



Exercises Preparation

Setup Hadoop, HDFS, Yarn



Install and Setup Java

1. Install OpenJDK (JDK 8):

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

2. Verify installation:

```
java -version  
openjdk version "1.8.0_222"  
OpenJDK Runtime Environment (build 1.8.0_222-8u222-b10-1ubuntu1~18.04.1-b10)  
OpenJDK 64-Bit Server VM (build 25.222-b10, mixed mode)
```

2. SET *JAVA_HOME* and *JRE_HOME*:

```
sudo vi /etc/environment
```

```
JAVA_HOME="/usr/lib/jvm/java-8-openjdk-amd64"  
JRE_HOME="/usr/lib/jvm/java-8-openjdk-amd64/jre"
```



Setup Hadoop User

1. Create User:

```
sudo adduser hadoop  
sudo passwd hadoop
```

2. Switch To User:

```
sudo su hadoop
```

3. Switch Back To Root user:

```
exit
```



Setup SSH (needed by Hadoop components)

1. Install SSH and PDSh:

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

2. Create Private/Public Keypair for hadoop user (*without passphrase*):

```
sudo su hadoop
cd
ssh-keygen -t rsa -N "" -f /home/hadoop/.ssh/id_rsa
```

3. Add Public Key To Authorized Keys file (to enable passwordless ssh login)

```
cat /home/hadoop/.ssh/id_rsa.pub >> /home/hadoop/.ssh/authorized_keys
chmod 0600 /home/hadoop/.ssh/authorized_keys
```



Setup SSH (needed by Hadoop components)

4. Check If SSH Is Working

```
hadoop@big-data:~$ ssh localhost
The authenticity of host 'localhost (127.0.0.1)' can't be established.
ECDSA key fingerprint is SHA256:YEUFLiBVczkz2rvKWNyU9hB2ix2jnhBqLbsJQfuBpE.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'localhost' (ECDSA) to the list of known hosts.
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.15.0-1044-gcp x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage
 System information as of Sat Oct 12 15:01:56 UTC 2019
 System load:  0.0          Processes:           117
 Usage of /:   5.8% of 28.90GB   Users logged in:     1
 Memory usage: 2%            IP address for ens4: 10.156.0.6
 Swap usage:  0%
30 packages can be updated.
17 updates are security updates.
Last login: Sat Oct 12 14:49:27 2019 from 80.144.211.195

hadoop@big-data:~$ exit
logout
Connection to localhost closed.

hadoop@big-data:~$
```



Install Hadoop

1. Download Hadoop (v3.1.1):

```
wget https://www-eu.apache.org/dist/hadoop/common/hadoop-3.1.2/hadoop-3.1.2.tar.gz
```

2. Extract Binaries:

```
tar -xvzf hadoop-3.1.2.tar.gz
```

3. Move Binaries:

```
mv hadoop-3.1.2 hadoop
```



Configure Hadoop

1. Set Up **UNIX** Environment Variables

```
vi .bashrc
```



```
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 YARN_HOME=$HADOOP_HOME
export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/lib/native
export PATH=$PATH:$HADOOP_HOME/sbin:$HADOOP_HOME/bin
```



```
source .bashrc
```

Configure Hadoop

2. Add **Hadoop** Environment Variables (*hadoop-env.sh*)

```
vi /home/hadoop/hadoop/etc/hadoop/hadoop-env.sh
```



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

Configure Hadoop

3. Set Up **CORE** Variables (*core-site.xml*)

```
vi /home/hadoop/hadoop/etc/hadoop/core-site.xml
```



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

Configure Hadoop

4. Set Up **HDFS** Variables (*hdfs-site.xml*)

```
vi /home/hadoop/hadoop/etc/hadoop/hdfs-site.xml
```



```
<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>
```



Configure Hadoop

5. Set Up **MapReduce** Variables (*mapred-site.xml*)

```
vi /home/hadoop/hadoop/etc/hadoop/mapred-site.xml
```

```
<configuration>
  <property>
    <name>mapreduce.framework.name</name>
    <value>yarn</value>
  </property>
  <property>
    <name>yarn.app.mapreduce.am.env</name>
    <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
  </property>
  <property>
    <name>mapreduce.map.env</name>
    <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
  </property>
  <property>
    <name>mapreduce.reduce.env</name>
    <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
  </property>
</configuration>
```



Configure Hadoop

6. Set Up **YARN** Variables (*yarn-site.xml*)

```
vi /home/hadoop/hadoop/etc/hadoop/yarn-site.xml
```



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

Configure Hadoop

7. Clear HDFS

```
hdfs namenode -format
```

8. Start HDFS:

```
start-dfs.sh
```

9. Start YARN:

```
start-yarn.sh
```



Check Hadoop/HDFS

10. Run Admin Status Report

```
hdfs dfsadmin -report
```



```
Configured Capacity: 31035637760 (28.90 GB)
Present Capacity: 28187471872 (26.25 GB)
DFS Remaining: 2818747296 (26.25 GB)
DFS Used: 24576 (24 KB)
DFS Used%: 0.00%
Replicated Blocks:
Under replicated blocks: 0
blocks with corrupt replicas: 0
Missing blocks: 0
Missing blocks (with replication factor 1): 0
Low redundancy blocks with highest priority to recover: 0
Pending deletion blocks: 0
Erasure Coded Block Groups:
Low redundancy block groups: 0
block groups with corrupt internal blocks: 0
Missing block groups: 0
Low redundancy blocks with highest priority to recover: 0
Pending deletion blocks: 0

-----
Live datanodes (1):
Name: 127.0.0.1:9866 (localhost)
Hostname: big-data.c.dhw-253679.internal
Decommission Status : Normal
Configured Capacity: 31035637760 (28.90 GB)
DFS Used: 24576 (24 KB)
Non DFS Used: 2831388672 (2.64 GB)
DFS Remaining: 2818747296 (26.25 GB)
DFS Used%: 0.00%
DFS Remaining%: 90.82%
Configured Cache Capacity: 0 (0 B)
Cache Used: 0 (0 B)
Cache Remaining: 0 (0 B)
Cache Used%: 100.00%
Cache Remaining%: 0.00%
Xreceivers: 1
Last contact: Sat Oct 12 15:19:44 UTC 2019
Last Block Report: Sat Oct 12 15:18:29 UTC 2019
Num of Blocks: 0
```



Check Hadoop/HDFS

11. Check Ressource Manager Landing Page (<http://XXX.XXX.XXX.XXX:8088/cluster>):

The screenshot shows the Hadoop Resource Manager landing page at <http://35.235.31.203:8088/cluster>. The page title is "Nodes of the cluster". On the left, there is a sidebar with navigation links for Cluster (About, Nodes, Node Labels, Applications), Scheduler (Scheduler, Tools), and Tools. The main content area displays "Cluster Metrics" and "Cluster Nodes Metrics" tables. Below these are "Scheduler Metrics" and a detailed "Nodes" table. The "Nodes" table lists one node: /default-rack (Node Address: big-data.c.dhbw-254309.internal:40247, Node HTTP Address: big-data.c.dhbw-254309.internal:8042). The page also includes a search bar and navigation links for First, Previous, Next, and Last.

Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	VCores Used	VCores Total	VCores Reserved
0	0	0	0	0	0 B	8 GB	0 B	0	8	0

Active Nodes	Decommissioning Nodes	Decommissioned Nodes	Lost Nodes	Unhealthy Nodes	Rebooted Nodes	Shutdown Nodes
1	0	0	0	0	0	0

Scheduler Type	Scheduling Resource Type	Minimum Allocation	Maximum Allocation	Maximum Cluster Application Priority
Capacity Scheduler	[memory-mb (unit=Mi), vcores]	<memory:1024, vCores:1>	<memory:8192, vCores:4>	0

Node Labels	Rack	Node State	Node Address	Node HTTP Address	Last health-update	Health-report	Containers	Allocation Tags	Mem Used	Mem Avail	VCores Used	VCores Avail	Version
/default-rack	RUNNING	big-data.c.dhbw-254309.internal:40247	big-data.c.dhbw-254309.internal:8042	Sat Oct 12 15:23:36 +0000 2019	0		0 B	8 GB	0	8	3.1.2		



Check Hadoop/HDFS

12. Check NameNode Landing and Status Page (<http://XXX.XXX.XXX.XXX:9870>):

The screenshot shows the Hadoop Overview page for the cluster 'localhost:9000' (active). It includes sections for Overview, Summary, and a detailed table of system metrics.

Overview (localhost:9000) (active)

Started:	Sat Oct 12 17:18:25 +0200 2019
Version:	3.1.2, r1019dd65bdf12a05ef48ac71e84550d58fe0d0a
Compiled:	Tue Jan 29 02:39:00 +0100 2019 by sunlig from branch-3.1.2
Cluster ID:	CID-dcd822c-0edf-4dd3-ab0-715b27d6d4c1
Block Pool ID:	BP-540696523-10.156.0.6-157089314429

Summary

Security is off.
Safemode is off.
0 files and directories, 0 blocks (0 replicated blocks, 0 erasure coded block groups) = 1 total filesystem object(s).
Heap Memory used 97.07 MB of 529 MB Heap Memory. Max Heap Memory is 3.26 GB.
Non Heap Memory used 54.47 MB of 55.77 MB Committed Non Heap Memory. Max Non Heap Memory is <unbounded>.

Configured Capacity:	28.9 GB
Configured Remote Capacity:	0 B
DFS Used:	24 KB (0%)
Non DFS Used:	2.64 GB
DFS Remaining:	26.25 GB (90.82%)
Block Pool Used:	24 KB (0%)
DataNodes usages% (Min/Median/Max/StDev):	0.00% / 0.00% / 0.00% / 0.00%
Live Nodes	1 (Decommissioned: 0, In Maintenance: 0)

The screenshot shows the Datanode Information page. It features a histogram of disk usage and a table of active datanodes.

Datanode Information

Datanode usage histogram

In operation

Node	Http Address	Last contact	Last Block Report	Capacity	Blocks	Block pool used	Version
log-data.c.chrw-254309 internal:9896 (127.0.0.1:9896)	http://log-data.c.chrw-254309.internal.9896	2s	8m	28.9 GB	0	24 KB (0%)	3.1.2

Showing 1 to 1 of 1 entries

Entering Maintenance



Check Hadoop/HDFS

13. Check HDFS File Browser (<http://XXX.XXX.XXX.XXX:9870/explorer.html#/>)

The screenshot shows a web-based HDFS file browser interface. At the top, there is a toolbar with various icons for file operations like copy, move, delete, etc. Below the toolbar is a navigation bar with links: Hadoop, Overview, Datanodes, Datanode Volume Failures, Snapshot, Startup Progress, and Utilities. The main content area is titled "Browse Directory" and shows a table of file entries. The table has columns: Permission, Owner, Group, Size, Last Modified, Replication, Block Size, and Name. There is one entry listed: "drwxr-xr-x hadoop supergroup 0 B Oct 12 17:29 user". At the bottom of the table, it says "Showing 1 to 1 of 1 entries". The footer of the page says "Hadoop, 2018."

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
drwxr-xr-x	hadoop	supergroup	0 B	Oct 12 17:29	0	0 B	user



Working with HDFS

1. Create User Directory (*on HDFS*):

```
hadoop fs -mkdir /user  
hadoop fs -mkdir /user/hadoop
```

2. List Directories (*on HDFS*):

```
hadoop@big-data:~$ hadoop fs -ls /  
Found 1 items  
drwxr-xr-x    - hadoop supergroup          0 2019-10-12 15:29 /user  
hadoop@big-data:~$
```



Working with HDFS

3. Copy File (just a *random log file*) from local directory to HDFS:

```
hadoop fs -put /var/log/dpkg.log /user/hadoop/dpkg.log
```



Run Example MapReduce Job

1. Using MapReduce WordCount Jar provided by Hadoop to count words within file *dpkg.log*

```
hadoop jar hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.1.2.jar  
wordcount /user/hadoop/dpkg.log /user/hadoop/test_output
```

2. View Running MapReduce Job:

The screenshot shows the Hadoop Cluster Management UI at 35.235.41.203:8088/cluster. The main page is titled "All Applications".

Cluster Metrics:

	Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	Vcores Used	Vcores Total	Vcores Reserved
1	0	1	0	0	1	2 GB	8 GB	0 B	1	8	0

Scheduler Metrics:

Scheduler Type	Scheduling Resource Type	Minimum Allocation	Maximum Allocation	Maximum Cluster Application Priority
Capacity Scheduler	[memory-mb (unit=M), vcores]	<memory:1024, vCores:1>	<memory:8192, vCores:4>	0

Table of Applications:

ID	User	Name	Application Type	Queue	Application Priority	StartTime	FinishTime	State	FinalStatus	Running Containers	Allocated CPU Vcores	Allocated Memory MB	Reserved CPU Vcores	Reserved Memory MB	% of Queue	% of Cluster	Progress	Tracking UI	Blacklisted Nodes
application_1570893575375_0001	hadoop	word count	MAPREDUCE	default	0	Sat Oct 12 17:47:40 +0200 2019	N/A	RUNNING	UNDEFINED	1	1	2048	0	0	25.0	25.0	0	ApplicationMaster	0

Showing 1 to 1 of 1 entries



Run Example MapReduce Job

3. Take A Look At The Output/Result (*via Bash*):

```
hadoop@big-data:~$ hadoop fs -cat /user/hadoop/test_output/part-r-00000
...
libglx0:amd64 8
libgraphite2-3:amd64 8
libgtk2.0-0:amd64 8
libgtk2.0-bin:amd64 8
libgtk2.0-common:all 9
libharfbuzz0b:amd64 8
libice-dev:amd64 8
libice6:amd64 8
libjbig0:amd64 8
libjpeg-turbo8:amd64 8
libjpeg8:amd64 8
libnss3:amd64 8
libogg0:amd64 8
libpango-1.0-0:amd64 8
libpangocairo-1.0-0:amd64 8
...
```



Run Example MapReduce Job

4. Take A Look At The Output/Result (*via Web HDFS File Browser*):

Browse Directory

/user/hadoop/test_output

Show 25 entries

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
-rw-r--r--	hadoop	supergroup	0 B	Oct 12 17:47	1	128 MB	_SUCCESS
-rw-r--r--	hadoop	supergroup	6.26 KB	Oct 12 17:47	1	128 MB	part-r-00000

Showing 1 to 2 of 2 entries

part-r-00000

OPEN FILES
part-r-00000

206 libdatriel:amd64 8
207 libdrm-amdgpu:amd64 8
208 libdrm-intel:amd64 8
209 libdrm-nouveau2:amd64 8
210 libdrm-radeon1:amd64 8
211 libefiboot:amd64 8
212 libefivar:amd64 8
213 libflac8:amd64 8
214 libfontconfig:amd64 8
215 libfontenc:amd64 8
216 libgail-common:amd64 8
217 libgail18:amd64 8





Exercises I

Hadoop, HDFS, Yarn



Exercises

1. Clone git repo (to get sample data):

```
git clone https://github.com/marcelmittelstaedt/BigData.git
```

2.

- **Copy sample file** (*/BigData/exercises/winter_semester_2019-2020/01_hadoop/sample_data/Faust_1.txt*) from Git Repo **to HDFS**.
- Use and **run** default **MapReduce Jar** (*hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.1.2.jar*) **to calculate wordcount** for text file.
- **Copy result** of MapReduce job **back to local ubuntu filesystem**.

3.

- Use and **run** default **MapReduce Jar** (*hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.1.2.jar*) to **get the count of occurrences** of the exact string ,**Faust**‘ within text file.
- **Copy result** of MapReduce job **back to local ubuntu filesystem**.
- **Tip:** don't use *wordcount* part of jar but another MapReduce program on next slide.



MapReduce Examples within *hadoop-mapreduce-examples-3.1.1.jar*:

aggregatewordcount:	An Aggregate based mapreduce program that counts the words in the input files.
aggregatewordhist:	An Aggregate based mapreduce program that computes the histogram of the words in the input files.
bbp:	A mapreduce program that uses Bailey-Borwein-Plouffe to compute exact digits of Pi.
dbcount:	An example job that counts the pageview logs stored in a database.
distbbp:	A mapreduce program that uses a BBP-type formula to compute exact bits of Pi.
grep:	A mapreduce program that counts the matches of a regex in the input.
join:	A job that performs a join over sorted, equally partitioned datasets.
multifilewc:	A job that counts words from several files.
pentomino:	A mapreduce tile laying program to find solutions to pentomino problems.
pi:	A mapreduce program that estimates Pi using a quasi-Monte Carlo method.
randomtextwriter:	A mapreduce program that writes 10 GB of random textual data per node.
randomwriter:	A mapreduce program that writes 10 GB of random data per node.
secondarysort:	An example defining a secondary sort to the reduce phase.
sort:	A mapreduce program that sorts the data written by the random writer.
sudoku:	A sudoku solver.
teragen:	Generate data for the terasort.
terasort:	Run the terasort.
teravalidate:	Checking results of terasort.
wordcount:	A mapreduce program that counts the words in the input files.
wordmean:	A mapreduce program that counts the average length of the words in the input files.
wordmedian:	A mapreduce program that counts the median length of the words in the input files.
wordstandarddeviation:	A mapreduce program that counts the standard deviation of the length of the words in the input files.

