Submission by:

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Big Data Processing

(Assignment 3)

Title: Implementation of MapReduce Algorithm on Multi-Node Hadoop Cluster

Objective:

The objective of this project is to set up a multi-node EC2 instance on AWS, install Hadoop,implement the MapReduce algorithm in both single-node and multi-node clusters using the Hadoop streaming utility, and compare the execution time between the two setups.

Setup Multi-Node EC2 Instances:

- Log in to the AWS Management Console.
- Navigate to the EC2 dashboard.
- Launch four EC2 instances in the Mumbai region and south availability zone.
- Choose the Ubuntu OS during creation of EC2 instances.
- Named the instances according to my student ID.
- Assigned appropriate security groups and key pairs.
- Noted down the public IP addresses or DNS names of each instance.

Install Hadoop:

- SSH into each EC2 instance using the key pair.
- Install Java Development Kit (JDK 8) if not already installed.
- Download the Hadoop distribution 2.7.3 and extract it.
- Configure Hadoop by editing configuration files (hadoop-env.sh, core-site.xml, hdfs-site.xml, mapred-site.xml, etc.).
- Format the Hadoop file system using hadoop namenode -format.
- Start the Hadoop daemons: start-dfs.sh and start-yarn.sh.
- Verify the Hadoop installation through the web interface.

Implement MapReduce:

- Write the mapper and reducer code in python.
- Upload the code to a directory on the master node.

- Ensure the input data is available and accessible to Hadoop.
- Run the MapReduce job using the Hadoop streaming utility.
- Monitor the job progress through the Hadoop web interface.

- Check the output directory for the results upon completion.

#Mapper.py

```
#!/usr/bin/python3 -0
import sys

#Loop through each line in the inputfor
line in sys.stdin:

    # Remove leading and trailing whitespaceline
    = line.strip()

    # Split the line into words
    words = line.split()

    # Emit key-value pairs of word and count of 1for
    word in words:
        print(word,"\t",1)
```

#Reducer.py

```
#!/usr/bin/python3 -0

import sys

#Initialize variables to keep track of current word and its count
current word = None
current_count = 0

#Loop through each line in the inputfor
line in sys.stdin:

    #Split the line into word and count, separated by tab
    word, count = line.strip().split('\t', 1)

    #Convert count to integer
    count = int(count)

    #If the word is the same as the current word, increment its countif
    word == current_word:
```

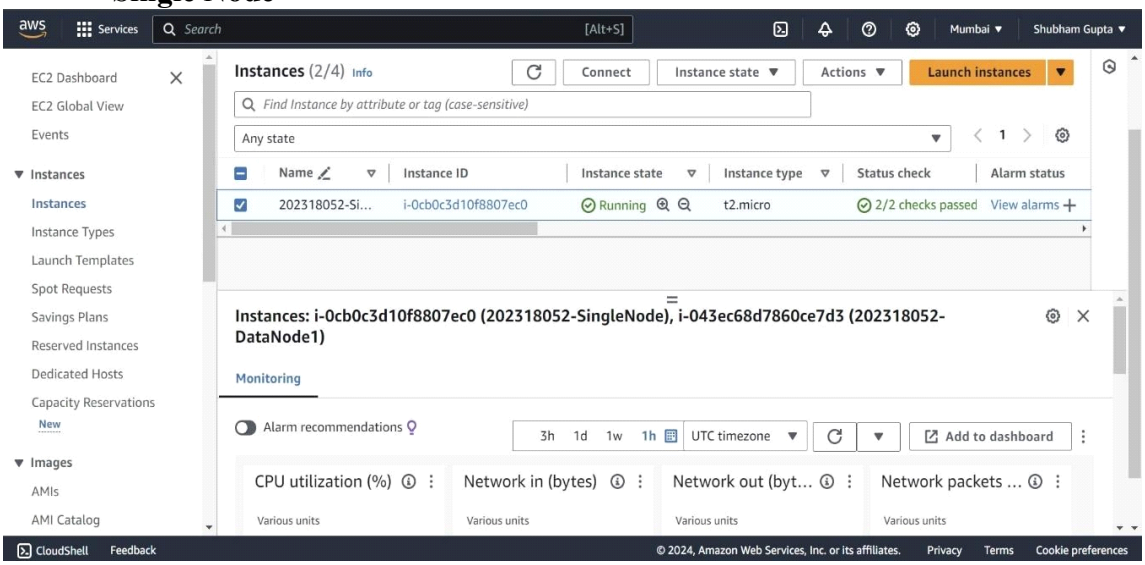
```
        current_count += count

    else:

        #If the word is different, print the current word and its countif
        current word:

            print(current_word,"\t",current_count)

            #Update current word and its count
            current word = word
            current count = count

#Print the last word and its countif
current word:
    print(current_word,"\t",current_count)
```

Compare Execution Time:

- Record the start time before running the MapReduce job.
- Execute the job on both single-node and multi-node clusters.
- Note the completion time after each execution.
- Calculate the execution time difference between the two setups.

Results and Screenshots:

- **Single Node**



Without Hadoop

```
ubuntu@ip-172-31-41-195:~$ time cat corpus.txt | python3 mapper.py | sort | python3 reducer.py
!       26
!!!!!!!!        1
!)      1
"       482
"",     14
"","pc"         7
"","pcs"        7
""Do    1
""The   1
""There's       1
```

```
real    1m6.636s
user    0m5.413s
sys     0m0.466s
ubuntu@ip-172-31-41-195:~$
```

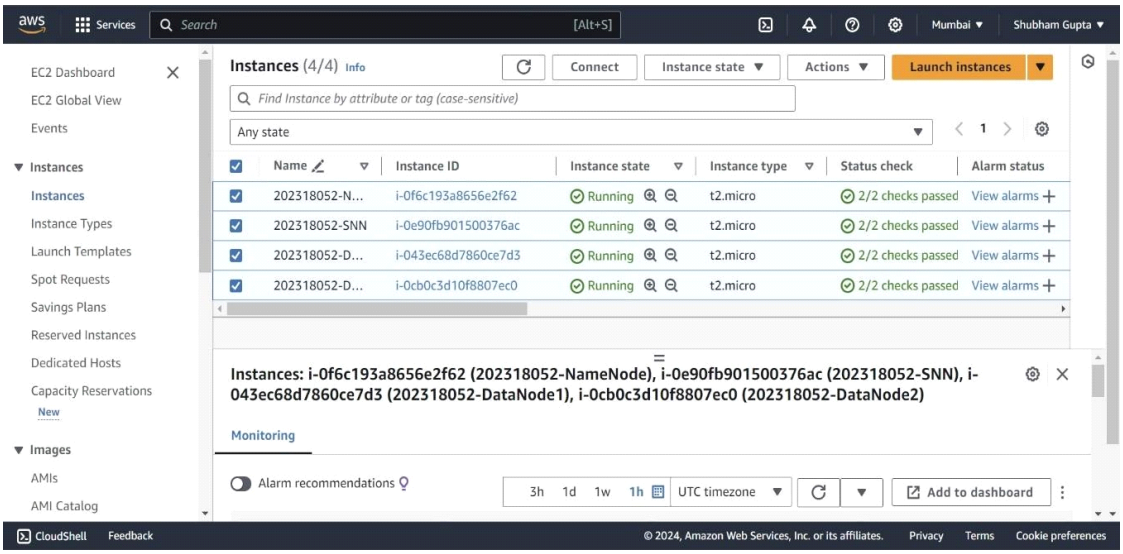
With Hadoop

```
ubuntu@ip-172-31-41-195:~$ time hadoop jar /home/ubuntu/hadoop/share/hadoop/tools/lib/hadoop-streaming-2.9.1.jar -mapper /home/ubuntu/mapper.py -reducer /home/ubuntu/reducer.py -input /input/corpus.txt -output /output/wordscounts
packageJobJar: [/tmp/hadoop-unjar5082568089063517402/] [] /tmp/streamjob8271078526609092725.jar tmpDir=null
24/02/24 05:08:12 INFO client.RMProxy: Connecting to ResourceManager at localhost/127.0.0.1:8032
24/02/24 05:08:12 INFO client.RMProxy: Connecting to ResourceManager at localhost/127.0.0.1:8032
24/02/24 05:08:12 INFO mapred.FileInputFormat: Total input files to process : 1
24/02/24 05:08:13 INFO mapreduce.JobSubmitter: number of splits:2
24/02/24 05:08:13 INFO Configuration.deprecation: yarn.resourcemanager.system-metrics-publisher.enabled is deprecated. Instead, use yarn.system-metrics-publisher.enabled
24/02/24 05:08:13 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1708748829675_0005
24/02/24 05:08:14 INFO impl.YarnClientImpl: Submitted application application_1708748829675_0005
24/02/24 05:08:14 INFO mapreduce.Job: The url to track the job: http://ip-172-31-41-195.ap-south-1.compute.internal:8088/proxy/application_1708748829675_0005/
24/02/24 05:08:14 INFO mapreduce.Job: Running job: job_1708748829675_0005
24/02/24 05:08:20 INFO mapreduce.Job: Job job_1708748829675_0005 running in uber mode : false
24/02/24 05:08:20 INFO mapreduce.Job:  map 0% reduce 0%
24/02/24 05:08:38 INFO mapreduce.Job:  map 37% reduce 0%
24/02/24 05:08:44 INFO mapreduce.Job:  map 56% reduce 0%
24/02/24 05:08:50 INFO mapreduce.Job:  map 67% reduce 0%
24/02/24 05:08:55 INFO mapreduce.Job:  map 83% reduce 0%
24/02/24 05:08:56 INFO mapreduce.Job:  map 100% reduce 0%
24/02/24 05:09:12 INFO mapreduce.Job:  map 100% reduce 94%
24/02/24 05:09:15 INFO mapreduce.Job:  map 100% reduce 100%
24/02/24 05:09:16 INFO mapreduce.Job: Job job_1708748829675_0005 completed successfully
24/02/24 05:09:16 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=341906164
                FILE: Number of bytes written=513458624
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=87466386
                HDFS: Number of bytes written=7297521
                HDFS: Number of read operations=9
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
```

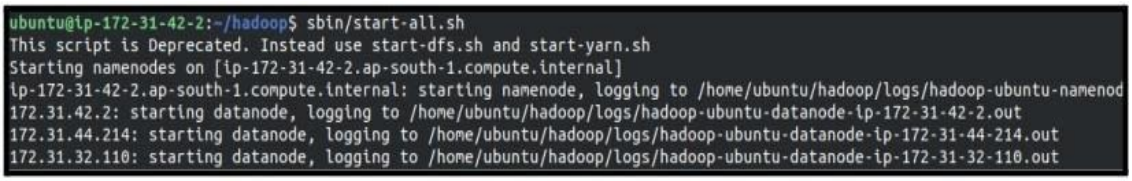
```
real    2m17.928s
user    2m13.154s
sys     0m3.162s
ubuntu@ip-172-31-41-195:~$
```

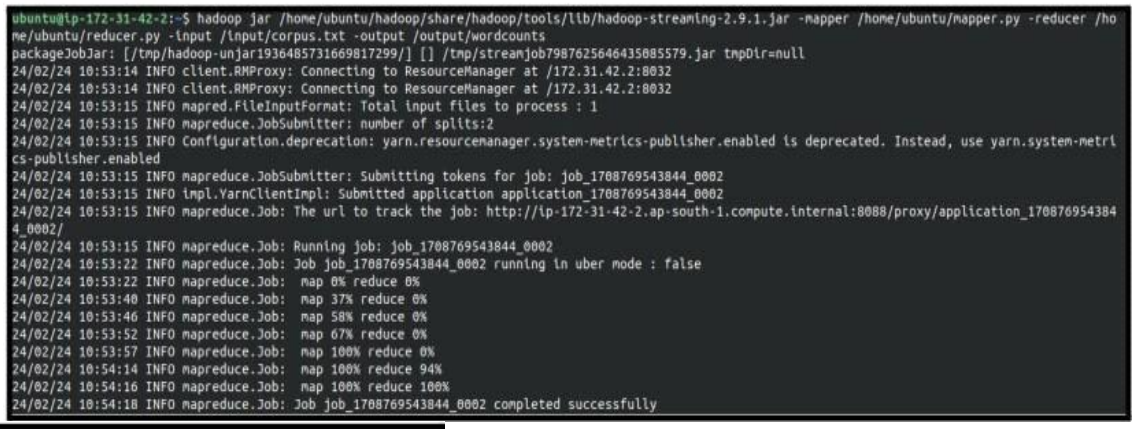
```
ubuntu@ip-172-31-41-195:~$ hdfs dfs -cat /output/wordscounts/part-00000
!       26
!!!!!!!!        1
!)      1
"       482
"",     14
"","pc"         7
"","pcs"        7
""Do    1
""The   1
""There's       1
""We    2
""},    7
"#[FROM         1
```

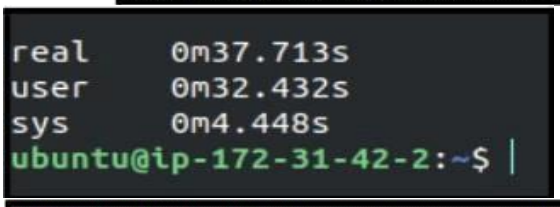
- **Multi-Node cluster**

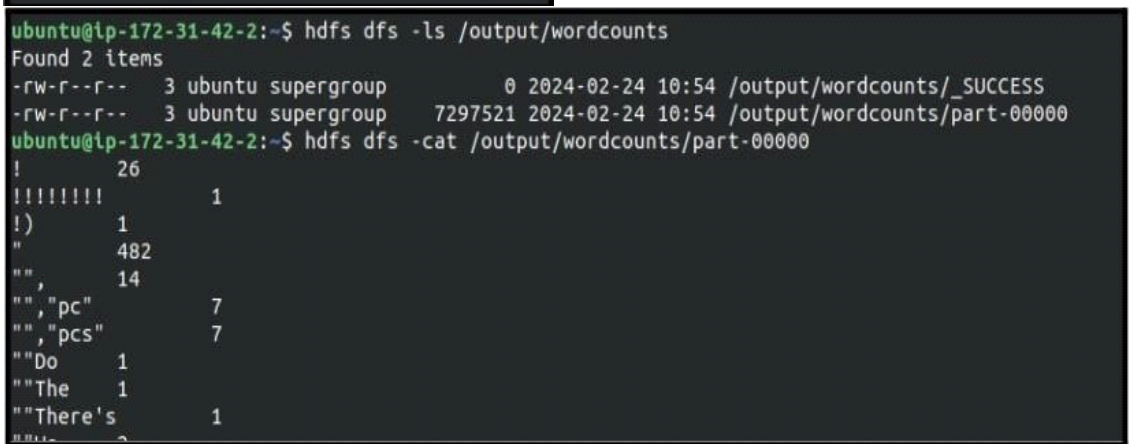


With Hadoop multi-node cluster









Conclusion:

In conclusion, setting up a multi-node Hadoop cluster on AWS and implementing MapReducealgorithms allows for distributed data processing has significantly improve performance compared to single-node setups. The comparison of execution times shows efficiency of the cluster configuration.