

## ENGR 516 ECC - Assignment 1

By

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### ❖ Hadoop Installation:

Below are the steps which I performed for Hadoop installation:

- Step 1: Created instance on Jetstream with Ubuntu to host Hadoop.
- Step 2: Updated JDK 11 as a prerequisite for running Hadoop.
- Step 3: Downloaded Hadoop 3.3.6.
- Step 4: I updated configuration files such as `hdfs-site.xml`, `mapred-site.xml`, they contain important settings for Hadoop's distributed file system and MapReduce framework.
- Step 5: I setup environment variables such as `JAVA_HOME`, `HADOOP_HOME` in `.bashrc`.
- Step 6: I started Hadoop with `start-all.sh` script. This script includes NameNode, DataNode, NodeManager, ResourceManager startup process.

```
hadoop@sdiware-ecc:~$ 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 [sdiware-ecc]
Starting resourcemanager
Starting nodemanagers
hadoop@sdiware-ecc:~$
```

Fig: Start-all.sh Output

```
hadoop@sdiware-ecc:~$ jps
3696 SecondaryNameNode
4529 Jps
4066 NodeManager
3941 ResourceManager
3303 NameNode
3447 DataNode
hadoop@sdiware-ecc:~$
```

Fig: All process Up and Running

```
export JAVA_HOME=/usr/lib/jvm/java-11-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"
```

Fig: Environment variables setup in .bashrc

← → ↻ ⚠ Not secure | 149.165.174.43:9870/dfshealth.html#tab-overview

Hadoop

Overview

Datanodes

Datanode Volume Failures

Snapshot

Startup Progress

Utilities

Overview

'localhost:9000' (✓active)

Started:	Mon Oct 16 15:07:58 -0400 2023
Version:	3.3.6, r1be78238728da9266a4f88195058f0d012bf9c
Compiled:	Sun Jun 18 04:22:00 -0400 2023 by ubuntu from (HEAD detached at release-3.3.6-RC1)
Cluster ID:	CID-fc133317-96ea-4dcd-8084-9349f83449e8
Block Pool ID:	BP-1680904377-10.0.195.239-1697232599393

Summary

Security is off.

Safemode is off.

188 files and directories, 163 blocks (163 replicated blocks, 0 erasure coded block groups) = 351 total filesystem object(s).


Heap Memory used 197.23 MB of 701 MB Heap Memory. Max Heap Memory is 7.34 GB.

Non Heap Memory used 54.11 MB of 57.5 MB Committed Non Heap Memory. Max Non Heap Memory is <unbounded>.

Configured Capacity:	57.97 GB
Configured Remote Capacity:	0 B
DFS Used:	16.45 MB (0.03%)
Non DFS Used:	13.03 GB
DFS Remaining:	44.9 GB (77.46%)
Block Pool Used:	16.45 MB (0.03%)
DataNodes usages% (Min/Median/Max/stdDev):	0.03% / 0.03% / 0.03% / 0.00%
Live Nodes	1 (Decommissioned: 0, In Maintenance: 0)

Fig: Hadoop UI

← → ↻ ⚠ Not secure | 149.165.174.43:9000/cluster



All Applications

Cluster Metrics

Cluster Nodes Metrics

Scheduler Metrics

Capacity Scheduler

Scheduling Resource Type

Minimum Allocation

Maximum Allocation

0

Ma

Cluster

About

Nodes

Node Labels

Applications

NEW

NEW SAVING

SUBMITTED

ACCEPTED

BURNING

FINISHED

FAILED

KILLED

Scheduler

Tools

ID	User	Name	Application Type	Application Tags	Queue	Application Priority	StartTime	LaunchTime	FinishTime	State	FinalStatus	Running Containers	Allocated CPU V-Cores	Allocated Memory MB	Allocated GPUs	Reserved CPU V-Cores	Reserved Memory MB
No data available in table																	
Showing 0 to 0 of 0 entries																	

Fig Hadoop Cluster

## ❖ PART 1. Output the top-3 IP addresses with the granularity of an hour

### Mapper (Map\_granularityHour.py):

- Below mapper code searches and extracts IP addresses and hours from input log file.
- For each match it prints the hour and IP along 1 to indicate the count which is passed to reducer.

```
import re
import sys

# Regex given to extract IP and hour in the Assignment.
pattern = re.compile(r'(\d+\.\d+\.\d+\.\d+).*?(\d{4}:\d{2}):\d{2}')

for line in sys.stdin:
    patternFound = pattern.search(line)
    if patternFound:
        ip, hour = patternFound.groups()
        print(f'Hour: {hour}, IP: {ip}, 1')
```

Fig: Mapper (Map\_granularityHour.py)

### Reducer (Reduce\_Part1\_2.py):

- It aggregates the count of each IP address for specific hour, then sorts the IP addresses according to their count in descending order.
- Finally prints the top 3 IPs with their count for each hour.

```
import sys
from collections import defaultdict

# To store hourly stats of IP address and their count
hourlyStats = defaultdict(lambda: defaultdict(int))

for line in sys.stdin:
    line = line.strip()
    hour, ip, count = line.split(',')
    # Update the IP address with count of occurrences for specific hour
    hourlyStats[hour][ip] += int(count)

for hour, stats in hourlyStats.items():
    hourParts = hour.split(':')
    extractedHour = hourParts[2]
    # Sorting in descending according the count and taking top 3 IP addresses
    topIPs = sorted(stats.items(), key=lambda x: x[1], reverse=True)[:3]
    # Printing top IP addresses, count and Hour
    for ip, count in topIPs:
        print("-----")
        print(f"TOTAL COUNT: {count}, {ip}, Hour: {extractedHour}:00")
    print("-----")
```

Fig: Reducer (Reduce\_Part1\_2.py)

## Command to run Map Reduce:

*Hadoop jar \$HADOOP\_HOME/share/adoop/tools/lib/adoop-streaming-3.3.6.jar -files  
Map\_granularityHour.py,Reduce\_Part1\_2.py -mapper 'python3 Map\_granularityHour.py' -reducer  
'python3 Reduce\_Part1\_2.py' -input /inputFolder/sample.log -output  
/outputFolder\_part1\_granularityHour*

## Logs:

```
hadoop@sdiware-ec2:~$  
hadoop@sdiware-ec2:~$ hadoop jar $HADOOP_HOME/share/adoop/tools/lib/adoop-streaming-3.3.6.jar -files Map_granularityHour.py,Reduce_Part1_2.py -mapper 'python3 Map_granularityHour.py' -reducer 'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output /outputFolder_part1_granularityHour  
2023-10-16 04:48:21,476 INFO client.DefaultHadoopFailoverProxyProvider: Connecting to ResourceManager at /0.0.0.0:8032  
2023-10-16 04:48:21,476 INFO mapreduce.JobResourceUploader: Disabling Hbase Coding for path: /tmp/hadoop-yarn/staging/hadoop/.staging/job_1607430851016_0001  
2023-10-16 04:48:22,308 INFO mapred.FileInputFormat: Total input files to process : 1  
2023-10-16 04:48:22,418 INFO mapreduce.JobSubmitter: number of splits:2  
2023-10-16 04:48:22,559 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1607430851016_0001  
2023-10-16 04:48:22,559 INFO mapreduce.JobSubmitter: Executing with tokens: {}  
2023-10-16 04:48:22,660 INFO conf.Configuration: resource-types.xml not found  
2023-10-16 04:48:22,666 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.  
2023-10-16 04:48:22,978 INFO impl.YarnClientImpl: Submitted application application_1607430851016_0001  
2023-10-16 04:48:23,000 INFO mapreduce.Job: The url to track the job: http://sdiware-ec2:8088/proxy/application_1607430851016_0001/  
2023-10-16 04:48:23,001 INFO mapreduce.Job: Running job: job_1607430851016_0001  
2023-10-16 04:48:29,009 INFO mapreduce.Job: Job job_1607430851016_0001 running in uber mode : false  
2023-10-16 04:48:29,070 INFO mapreduce.Job: map 0% reduce 0%  
2023-10-16 04:48:33,112 INFO mapreduce.Job: map 50% reduce 0%  
2023-10-16 04:48:34,117 INFO mapreduce.Job: map 100% reduce 0%  
2023-10-16 04:48:39,319 INFO mapreduce.Job: map 100% reduce 100%  
2023-10-16 04:48:39,146 INFO mapreduce.Job: Job job_1607430851016_0001 completed successfully  
2023-10-16 04:48:39,210 INFO mapreduce.Job: Counters: 55  
  File System Counters  
    FILE: Number of bytes read=12201  
    FILE: Number of bytes written=86403  
    FILE: Number of read operations=0  
    FILE: Number of large read operations=0  
    FILE: Number of write operations=0  
    HDFS: Number of bytes read=106087  
    HDFS: Number of bytes written=376  
    HDFS: Number of read operations=11  
    HDFS: Number of large read operations=0  
    HDFS: Number of write operations=2  
    HDFS: Number of bytes read erasure-coded=0  
  Job Counters  
    Killed map tasks=1  
    Launched map tasks=2  
    Launched reduce tasks=1  
    Data-local map tasks=2  
    Total time spent by all maps in occupied slots (ms)=3728  
    Total time spent by all reduces in occupied slots (ms)=1892  
    Total time spent by all map tasks (ms)=3728  
    Total time spent by all reduce tasks (ms)=1892  
    Total vcore-milliseconds taken by all map tasks=3728  
    Total vcore-milliseconds taken by all reduce tasks=1892  
    Total megabyte-milliseconds taken by all map tasks=3817472  
    Total megabyte-milliseconds taken by all reduce tasks=1937488  
  Map-Reduce Framework  
    Map input records=319  
    Map output records=319  
    Map output bytes=11557  
    Map output materialized bytes=12207  
    Input split bytes=192  
    Combine input records=0  
    Combine output records=0  
    Reduce input groups=46  
    Reduce shuffle bytes=12207  
    Reduce input records=319  
    Reduce output records=7  
    Spilled Records=0
```

Fig: Logs

**Command to check output:** *hdfs dfs -cat /outputFolder\_part1\_granularityHour/part-00000*

## Final Output:

```
hadoop@sdiware-ec2:~$ hdfs dfs -cat /outputFolder_part1_granularityHour/part-00000  
-----  
TOTAL COUNT: 38, IP: 66.111.54.249, Hour: 03:00  
-----  
TOTAL COUNT: 36, IP: 5.211.97.39, Hour: 03:00  
-----  
TOTAL COUNT: 31, IP: 66.249.66.194, Hour: 03:00  
-----  
hadoop@sdiware-ec2:~$
```

Fig: Final Output

❖ **PART 2.1: Make your program like a database search. Your program should be able to accept parameters from users, such as 0-1, which means from time 00:00 to 01:00, and output the top-3 IP addresses in the given time period.**

**Mapper (Map\_databaseSearch.py):**

- I have modified the mapper to accept command line argument called time window.
- It is extracting the start hour and end hour from the time window mentioned in command line.
- And based on this, it filters and print entries that fall within the specified time window.

```
import re
import sys
import os

# Extracting starting hour and ending hour from env variable time window
startHour, endHour = map(int, os.environ.get('timewindow').split("-"))
pattern = re.compile(r'(\d+\.\d+\.\d+\.\d+).*?(\d{4}:\d{2}):\d{2}')

for line in sys.stdin:
    patternFound = pattern.search(line)
    if patternFound:
        ip, hour = patternFound.groups()
        hourParts = hour.split(':')
        _, _, extractedHour = hour.partition(':')
# Extract the hour as integer value
        extractedHour = int(extractedHour)
# Checked if the extracted hour is within starting and ending hour window
        if startHour <= extractedHour < endHour:
            print('Hour:', hour, ', IP:', ip, ', 1', sep='')
        else:
            continue
```

Fig: Mapper (Map\_databaseSearch.py)

**Reducer (Reduce\_Part1\_2.py):**

- Reducer for this part is the same as part 1.
- I have taken two test cases; first time window is 01 to 02 which has no IP addresses and second time window is 01 to 04 which has IP addresses.

**Test case 1 Time Window 01 to 02:**

**Command to run Map Reduce:**

```
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files
Map_databaseSearch.py,Reduce_Part1_2.py -mapper 'python3 Map_databaseSearch.py' -reducer
'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output
/outputFolder_part2_databaseSearch_test1 -cmdenv timewindow="01-02"
```

**Logs:**

```

hadoop@sdiware-ecc:~$ hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files Map_databaseSearch.py,Reduce_Part1_2.py -mapper 'python3 Map_databaseSearch.py' -reducer 'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output /outputFolder_part2_databaseSearch_test1 -cmdenv timewindow="01-04"
packageJobJar: [/tmp/hadoop-unjar/776485589884515833/] [] /tmp/streamjob09388035741186301.jar tmpDir=null
2023-10-10 05:09:13,182 INFO Client.DefaultHadoopAllowProxyProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-10-10 05:09:13,580 INFO Client.DefaultHadoopAllowProxyProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-10-10 05:09:13,672 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/hadoop/staging/job_1697432868842_0001
2023-10-10 05:09:14,422 INFO mapreduce.JobResourceUploader: Total input files to process : 1
2023-10-10 05:09:14,478 INFO mapreduce.JobSubmitter: number of splits:2
2023-10-10 05:09:14,611 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1697432868842_0001
2023-10-10 05:09:14,611 INFO mapreduce.JobSubmitter: Executing with tokens: {}
2023-10-10 05:09:14,728 INFO conf.Configuration: resource-types.xml not found
2023-10-10 05:09:14,728 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'
2023-10-10 05:09:15,063 INFO Impl.VarClientImpl: Submitted application, application_1697432868842_0001
2023-10-10 05:09:15,087 INFO mapreduce.Job: The url to track the job: http://sdiware-ecc:8088/proxy/application_1697432868842_0001/
2023-10-10 05:09:15,088 INFO mapreduce.Job: Running job: job_1697432868842_0001
2023-10-10 05:09:20,158 INFO mapreduce.Job: Job job_1697432868842_0001 running in uber mode : false
2023-10-10 05:09:24,201 INFO mapreduce.Job: map 100% reduce 0%
2023-10-10 05:09:29,221 INFO mapreduce.Job: map 100% reduce 100%
2023-10-10 05:09:31,236 INFO mapreduce.Job: Job job_1697432868842_0001 completed successfully
2023-10-10 05:09:31,293 INFO mapreduce.Job: Counters: 54

File System Counters
  FILE: Number of bytes read=6
  FILE: Number of bytes written=848953
  FILE: Number of read operations=0
  FILE: Number of write operations=0
  HDFS: Number of large read operations=0
  HDFS: Number of bytes read=186687
  HDFS: Number of bytes written=0
  HDFS: Number of read operations=11
  HDFS: Number of large read operations=0
  HDFS: Number of write operations=2
  HDFS: Number of bytes read erasure-coded=0

Job Counters
  Launched map tasks=2
  Launched reduce tasks=1
  Default label map tasks=2
  Total time spent by all maps in occupied slots (ms)=3936
  Total time spent by all reduces in occupied slots (ms)=1778
  Total time spent by all map tasks (ms)=3936
  Total time spent by all reduce tasks (ms)=1778
  Total vcore-milliseconds taken by all map tasks=3936
  Total vcore-milliseconds taken by all reduce tasks=1778
  Total megabyte-milliseconds taken by all map tasks=4838464
  Total megabyte-milliseconds taken by all reduce tasks=1528672

Map-Reduce Framework
  Map input records=110
  Map output records=0
  Map output bytes=0
  Map output materialized bytes=12
  Input split bytes=192
  Combine input records=0
  Combine output records=0
  Reduce input groups=0
  Reduce shuffle bytes=12
  Reduce input records=0
  Reduce output records=0
  Spilled Records=0
  Shuffled Mpps =2
  Failed Shuffles=0
  Merged Map outputs=2

```

Fig: Logs

**Command to check output:** `hdfs dfs -cat /outputFolder_part2_databaseSearch_test1/part-00000`

**Final Output:**

```

hadoop@sdiware-ecc:~$ hdfs dfs -cat /outputFolder_part2_databaseSearch_test1/part-00000
hadoop@sdiware-ecc:~$

```

Fig: Final Output

**Test Case 2 Time Window 01 to 04:**

**Command to run Map Reduce:**

`hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files Map_databaseSearch.py,Reduce_Part1_2.py -mapper 'python3 Map_databaseSearch.py' -reducer 'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output /outputFolder_part2_databaseSearch_test2 -cmdenv timewindow="01-04"`

**Logs:**

```

hadoop@sdiware-ec2:~$ hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files Map_databaseSearch.py,Reduce_Part1_2.py -mapper 'python3 Map_databaseSearch.py' -reducer 'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output /outputFolder/part2_databaseSearch_test2 -cdenv timeindoor "01-04"
packageJobJar: [/tmp/hadoop-unjar10341780156467261348/] [] /tmp/streamJob5169556841724972280.jar tmpDir=null
2023-10-16 05:12:43,882 INFO client.DefaultHadoopWritableProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-10-16 05:12:43,924 INFO client.DefaultHadoopWritableProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-10-16 05:12:42,809 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/hadoop/.staging/job_1697432868842_0004
2023-10-16 05:12:42,383 INFO mapreduce.FileInputFormat: Total input files to process : 1
2023-10-16 05:12:42,345 INFO mapreduce.JobSubmitter: number of splits:2
2023-10-16 05:12:42,474 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1697432868842_0004
2023-10-16 05:12:42,474 INFO mapreduce.JobSubmitter: Executing with tokens: []
2023-10-16 05:12:42,583 INFO conf.Configuration: resource-types.xml not found
2023-10-16 05:12:42,583 INFO resource.ResourceUtilis: Unable to find 'resource-types.xml'.
2023-10-16 05:12:42,601 INFO impl.YarnClientImpl: Submitted application application_1697432868842_0004
2023-10-16 05:12:42,643 INFO mapreduce.Job: The url to track the job: http://sdiware-ec2:8088/proxy/application_1697432868842_0004/
2023-10-16 05:12:42,644 INFO mapreduce.Job: Running job: job_1697432868842_0004
2023-10-16 05:12:42,783 INFO mapreduce.Job: Job job_1697432868842_0004 running in uber mode : false
2023-10-16 05:12:42,783 INFO mapreduce.Job: map 0% reduce 0%
2023-10-16 05:12:51,748 INFO mapreduce.Job: map 100% reduce 0%
2023-10-16 05:12:54,761 INFO mapreduce.Job: map 100% reduce 100%
2023-10-16 05:12:55,771 INFO mapreduce.Job: Job job_1697432868842_0004 completed successfully
2023-10-16 05:12:55,842 INFO mapreduce.Job: Counters: 54
File System Counters
  FILE: Number of bytes read=11563
  FILE: Number of bytes written=82167
  FILE: Number of read operations=0
  FILE: Number of large read operations=0
  FILE: Number of write operations=0
  HDFS: Number of bytes read=106687
  HDFS: Number of bytes written=773
  HDFS: Number of read operations=11
  HDFS: Number of large read operations=0
  HDFS: Number of write operations=2
  HDFS: Number of bytes read erasure-coded=0
Job Counters
  Launched map tasks=2
  Launched reduce tasks=1
  Data-local map tasks=2
  Total time spent by all maps in occupied slots (ms)=3745
  Total time spent by all reduces in occupied slots (ms)=1754
  Total time spent by all map tasks (ms)=3745
  Total time spent by all reduce tasks (ms)=1754
  Total vcore-milliseconds taken by all map tasks=3745
  Total vcore-milliseconds taken by all reduce tasks=1754
  Total megabyte-milliseconds taken by all map tasks=3834880
  Total megabyte-milliseconds taken by all reduce tasks=1796096
Map-Reduce Framework
  Map input records=319
  Map output records=319
  Map output bytes=18919
  Map output materialized bytes=11569
  Input split bytes=192
  Combine input records=0
  Combine output records=0
  Reduce input groups=45
  Reduce shuffle bytes=11569
  Reduce input records=319
  Reduce output records=7
  Spilled Records=638
  Shuffled Maps=2
  Failed Shuffles=0
  Merged Map outputs=2
  GC time elapsed (ms)=40
  CPU time spent (ms)=1480

```

Fig: Logs

Command to check output: `hdfs dfs -cat /outputFolder_part2_databaseSearch_test2/part-00000`

Final Output:

```

hadoop@sdiware-ec2:~$ hdfs dfs -cat /outputFolder_part2_databaseSearch_test2/part-00000
-----
TOTAL COUNT: 38, IP:66.111.54.249, Hour: 03:00
-----
TOTAL COUNT: 36, IP:5.211.97.39, Hour: 03:00
-----
TOTAL COUNT: 31, IP:66.249.66.194, Hour: 03:00
-----
hadoop@sdiware-ec2:~$

```

Fig: Final Output

## ❖ PART 2.2: Run it along with three other examples, WordCount, Sort, Grep, at the same time, and test fair and capacity schedulers.

### Running all task:

- To run all the task in parallel that are wordcount, sort, database search and grep I developed a script called runAll.sh.
- I ran these jobs individually and added them in script with & at the end to make it run in background and concurrently.
- I have also added individual mapper and reducer code and output for each of the above task.
- I have added each queue name in each command with the flag -D mapreduce.job.queueName. Below is the screenshot of runAll.sh.

```
#!/bin/bash

# Database Search Job
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -D mapreduce.job.queueName=DatabaseSearch -files Map_databaseSearch.py,Reduce_Part1_2.py -mapper 'python3 Map_databaseSearch.py' -reducer 'python3 Reduce_Part1_2.py' -input /inputFolder/sample.log -output /outputFolder_part2_databaseSearch_test1_parallel -cmdenv timewindow="01-02" &

# Word Count Job
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -D mapreduce.job.queueName=WordCount -files Map_wc.py,Reduce_wc.py -mapper 'python3 Map_wc.py' -reducer 'python3 Reduce_wc.py' -input /inputFolder/sample.log -output /outputFolder_wc_parallel &

# Sort Job
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -D mapreduce.job.queueName=Sort -files Map_sort.py,Reduce_sort.py -mapper 'python3 Map_sort.py' -reducer 'python3 Reduce_sort.py' -input /inputFolder/sample.log -output /outputFolder_sort_parallel &

# Grep Job
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-*.jar -D mapreduce.job.queueName=Grep -files Map_grep.py,Reduce_grep.py -mapper 'python3 Map_grep.py' -reducer 'python3 Reduce_grep.py' -input /inputFolder/sample.log -output /outputFolder_grep_parallel -cmdenv search_pattern="Dual" &

wait

echo "----- All task completed -----"
```

Fig: runAll.sh

## ❖ Sort Task:

### Mapper Sort (Map\_sort.py):

- It extracts the first word as IP and remaining words as string.
- It then prints IP along with rest words in tab-separated format and sends it to reducer.

```
import sys

for line in sys.stdin:
    line = line.strip()
    words = line.split()
    if words:
        IPAddress, *rest = words
        print(f"{IPAddress}\t{' '.join(rest)}")
~
~
~
```



Fig: Mapper Sort (Map\_sort.py)

### Reducer Sort (Reduce\_sort.py):

- It stores log entries in dictionary and then sorts the IP address and prints it alongside the corresponding log entries.

```
import sys

# Created a dictionary to store log entries by IP address
logEntries = {}

for line in sys.stdin:
    line = line.strip()
    ipAddress, logEntry = line.split('\t', 1)
    # Check if IP address is already in the dictionary and if not add it with empty list
    if ipAddress not in logEntries:
        logEntries[ipAddress] = []
    # Adding log entry to list with corresponding IP Address
    logEntries[ipAddress].append(logEntry)
sortedIps = sorted(logEntries.keys())
# Iterating through IP Address and printing the IP Address and their Log Entries
for ipAddress in sortedIps:
    for logEntry in logEntries[ipAddress]:
        print(f"{ipAddress} {logEntry}")
        print("-----")
~
~
```

Fig: Reducer Sort (Reduce\_sort.py)

### Command to run Map Reduce:

```
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files
Map_sort.py,Reduce_sort.py -mapper 'python3 Map_sort.py' -reducer 'python3 Reduce_sort.py' -
input /inputFolder/sample.log -output /outputFolder_sort
```

**Command to check output:** `hdfs dfs -cat /outputFolder_sort/part-00000`

### Final Output:

- It shows logs sorted according to IP address.



- It processes word count pairs and consolidates the counts for each word.
- It sums the count for each word and when word changes it prints the word and count.

```
#!/usr/bin/env python

import sys

currentWord = None
currentCount = 0

for line in sys.stdin:
    line = line.strip()
    word, count = line.split('\t', 1)

    try:
        count = int(count)
    except ValueError:
        continue

    if currentWord == word:
        currentCount += count
    else:
        if currentWord:
            print(f'{currentWord}\t{currentCount}')
            print("-----")
        currentWord = word
        currentCount = count

if currentWord:
    print(f'{currentWord}\t{currentCount}')
```

Fig: Reducer Word Count (Reduce\_wc.py)

#### Command to run Map Reduce:

```
hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-3.3.6.jar -files
Map_wc.py,Reduce_wc.py -mapper 'python3 Map_wc.py' -reducer 'python3 Reduce_wc.py' -input
/inputFolder/sample.log -output /outputFolder_wc
```

**Command to check output:** `hdfs dfs -cat /outputFolder_wc/part-00000`

#### Final Output:

- It shows word count of each word from the log file.

```

sim      6
-----
site     1
-----
sport    1
-----
sports   1
-----
static   30
-----
stexists      8
-----
stove      1
-----
support    2
-----
t445       1
-----
t51         1
-----
tag         3
-----
telegram    4
-----
third       3
-----
tools       2
-----
torob       1
-----
updateVariation 8
-----
usqp        3
-----
v           3
-----
v1          5
-----

```

Fig: Final Output

### ❖ Grep Task:

#### **Mapper Grep (Map\_grep.py):**

- It takes the input for specific search pattern from user via command line and checks if it matches.
- If the line matches the search pattern it sends it to reducer.

```

import sys
import re
import os

# Check if the 'search_pattern' environment variable is set
search_pattern = os.environ.get('search_pattern')
if not search_pattern:
    print("The 'search_pattern' environment variable is not defined")
    sys.exit(1)
patternFound = re.compile(search_pattern)
for line in sys.stdin:
    line = line.strip()
    if patternFound.search(line):
        print(line)
~
~
~

```

Mapper Grep (Map\_grep.py)

#### Reducer Grep (Reduce\_grep.py):

- It prints out the line which it receives from the mapper after filtering according to search pattern.

```

import sys

for line in sys.stdin:
    line = line.strip()
    print(line)
    print("-----")
~
~
~

```

Reducer Grep (Reduce\_grep.py)

#### TestCase 1 “Dual” as search pattern:

##### Command to run Map Reduce:

```

hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-*.jar -files
Map_grep.py,Reduce_grep.py -mapper 'python3 Map_grep.py' -reducer 'python3 Reduce_grep.py' -
input /inputFolder/sample.log -output /outputFolder_grep -cmdenv search_pattern="Dual"

```

**Command to check output:** `hdfs dfs -cat /outputFolder_grep/part-00000`

#### Final Output for Test Case 1:

```

hadoop@diware-ec2:~$ hdfs dfs -cat /outputFolder_grep/part-00000
5.78.198.52 - - [22/Jan/2019:03:56:21 +0330] "GET /m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29 HTTP/1.1" 200 21931 "https://www.zanbil.ir/m/browse/cell-phone/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:22 +0330] "GET /settings/logo HTTP/1.1" 200 4120 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:26 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:27 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:28 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:29 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:30 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 198 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:32 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
5.78.198.52 - - [22/Jan/2019:03:56:33 +0330] "POST /m/updateVariation?_amp_source_origin=https%3A%2F%2Fwww.zanbil.ir HTTP/1.1" 200 171 "https://www.zanbil.ir/m/product/33978/64784/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Linux; Android 8.0.0; SAMSUNG SM-G950F Build/R10NM) AppleWebKit/537.36 (KHTML, like Gecko) SamsungBrowser/8.2 Chrome/63.0.3239.111 Mobile Safari/537.36 "-"
-----
66.249.66.194 - - [22/Jan/2019:03:56:47 +0330] "GET /m/product/31479/61477/XDAFAF309X88X08B4X08BAC-309X85X09X88X08B4X08BAC309X84-X09X87X09X88X08B4X09X88X08BAC-309X85X08B4F309X84-Honor-SX-Dual-16GB-328K1M-L21X29 HTTP/1.1" 200 211 41 "-" Mozilla/5.0 (Linux; Android 6.0.1; Nexus SX Build/PWB29P) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/41.0.2272.96 Mobile Safari/537.36 (compatible; Googlebot/2.1; +http://www.google.com/bot.html) "-"
-----
hadoop@diware-ec2:~$

```

Fig: Final Output

## Test Case 2 “telegram” as search pattern:

### Command to run Map Reduce:

```

hadoop jar $HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-*.jar -files
Map_grep.py,Reduce_grep.py -mapper 'python3 Map_grep.py' -reducer 'python3 Reduce_grep.py' -
input /inputFolder/sample.log -output /outputFolder_grep_test2 -cmdenv
search_pattern="telegram"

```

### Command to check output: `hdfs dfs -cat /outputFolder_grep_test2/part-00000`

### Final Output:

```

hadoop@diware-ec2:~$ hdfs dfs -cat /outputFolder_grep_test2/part-00000
2.177.12.140 - - [22/Jan/2019:03:50:24 +0330] "GET /static/images/amp/telegram.png HTTP/1.1" 200 4859 "https://www.zanbil.ir/m/product/33686/X08KAA309X84X09X88X08B4X08BAC309X84-X08B3X08B4X09X88X08B4X08BAC-309X85X08B4F309X84-Galaxy-A9-3282018X29-Dual-128GB-328SH-A920X29" Mozilla/5.0 (Android 7.1.1; Mobile; rv:64.0) Gecko/64.0 Firefox/64.0 "-"
-----
31.56.96.51 - - [22/Jan/2019:03:50:32 +0330] "GET /static/images/amp/telegram.png HTTP/1.1" 200 4859 "https://www.zanbil.ir/m/filter/b113" Mozilla/5.0 (Linux; Android 6.0; ALE-L21 Build/HuaweiALE-L21) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/66.0.3359.158 Mobile Safari/537.36 "-"
-----
5.209.200.218 - - [22/Jan/2019:03:57:07 +0330] "GET /static/images/amp/telegram.png HTTP/1.1" 200 4859 "https://www.zanbil.ir/m/filter/b99%2Cp4510%2Ctextists%2Ct116" Mozilla/5.0 (Linux; Android 5.1.1; SM-G361H Build/LMY48B) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/55.0.2883.91 Mobile Safari/537.36 "-"
-----
66.111.54.249 - - [22/Jan/2019:03:57:02 +0330] "GET /static/images/amp/telegram.png HTTP/1.1" 200 4859 "https://www.zanbil.ir/m/browse/refrigerator-and-freezer/X08B8C308BAE30DA8B6X08B4X09X84-X09X81X08B81X08B8C308B2X08B81" Mozilla/5.0 (Linux; Android 5.0; SM-G900H Build/LRX21T) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/39.0.2171.93 Mobile Safari/537.36 "-"
-----
hadoop@diware-ec2:~$

```

Fig: Final Output

## ❖ Testing the Fair Scheduler:

→ To test the fair scheduler, I added below properties in \$HADOOP\_HOME/yarn-site.xml. It is fair scheduler module which is required to change the scheduler to fair.

```
<!-- YARN configurations for fair scheduling-->
<property>
<name>yarn.resourcemanager.scheduler.class</name>
<value>org.apache.hadoop.yarn.server.resourcemanager.scheduler.fair.FairScheduler</value>
</property>
<property>
<name>yarn.scheduler.fair.allocation.file</name>
<value>/home/hadoop/hadoop/etc/hadoop/fair-scheduler.xml</value>
</property>
</configuration>
```

Fig: yarn-site.xml for fair scheduler

→ I also created fair-sheduler.xml file and allocated below queues in it.

1. Database Search
2. Word Count
3. Sort
4. Grep

```
<?xml version="1.0"?>
<allocations>
  <defaultQueueSchedulingPolicy>fair</defaultQueueSchedulingPolicy>
  <queue name="root">
    <queue name="DatabaseSearch">
      <schedulingPolicy>fair</schedulingPolicy>
      <weight>0.75</weight>
    </queue>
    <queue name="WordCount">
      <schedulingPolicy>fair</schedulingPolicy>
      <weight>0.50</weight>
    </queue>
    <queue name="Sort">
      <schedulingPolicy>fair</schedulingPolicy>
      <weight>0.25</weight>
    </queue>
    <queue name="Grep">
      <schedulingPolicy>fair</schedulingPolicy>
      <weight>0.25</weight>
    </queue>
  </queue>
</allocations>
```

Fig: fair-scheduler.xml

→ Below are the queues which are created in Hadoop.

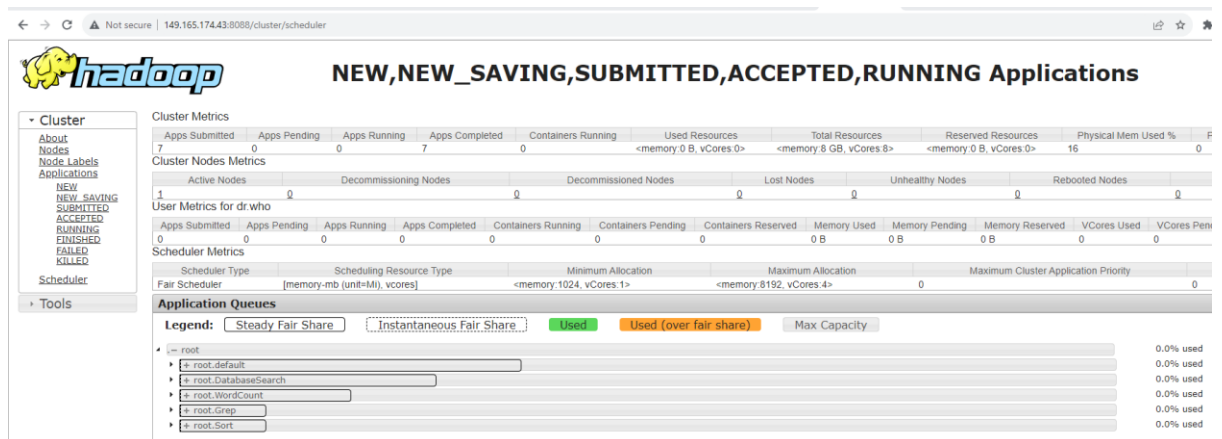


Fig: Initial Queues in Hadoop

- In fair-scheduler.xml, I have given more weight database search as it was consuming more resources and initially it failed hence, I increased the weight.
- In the below screenshot, we can see DatabaseSearch queue is running first.

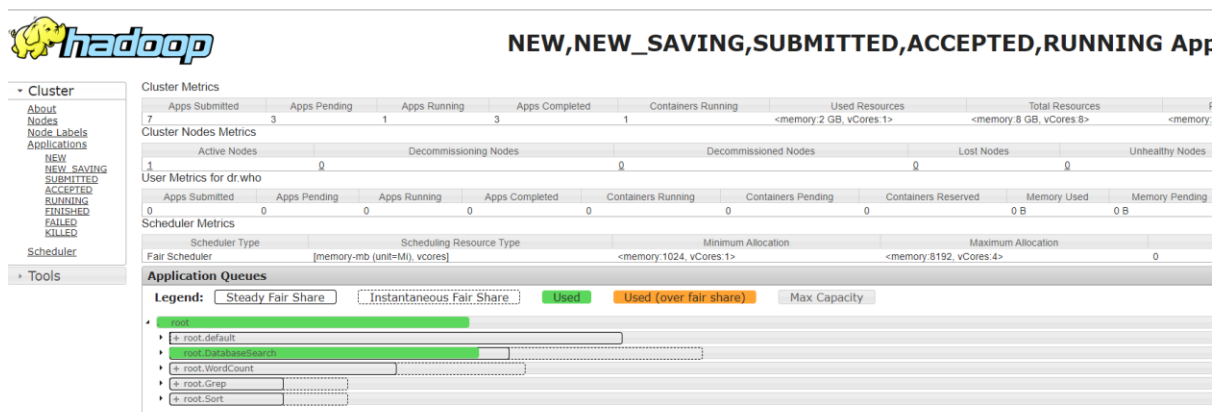


Fig: DatabaseSearch Queue running first

- I also gave name WordCount slightly less weight than DatabaseSearch but more than other two and hence it is running on second number as seen in below screenshot.



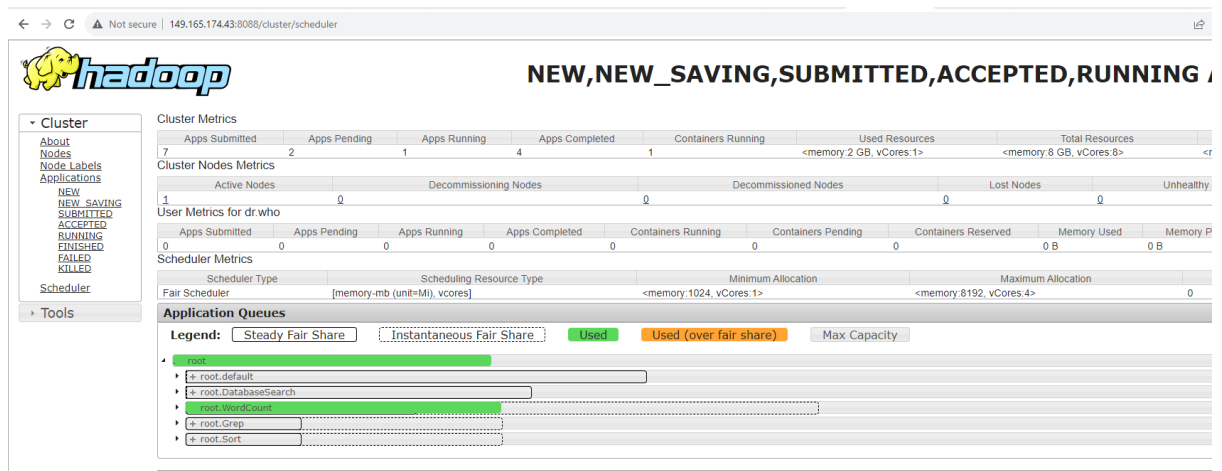


Fig: WordCount queue running second

→ I gave equal weights to both Sort and Grep as they were relatively less bulky and executed fast. As seen in below screenshot they are running concurrently.

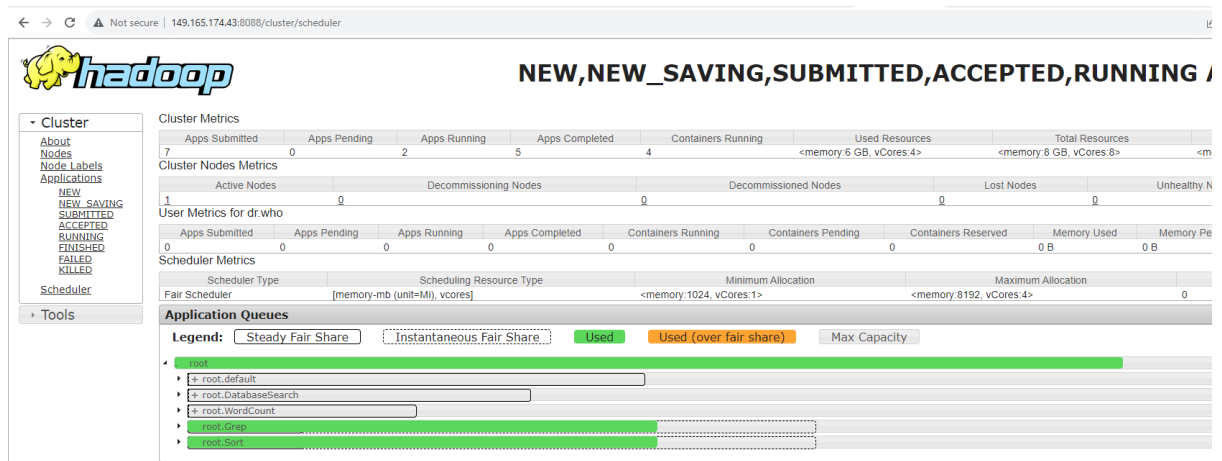


Fig: Grep and Sort queue running concurrently

## ❖ Testing the Capacity Scheduler:

- To implement capacity scheduler, I modified capacity-scheduler.xml.
- I have configured databaseSearch, wordcount, sort, grep queues in my capacity-scheduler.xml as shown in below screenshot.

```
<property>
  <name>yarn.scheduler.capacity.root.DatabaseSearch.capacity</name>
  <value>35</value>
  <description>DatabaseSearch queue target capacity.</description>
</property>

<property>
<name>yarn.scheduler.capacity.root.WordCount.capacity</name>
<value>25</value>
<description>WordCount queue target capacity.</description>
</property>

<property>
  <name>yarn.scheduler.capacity.root.Sort.capacity</name>
  <value>25</value>
<description>Sort queue target capacity.</description>
</property>

<property>
  <name>yarn.scheduler.capacity.root.Grep.capacity</name>
  <value>15</value>
  <description>Grep queue target capacity.</description>
</property>
```

Fig: Capacity-scheduler.xml with sort, grep, wordcount and DatabaseSearch Queue

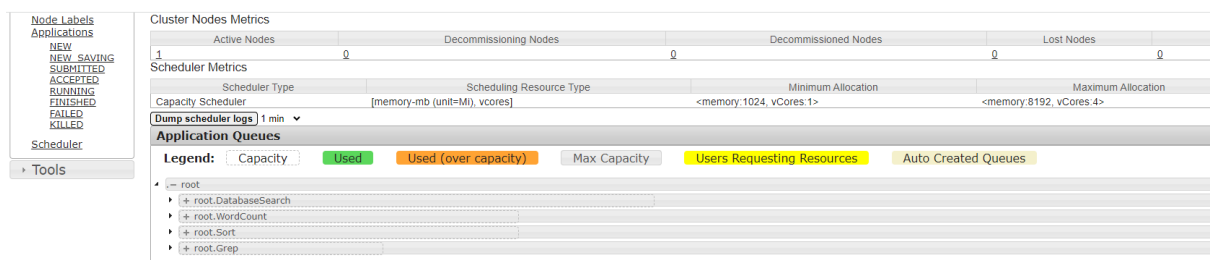
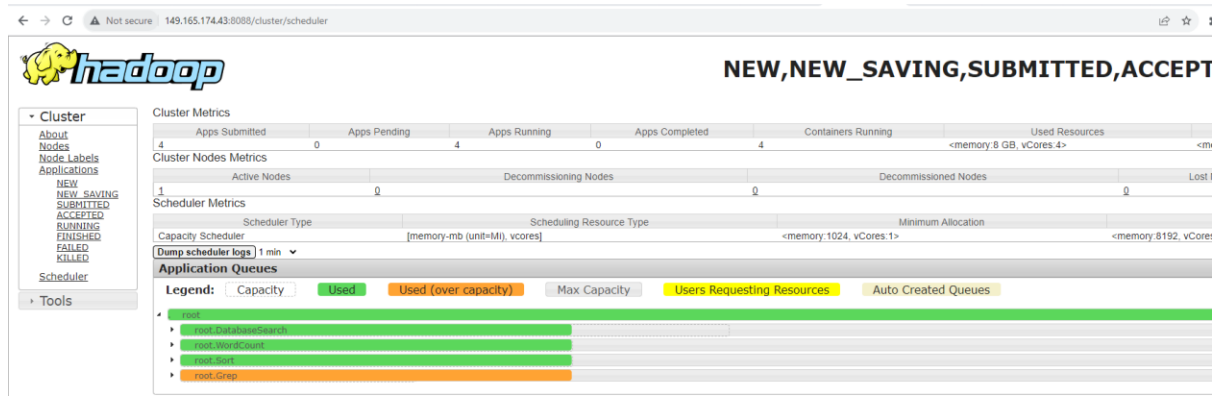


Fig: Capacity Scheduler with sort, grep, wordcount and DatabaseSearch Queue

- Soon I noticed from below that queues reached at max capacity and got stuck hence I implemented priority handling in fair scheduling.
- I saw the queues executed smoothly in fair scheduling.



## ❖ Conclusion:

I got to learn many topics related to scheduling and map-reduce framework along with Hadoop.

## ❖ Reference:

1. [How to Install Apache Hadoop on Ubuntu 22.04 – TecAdmin](#)