Exercises Preparation

Setup Hadoop, HDFS and Yarn manually (standalone)

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_275"
OpenJDK Runtime Environment (build 1.8.0_275-8u275-b01-0ubuntu1~20.04-b01)
OpenJDK 64-Bit Server VM (build 25.275-b01, 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 --disabled-password  --gecos "" 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*):

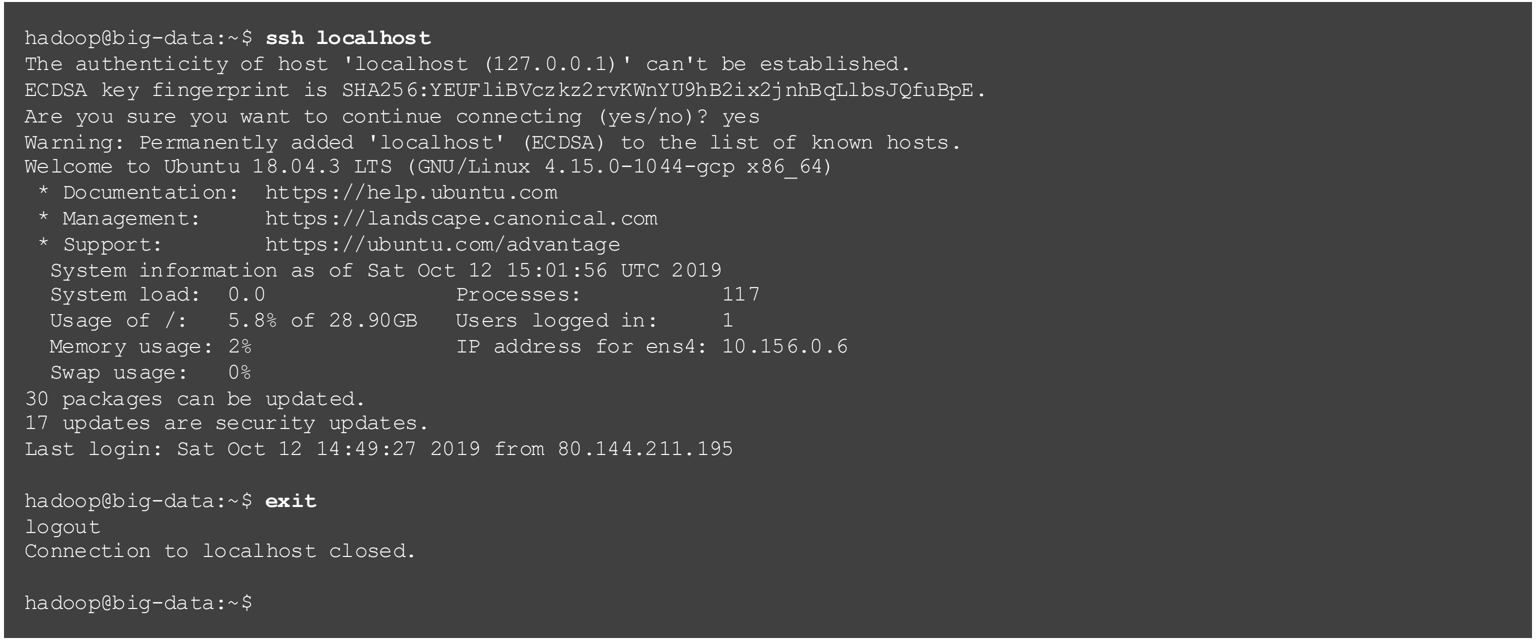
```
sudo su hadoop
cd
ssh-keygen -t rsa -N "" -f /home/hadoop/.ssh/id_rsa
```

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:YEUFliBVczkz2rvKWnYU9hB2ix2jnhBqLlbsJQfuBpE.
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://archive.apache.org/dist/hadoop/common/hadoop-3.1.2/hadoop-3.1.2.tar.gz
```

2. Extract Binaries:

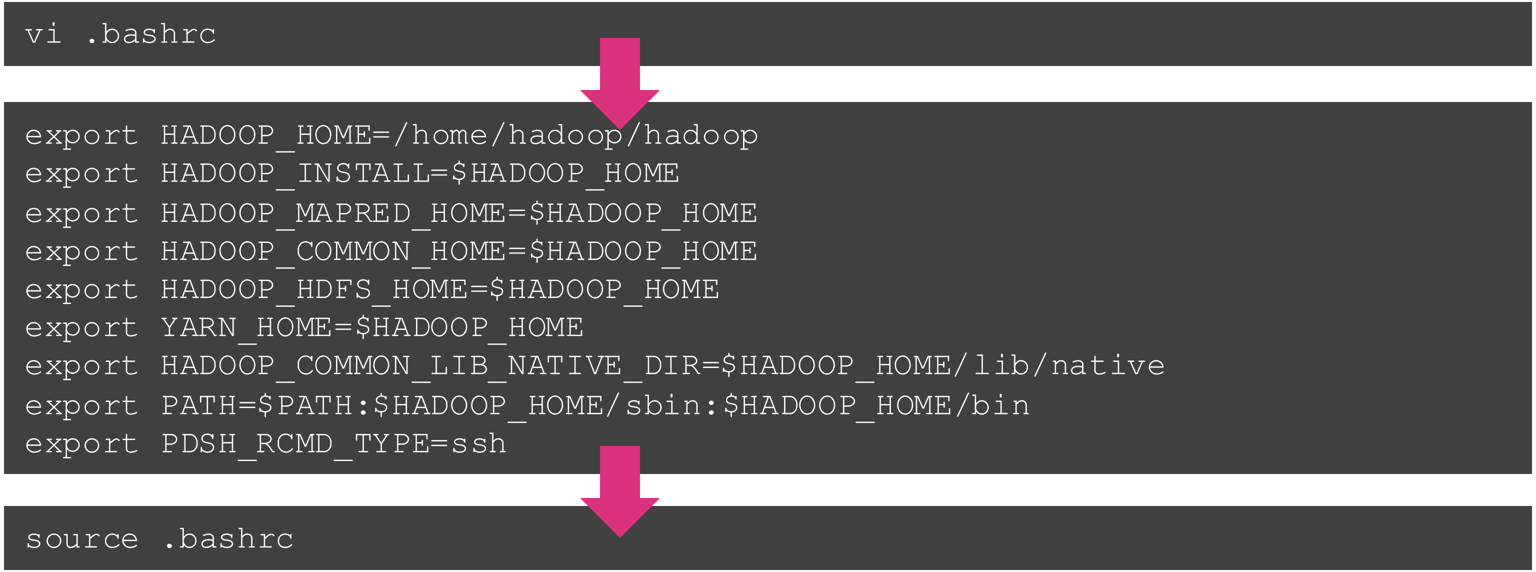
```
tar -xvzf hadoop-3.1.2.tar.gz
```

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
export PDSH_RCMD_TYPE=ssh
```

```
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>

        <property>
                <name>yarn.nodemanager.resource.memory-mb</name>
                <value>16384</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

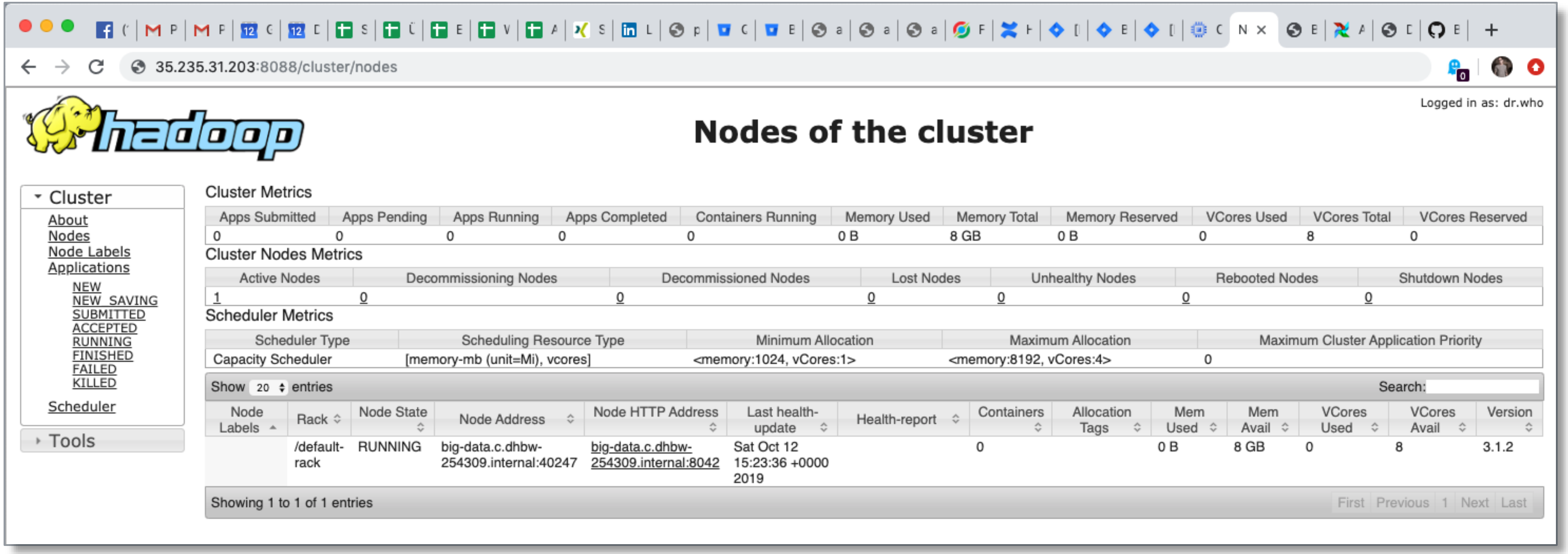
```
hdfs dfsadmin -report
```

```
Configured Capacity: 31035637760 (28.90 GB)
Present Capacity: 28187471872 (26.25 GB)
DFS Remaining: 28187447296 (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.dhbw-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: 28187447296 (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%
Xceivers: 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):



Logged in as: dr.who

Nodes of the cluster

- Cluster
  - About
  - Nodes
  - Node Labels
  - Applications
    - NEW
    - NEW_SAVING
    - SUBMITTED
    - ACCEPTED
    - RUNNING
    - FINISHED
    - FAILED
    - KILLED
  - Scheduler
- Tools

Cluster Metrics

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

Cluster Nodes Metrics

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

Scheduler Metrics

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

Show 20 entries Search:

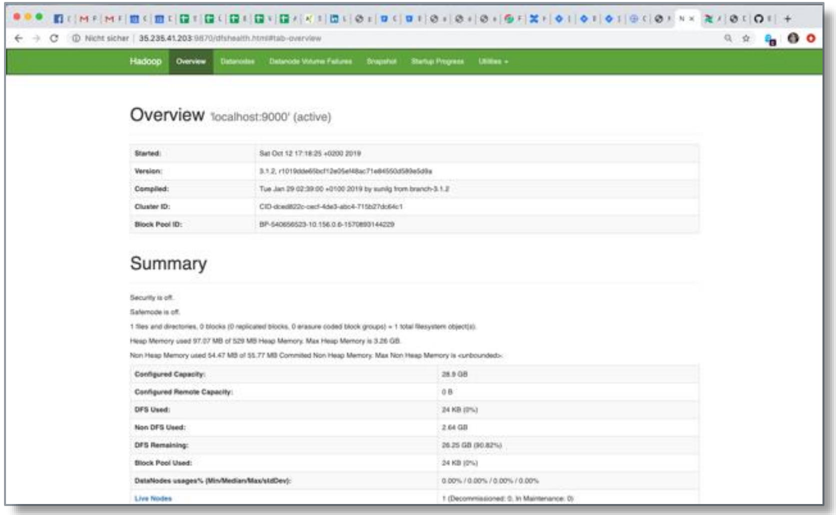
Node Labels	Rack	Node State	Node Address	Node HTTP Address	Last health-update	Health-report	Containers	Allocation Tags	Mem Used	Mem Avail	VCores Used	VCores Avail	Version
	/default-rack	RUNNING	big-data.c.dhbw-254309.internal:40247	big-data.c.dhbw-254309.internal:8042	Sat Oct 12 15:23:36 +0000 2019	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

Showing 1 to 1 of 1 entries

First Previous 1 Next Last

Check Hadoop/HDFS

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



Overview 'localhost:9000' (active)

Started:	Sat Oct 12 17:18:25 +0200 2019
Version:	3.1.2, r1019dde65bcf12e05ef48ac71e84550d589e5d9a
Compiled:	Tue Jan 29 02:39:00 +0100 2019 by sunilg from branch-3.1.2
Cluster ID:	CID-dced822c-cecf-4de3-abc4-715b27dc64c1
Block Pool ID:	BP-540656523-10.156.0.6-1570893144229

Summary

Security is off.

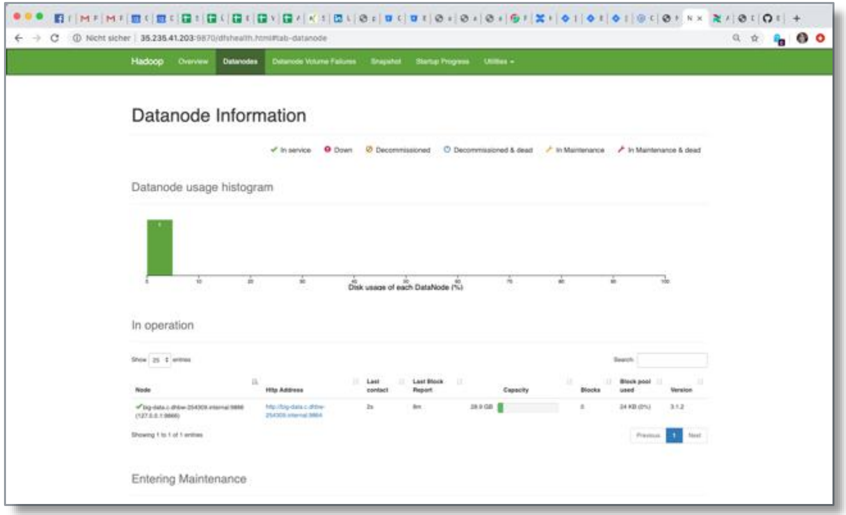
Safemode is off.

1 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 Commited 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/stdDev):	0.00% / 0.00% / 0.00% / 0.00%
Live Nodes	1 (Decommissioned: 0, In Maintenance: 0)



Datanode Information

Datanode usage histogram

In operation

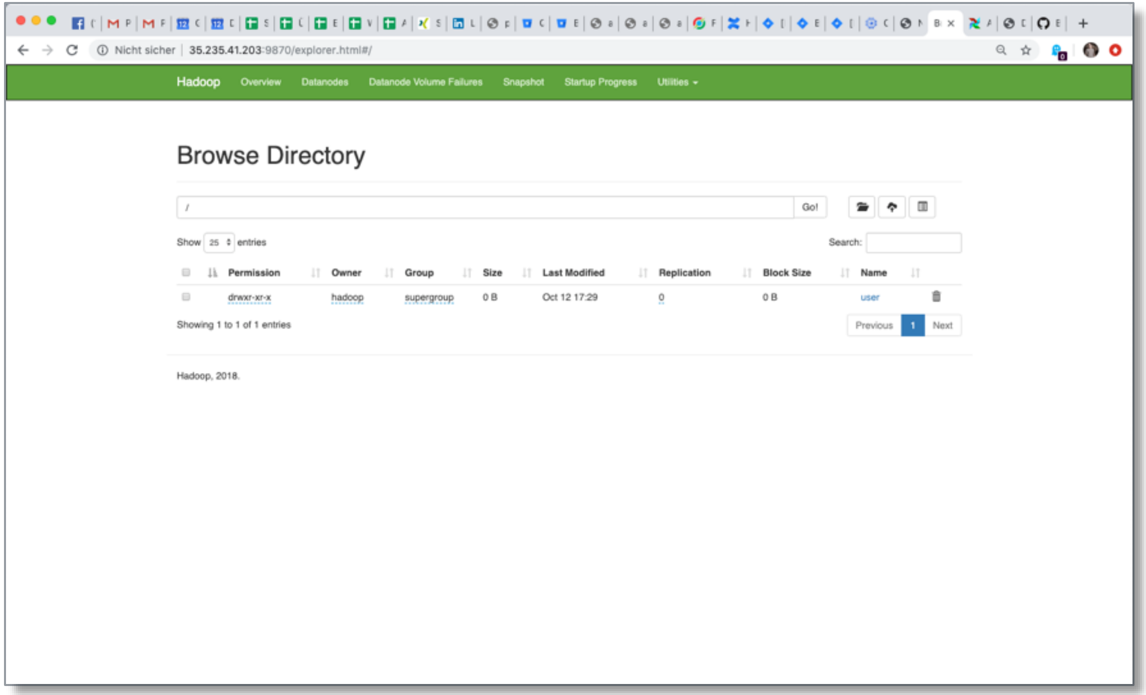
Node	Http Address	Last contact	Last Block Report	Capacity	Blocks	Block pool used	Version
✓ big-data.c.dhbw-254309.internal:9866 (127.0.0.1:9866)	http://big-data.c.dhbw-254309.internal:9864	2s	8m	28.9 GB	0	24 KB (0%)	3.1.2

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#/)



Browse Directory

/

Show 25 entries　　Search:

□	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

Showing 1 to 1 of 1 entries　　Previous 1 Next

Hadoop, 2018.

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:

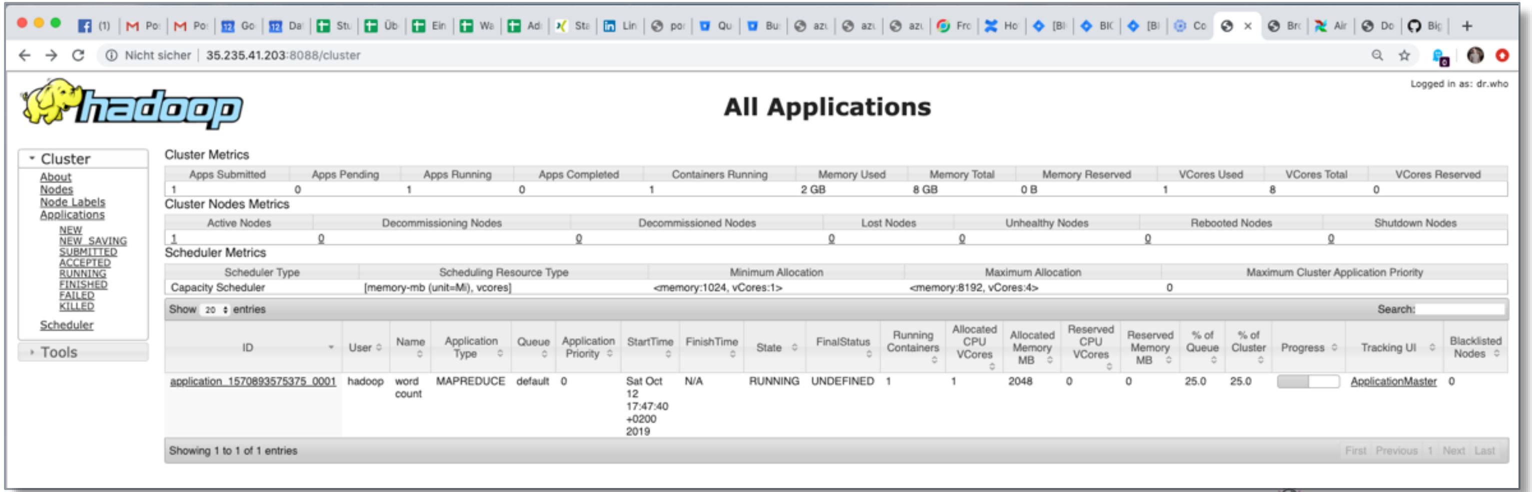
```
hadoop fs -put /var/log/dpkg.log /user/hadoop/dpkg.log
```

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:



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	1	2 GB	8 GB	0 B	1	8	0

Cluster Nodes Metrics

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

Scheduler Metrics

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

Show 20 entries Search:

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		ApplicationMaster	0

Showing 1 to 1 of 1 entries

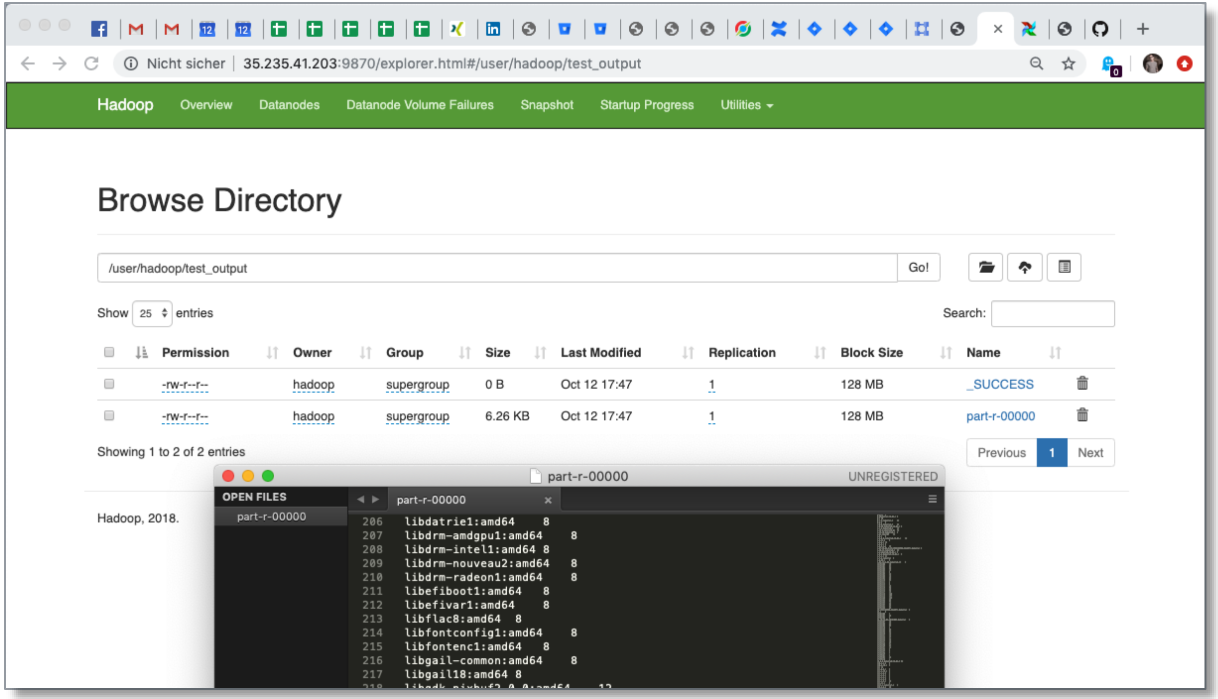
Run Example MapReduce Job

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

□	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

```
libdatrie1:amd64	8
libdrm-amdgpu1:amd64	8
libdrm-intel1:amd64 8
libdrm-nouveau2:amd64	8
libdrm-radeon1:amd64	8
libefiboot1:amd64	8
libefivar1:amd64	8
libflac8:amd64	8
libfontconfig1:amd64	8
libfontenc1:amd64	8
libgail-common:amd64	8
libgail18:amd64 8
libgdk-pixbuf2.0-0:amd64	12
```

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_2024-2025/01_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 occurences** 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.

Help

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.

Stop Your VM Instance

```
gcloud compute instances stop big-data
```