its physical storage location. Locality is an important aspect of the Hadoop MapReduce framework, and it relates to the principle of processing data at or near its physical storage location. By prioritizing locality, Hadoop can reduce network load and improve system performance.
- Use case:

- Locality aims to reduce the amount of data that needs to be transferred over the network, reduce network load, and improve system performance. Hadoop achieves locality by attempting to schedule tasks on nodes where their input data is stored, which is known as data locality. This is made possible by Hadoop storing data in a distributed manner across a cluster of standard hardware nodes, with each node responsible for processing a portion of the data.
- When a task is scheduled on a node, the MapReduce framework attempts to read data from the local disk of that node first. Only when the data is not available locally, it is accessed from a remote node. By prioritizing data locality, Hadoop can significantly reduce the amount of data transmitted over the network, which is important for efficiently processing large data sets.

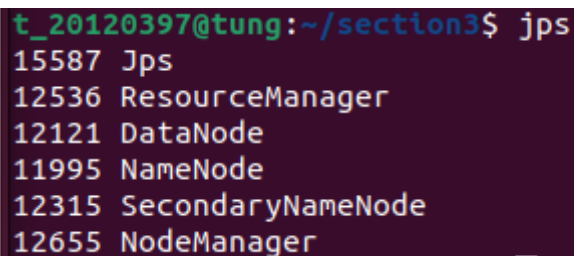
2.4. . Which problem is addressed by introducing a combiner function to the MapReduce model?

- In some cases, the Map tasks return multiple instances of the same <key,value> pair. The Combiner function summarizes these instances into a single <key,value> pair then transfers the result to the Reduce tasks, thus reducing the workload on them and speeding up the whole operation.

3. Running a warm-up problem: Word Count

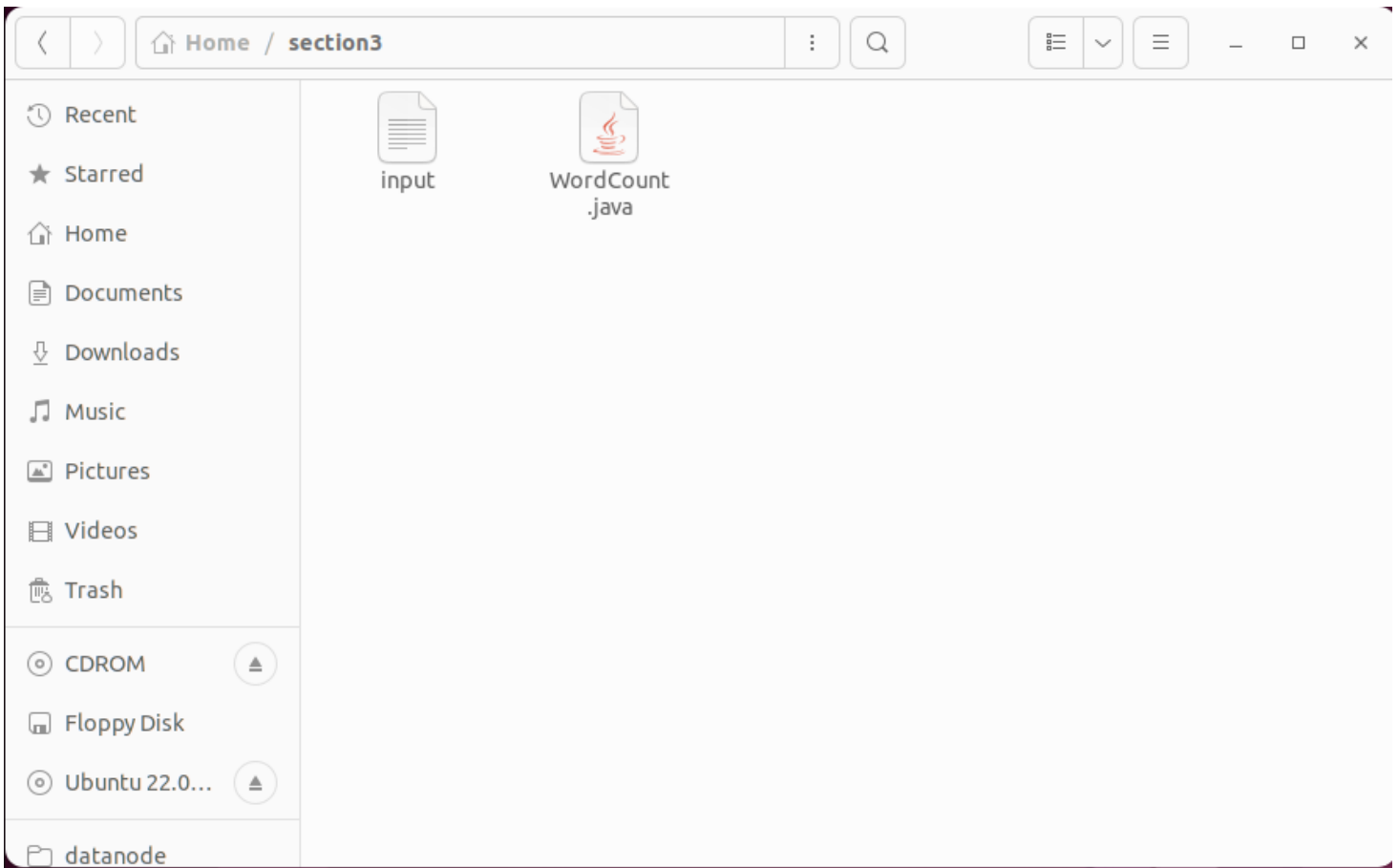
The process and result:

- run Hadoop

A terminal window with a dark purple background. The prompt is 't_20120397@tung:~/section3\$'. The command 'jps' has been executed, and the output lists several Java processes: '15587 Jps', '12536 ResourceManager', '12121 DataNode', '11995 NameNode', '12315 SecondaryNameNode', and '12655 NodeManager'.

```
t_20120397@tung:~/section3$ jps
15587 Jps
12536 ResourceManager
12121 DataNode
11995 NameNode
12315 SecondaryNameNode
12655 NodeManager
```

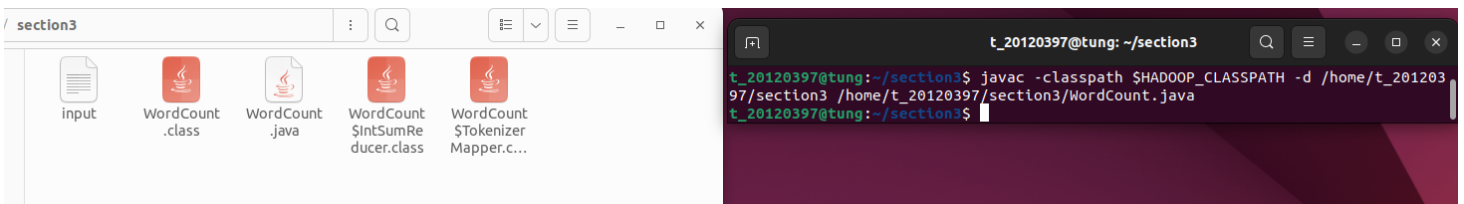
- Create folder to work



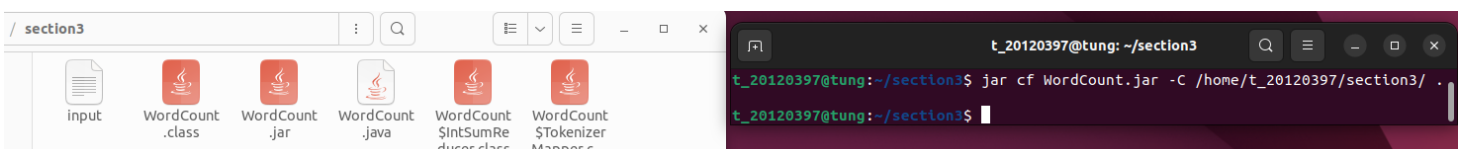
- Environment setting

```
t_20120397@tung:~/section3$ export HADOOP_CLASSPATH=${HADOOP_HOME}/share/hadoop/common/hadoop-common-3.3.4.jar:${HADOOP_HOME}/share/hadoop/mapreduce/hadoop-mapreduce-client-core-3.3.4.jar
t_20120397@tung:~/section3$ echo $HADOOP_CLASSPATH
/home/t_20120397/hadoop/share/hadoop/common/hadoop-common-3.3.4.jar:/home/t_20120397/hadoop/share/hadoop/mapreduce/hadoop-mapreduce-client-core-3.3.4.jar
```

- Add library



- Change file to jar



- Copy from local to hadoop

Browse Directory

Show entries

Search:

<input type="checkbox"/>	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name	
<input type="checkbox"/>	-rw-r--r--	t_20120397	supergroup	1.71 KB	Mar 20 11:57	1	128 MB	input.txt	

Showing 1 to 1 of 1 entries

Hadoop, 2022.

t_20120397@tung: ~/section3

copyFromLocal: '/home/t_20120397/section3/input.txt': No such file or directory
t_20120397@tung:~/section3\$ hadoop fs -copyFromLocal /home/t_20120397/section3/i
nput.txt /input_l1_s3/input.txt
t_20120397@tung:~/section3\$

- Compile and run

```
t_20120397@tung:~/section3$ hadoop jar WordCount.jar WordCount /input_l1_s3/input.txt /output_l1_s3
2023-03-20 11:59:32,277 INFO client.DefaultNoHARMAFailoverProxyProvider: Connecting to ResourceManager at /127.0.0.1:8032
2023-03-20 11:59:33,301 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with ToolRunner to remedy this.
2023-03-20 11:59:33,337 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/t_20120397/.staging/job_1679283655462_0004
2023-03-20 11:59:33,854 INFO input.FileInputFormat: Total input files to process : 1
2023-03-20 11:59:34,097 INFO mapreduce.JobSubmitter: number of splits:1
2023-03-20 11:59:34,572 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1679283655462_0004
```

- Check to see if it is successful

```
t_20120397@tung:~/section3$ hadoop fs -ls /output_l1_s3
Found 2 items
-rw-r--r--  1 t_20120397 supergroup      0 2023-03-20 12:00 /output_l1_s3/_SUCCESS
-rw-r--r--  1 t_20120397 supergroup  1516 2023-03-20 12:00 /output_l1_s3/part-r-00000
```

- Result

```
t_20120397@tung:~/section3$ hadoop fs -cat /output_l1_s3/part-r-00000
(jar/executable 1
(multi-terabyte 1
(see 2
(thousands 1
A 1
Architecture 2
Distributed 1
File 1
Guide) 1
Guide). 1
HDFS 1
Hadoop 3
MRAppMaster 1
MapReduce 4
Minimally, 1
NodeManager 1
ResourceManager 1
ResourceManager, 1
System 1
The 4
These, 1
This 1
Typically 2
YARN 1
a 5
abstract-classes. 1
across 1
aggregate 1
allows 1
already 1
amounts 1
and 11
and/or 1
application 1
applications 2
appropriate 1
are 5
assumes 1
bandwidth 1
both 1
by 1
```

4. Bonus

4.1. Extended Word Count: Unhealthy relationships

```
t_20120397@tung:~/section4$ hadoop fs -cat /s4_data/output1/part-r-00000
A pos
B eq
C neg
D eq
E eq
```

- Input:

A D

A B

B C

D B

B E

E C

- Output:

A pos

B eq

C neg

D eq

E eq

4.2. Setting up Fully Distributed Mode

References