Hadoop deployment and use HDFS

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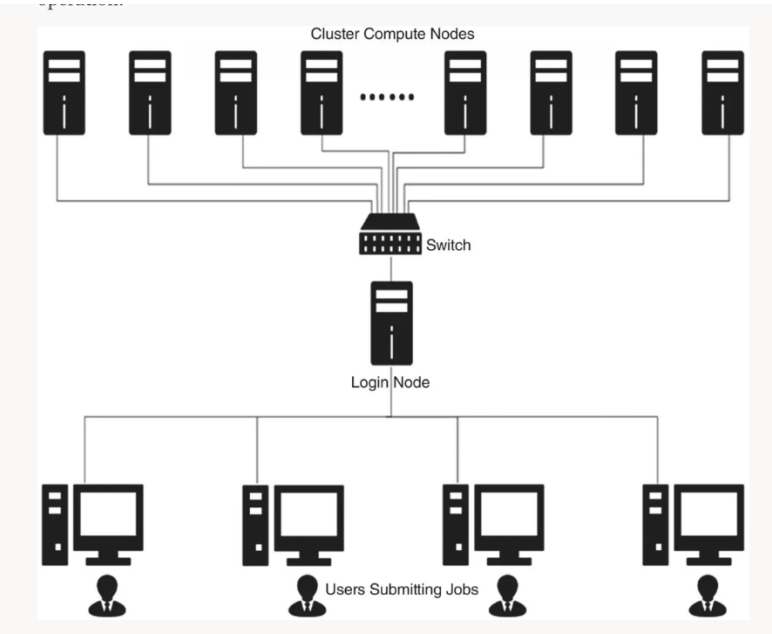
Table of Contents

Introduction

Our textbook describes cluster computing as a system involving multiple standalone PCs linked together to function as a single, integrated resource, offering heightened availability. These computing resources are connected via local area networks (LANs), creating a powerful virtual computer where each resource runs its own instance of an operating system.(1)



Given the exponential growth of data and the need for effective processing capabilities, Hadoop emerges as a vital tool in the big data ecosystem. Hadoop is designed to store and analyze vast amounts of data across a distributed environment using simple programming models. In this assignment , we will see the basics tips on how to manipulate it.

Task 1: Comparison of Hadoop Cluster Deployment Strategies

We have several ways to deploy the cluster: (1) (2) (3) (4)

- Standalone Mode: Hadoop runs on a single computer where the entire system is confined to one physical location.
- Pseudo-Distributed Mode: Each part of Hadoop that normally runs on separate machines runs on one machine.
- Fully Distributed Mode: Hadoop runs across many machines, splitting tasks among them to handle very large data sets efficiently.
- Cloud-Based Deployment: Hadoop runs on virtual machines in a data center managed by a cloud provider.
- Hybrid Deployment: Aa mix of on-premises and cloud-based resources, providing flexibility, especially for sensitive data that require more secure handling, while still offering scalability for less critical tasks

Strategy	Pros	Cons	Best use case
Standalone Mode	- Easy to set up and use. - Costs less as it uses existing computers.	- Only uses one computer. - Not good for big tasks or real-world use	Ideal for development and testing small datasets.
Pseudo-Distributed Mode	- Acts like a cluster but on one machine. - Good for catching problems early.	- Still limited to one computer. - Can't handle large data sets.	Suitable for developers simulating a cluster environment.

Fully Distributed Mode	- Uses many computers, so it's powerful and reliable. - Can grow as needed by adding more machines.	- Costs a lot to set up and keep running. - Needs a lot of technical skill to manage.	Large-scale data processing in enterprise environments.
Cloud-Based Deployment	- Can adjust to needs quickly, scaling up or down. - Less work to maintain as the service provider handles it.	- Security concerns since data is online. - Needs constant internet.	Businesses needing flexible computing resources without major upfront investment.
Hybrid Deployment	- Best of both worlds: control over critical data and cloud flexibility. - Can plan for disasters better	- Hard to manage because it combines two systems. - Can get expensive depending on setup.	Organizations with fluctuating workloads and strict data governance.

Real life examples

1. Standalone Mode

Example: A software developer working from home uses standalone mode to prototype a new data parsing algorithm. The initial development and testing phases are done on his local machine to debug and optimize the code before considering deployment on a larger scale.
Reference: "Using Hadoop in Standalone Mode," an article on DataFlair, DataFlair - Standalone Mode Hadoop, 2022.

2. Pseudo-Distributed Mode

Example: A tech startup utilizes pseudo-distributed mode to test their new recommendation system which integrates with their existing online retail platform. This setup allows them to simulate a distributed environment while using limited resources. Reference: "Configuring Hadoop in a Pseudo-Distributed Mode," a tutorial on Tutorialspoint, Tutorialspoint - Pseudo-Distributed Hadoop, 2021.

3. Fully Distributed Mode

Example: A healthcare analytics company processes large datasets of patient records across a fully distributed Hadoop cluster to identify trends and improve care outcomes. This deployment is crucial for handling the vast amount of data efficiently and in real time. Reference: "Benefits of Fully Distributed Mode in Hadoop," an analysis on GeeksforGeeks, GeeksforGeeks - Fully Distributed Hadoop, 2022.

4. Cloud-Based Deployment

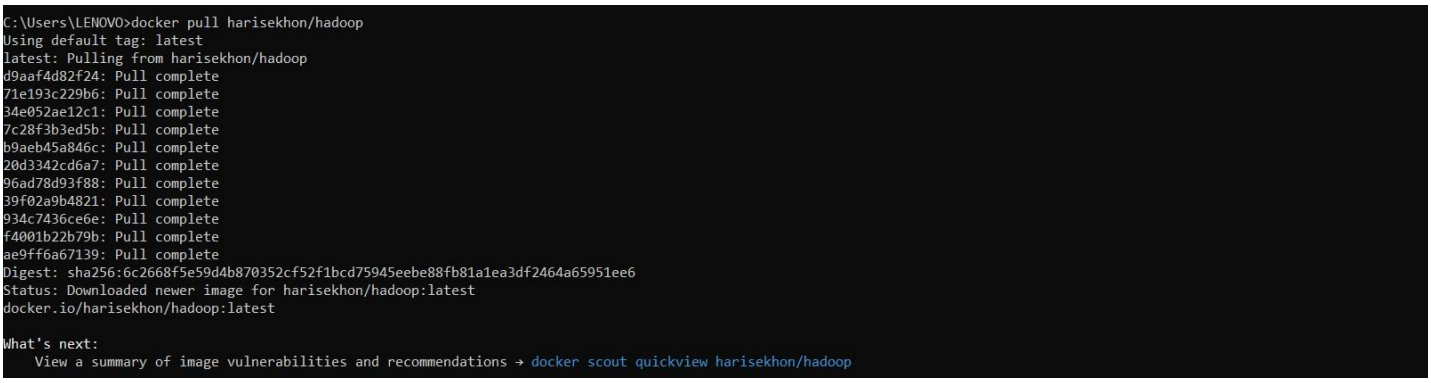
Example: An online media streaming service experiences variable viewer traffic and uses a cloud-based Hadoop deployment to manage this variability. They leverage Amazon EMR to quickly scale their processing capabilities during peak hours. Reference: "Scaling Big Data Processing with Cloud-Based Hadoop," an insight on InfoQ, InfoQ - Cloud-Based Hadoop, 2021.

5. Hybrid Deployment

Example: A multinational bank employs a hybrid Hadoop deployment where sensitive financial data is processed and stored on-premises while less sensitive data analytics tasks are performed in the cloud. This approach helps them maintain stringent security standards while still capitalizing on the scalability of cloud resources. Reference: "Navigating Hybrid Hadoop Deployments in Financial Services," an article on Hortonworks, Hortonworks - Hybrid Hadoop Deployment, 2020.

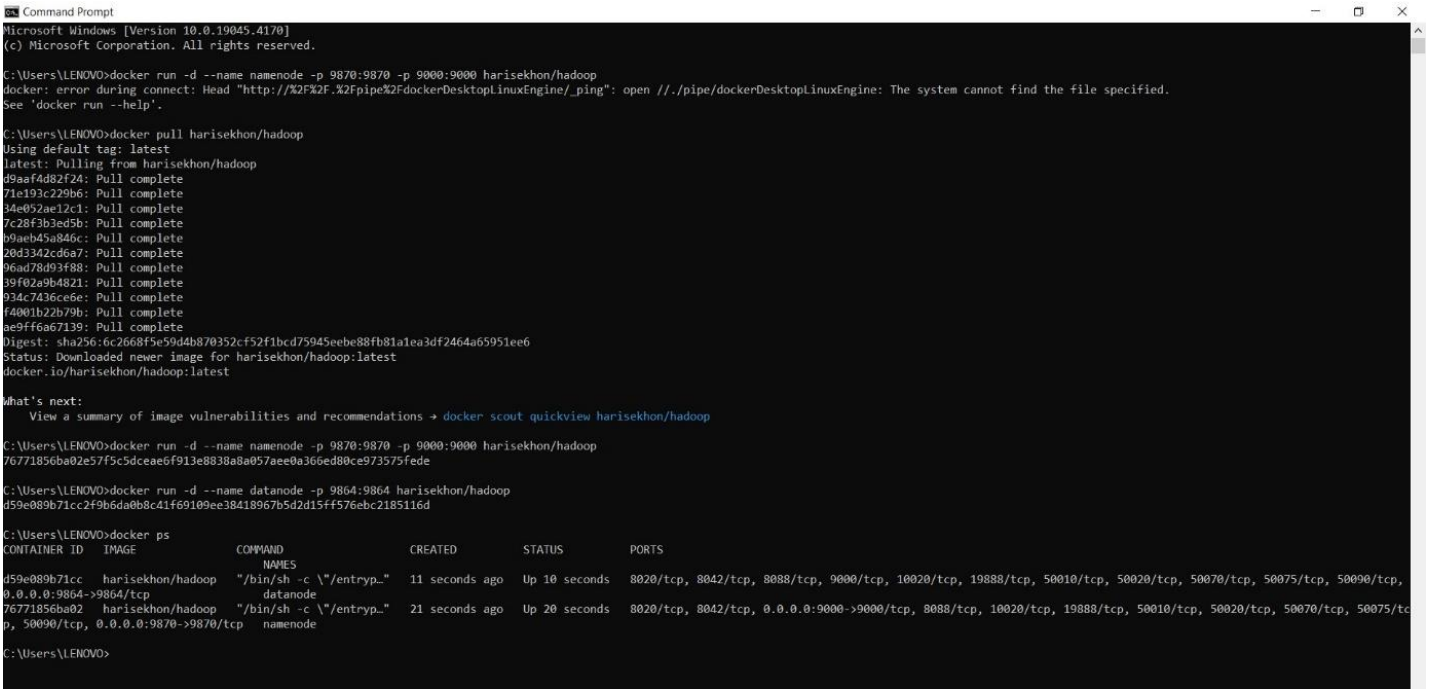
Task 2: Docker Integration and Hadoop Image Deployment

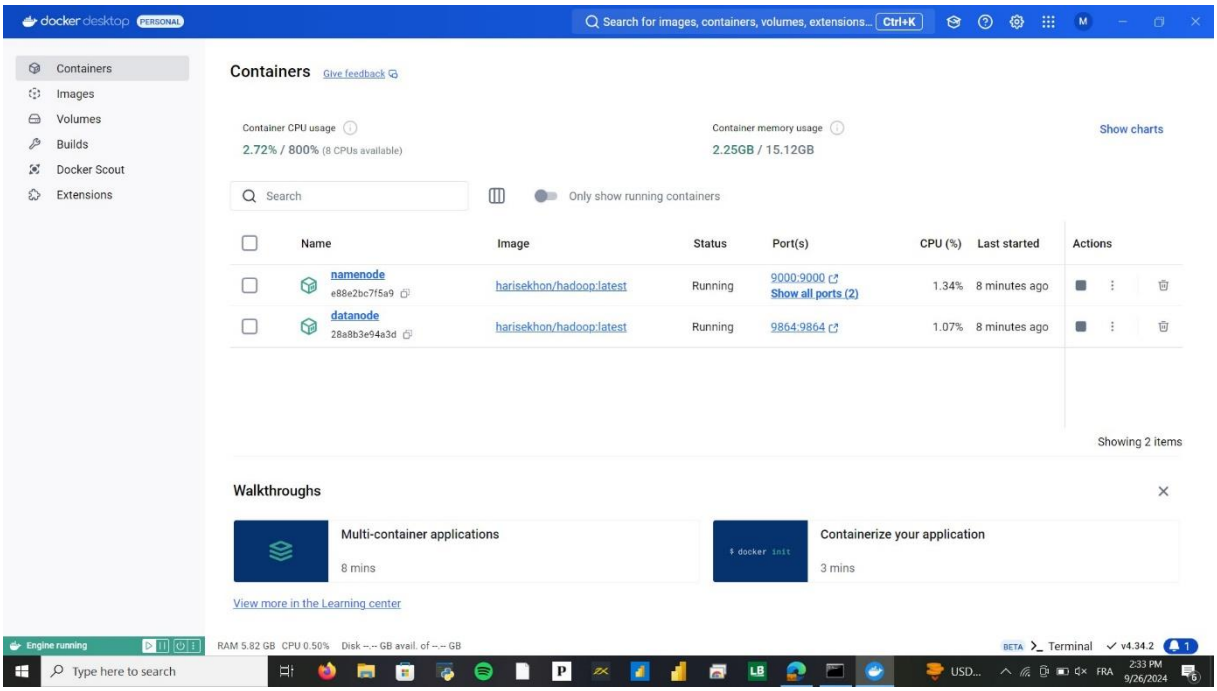
I successfully downloaded the Harisekhon Hadoop Docker image, which makes setting up Hadoop straightforward. This Docker image includes everything needed to run Hadoop without additional configuration.



Task 3: Configuration Insights of Namenode and Datanode

I have created two different containers.





For the Namenode, I demonstrated how to locate the fsimage and edit logs, which are crucial for understanding the state of the HDFS filesystem. For the Datanode, I showed where the data blocks, which store the actual data, are located.

```
@76771856ba02:/
[root@76771856ba02 /]#  cat /hadoop-2.8.2/etc/hadoop/hdfs-site.xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<configuration>
    <property>
        <name>dfs.replication</name>
        <value>1</value>
    </property>
</configuration>
[root@76771856ba02 /]# find / -name 'dfs'
/tmp/hadoop-root/dfs
[root@76771856ba02 /]# ls /tmp/hadoop-root/dfs/name/current
VERSION                             edits_inprogress_0000000000000000003  fsimage_0000000000000000000.md5  fsimage_0000000000000000002.md5
edits_0000000000000000001-0000000000000000002  fsimage_0000000000000000000           fsimage_0000000000000000002      seen_txid
[root@76771856ba02 /]# ls /tmp/hadoop-root/dfs/data/current
BP-1947034320-172.17.0.2-1510154331033  VERSION
[root@76771856ba02 /]#
```

On the name node I showed where the fsimage and edit logs are located.

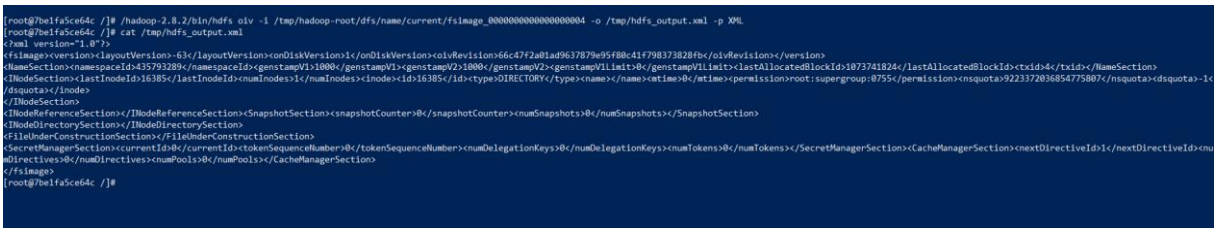
Data blocks

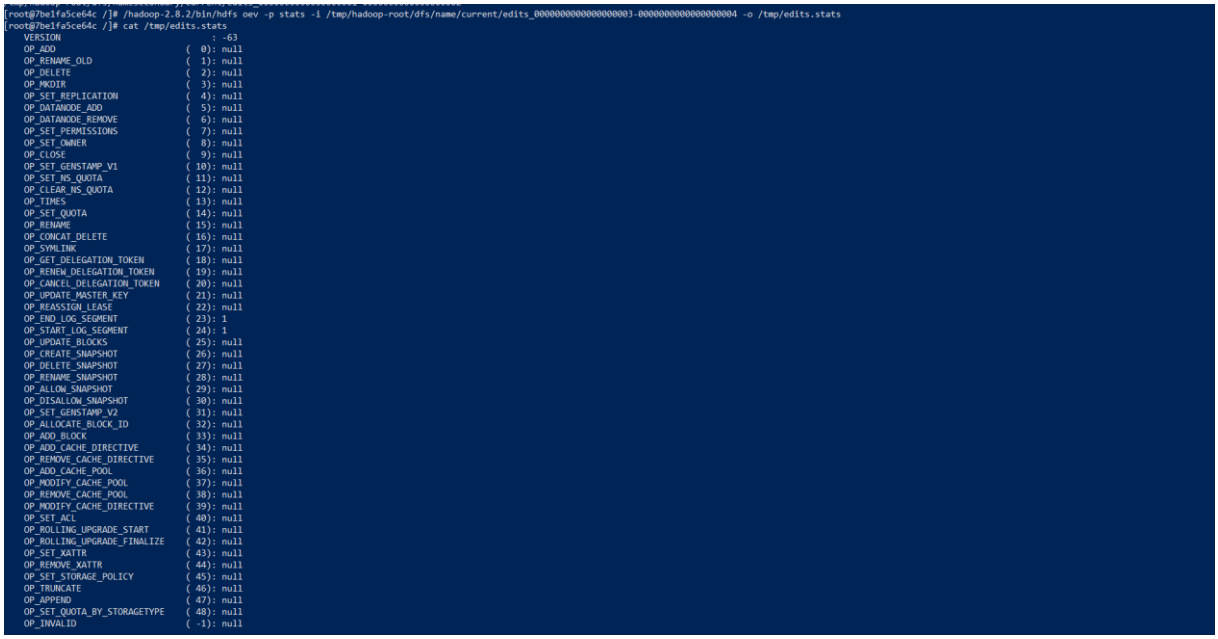
```
Command Prompt
C:\Users\LENOVO>docker exec -it datanode /bin/bash
[root@c450a54a7c0e /]# ls /tmp/hadoop-root/dfs/data/current
BP-1947034320-172.17.0.2-1510154331033  VERSION
[root@c450a54a7c0e /]# exit
exit

C:\Users\LENOVO>
```

```
exit
PS C:\Users\LENOVO> docker cp "C:\Users\LENOVO\OneDrive\Bureau\nouveau 1.txt" datanode:/hadoop/dfs/data/
Successfully copied 2.05kB to datanode:/hadoop/dfs/data/
PS C:\Users\LENOVO>
```

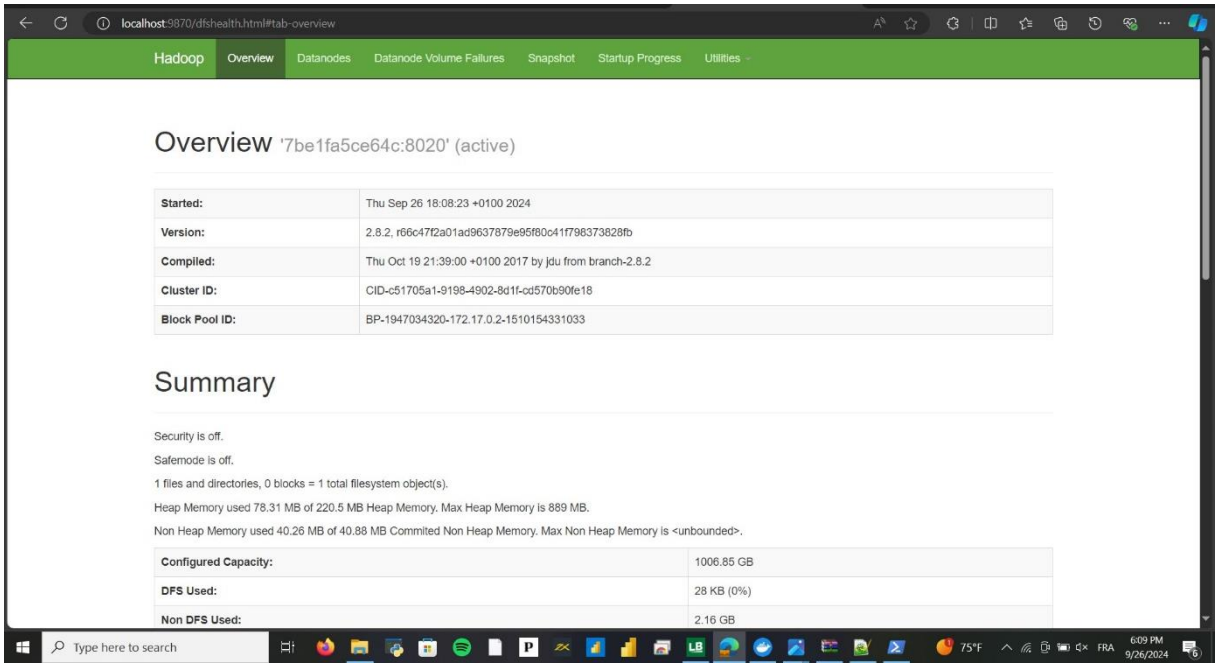
```
The filesystem under path '/user/root/mydata/nouveau1.txt' is HEALTHY
[root@c450a54a7c0e /]# hdfs fsck /user/root/mydata/nouveau1.txt -files -blocks -locations
Connecting to namenode via http://c450a54a7c0e:50070/fsck?ugi=root&files=1&blocks=1&locations=1&path=%2Fuser%2Froot%2Fmy
data%2Fnouveau1.txt
FSCK started by root (auth:SIMPLE) from /172.17.0.3 for path /user/root/mydata/nouveau1.txt at Thu Sep 26 16:14:57 UTC 2
024
/user/root/mydata/nouveau1.txt 17 bytes, 1 block(s):  OK
0. BP-1947034320-172.17.0.2-1510154331033:blk_1073741825_1001 len=17 Live_repl=1 [DatanodeInfoWithStorage[172.17.0.3:500
10,DS-a8a8726a-57df-4bbb-826c-78a81bd27dc1,DISK]]

Status: HEALTHY
 Total size:    17 B
 Total dirs:    0
 Total files:   1
 Total symlinks:                0
 Total blocks (validated):      1 (avg. block size 17 B)
 Minimally replicated blocks:   1 (100.0 %)
 Over-replicated blocks:        0 (0.0 %)
 Under-replicated blocks:       0 (0.0 %)
 Mis-replicated blocks:         0 (0.0 %)
 Default replication factor:    1
 Average block replication:     1.0
 Corrupt blocks:                0
 Missing replicas:              0 (0.0 %)
 Number of data-nodes:          1
 Number of racks:               1
FSCK ended at Thu Sep 26 16:14:57 UTC 2024 in 0 milliseconds


The filesystem under path '/user/root/mydata/nouveau1.txt' is HEALTHY
```

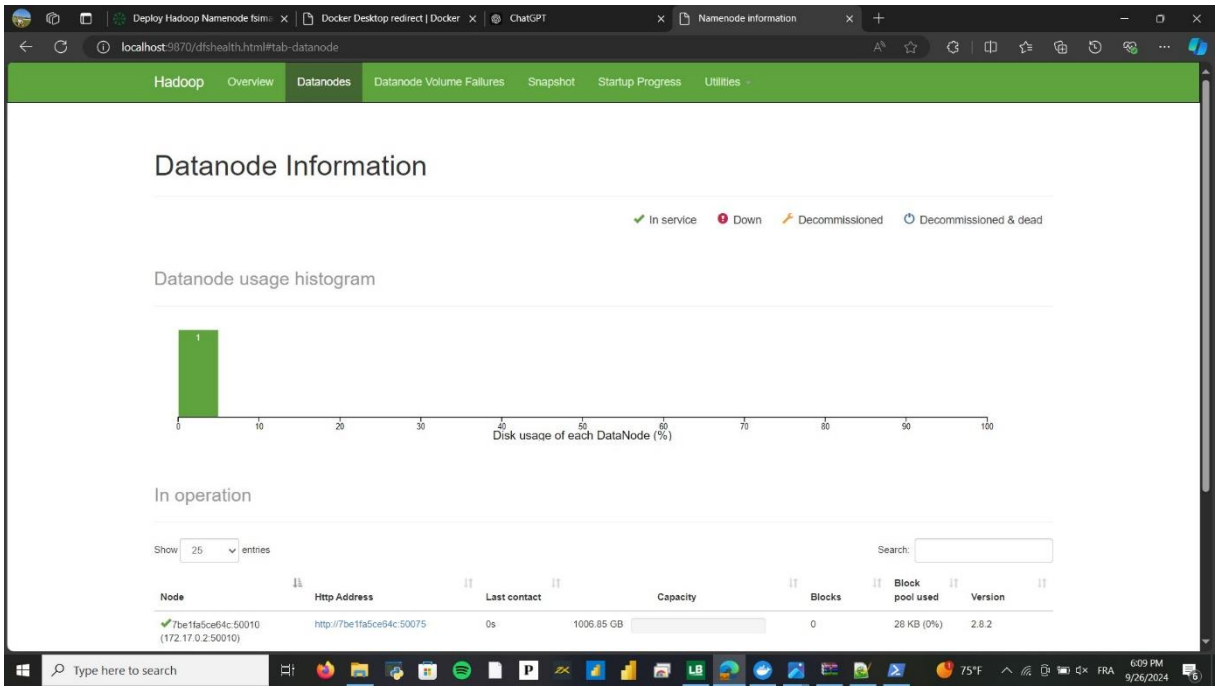
Task 4: Command Line Mastery for HDFS Information Extraction

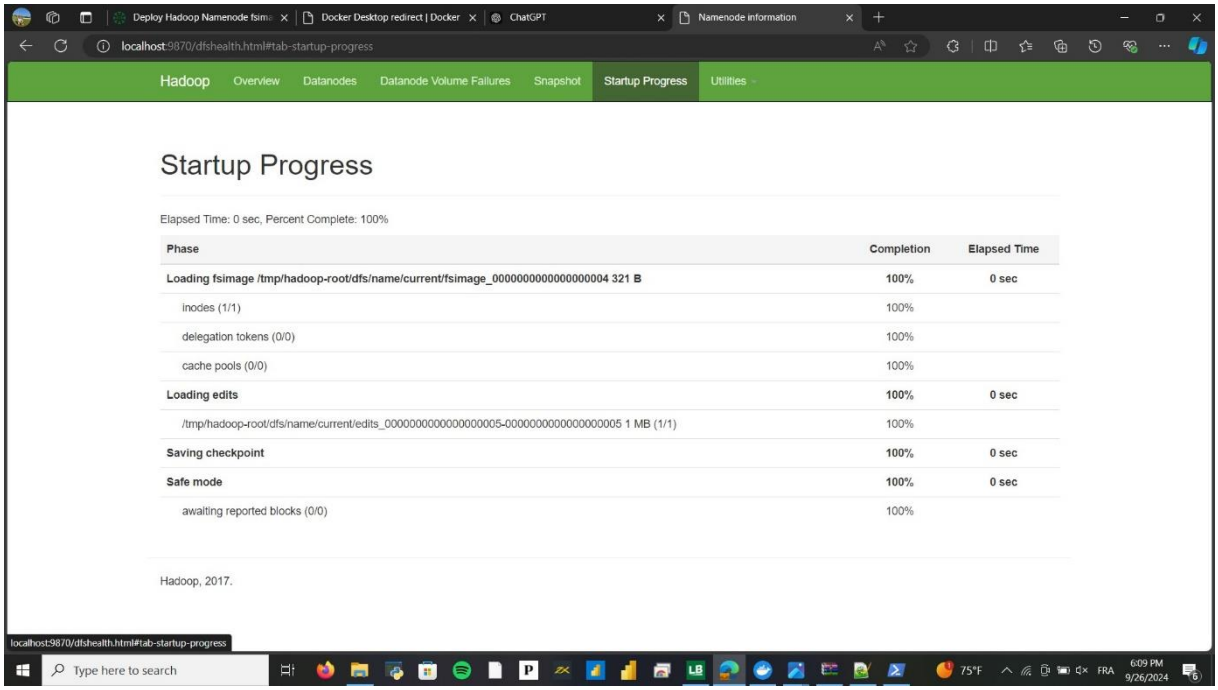




Task 5: Web Interface Utilization for Detailed HDFS Insights

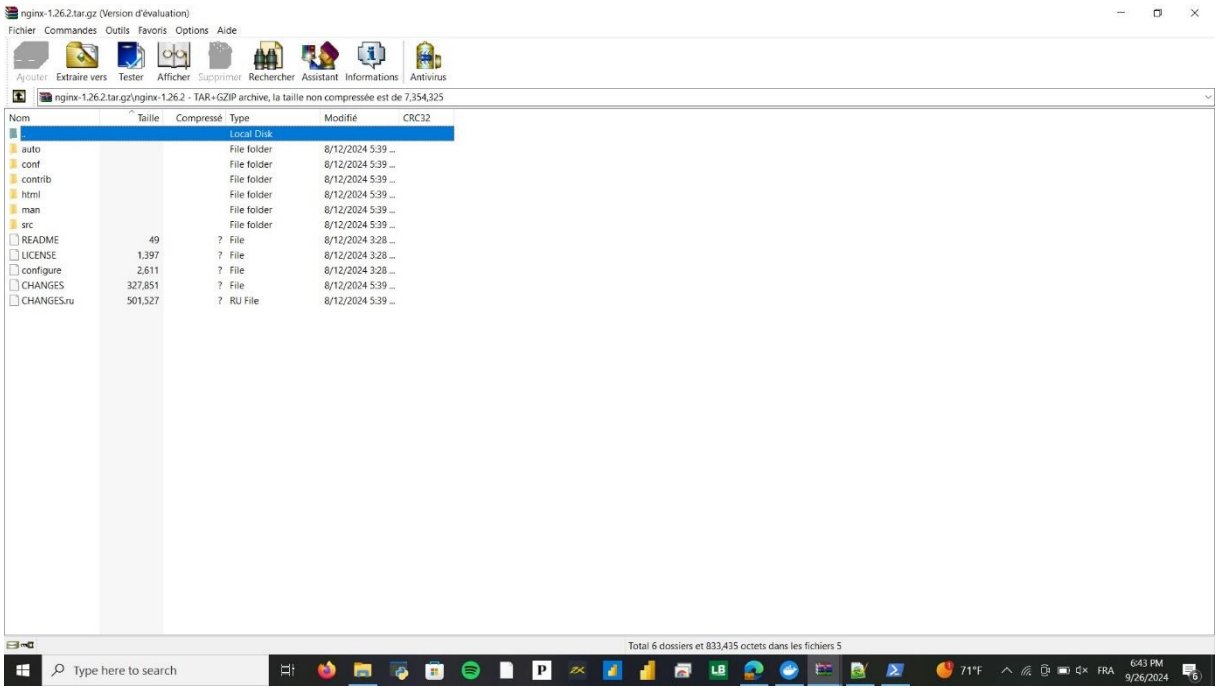


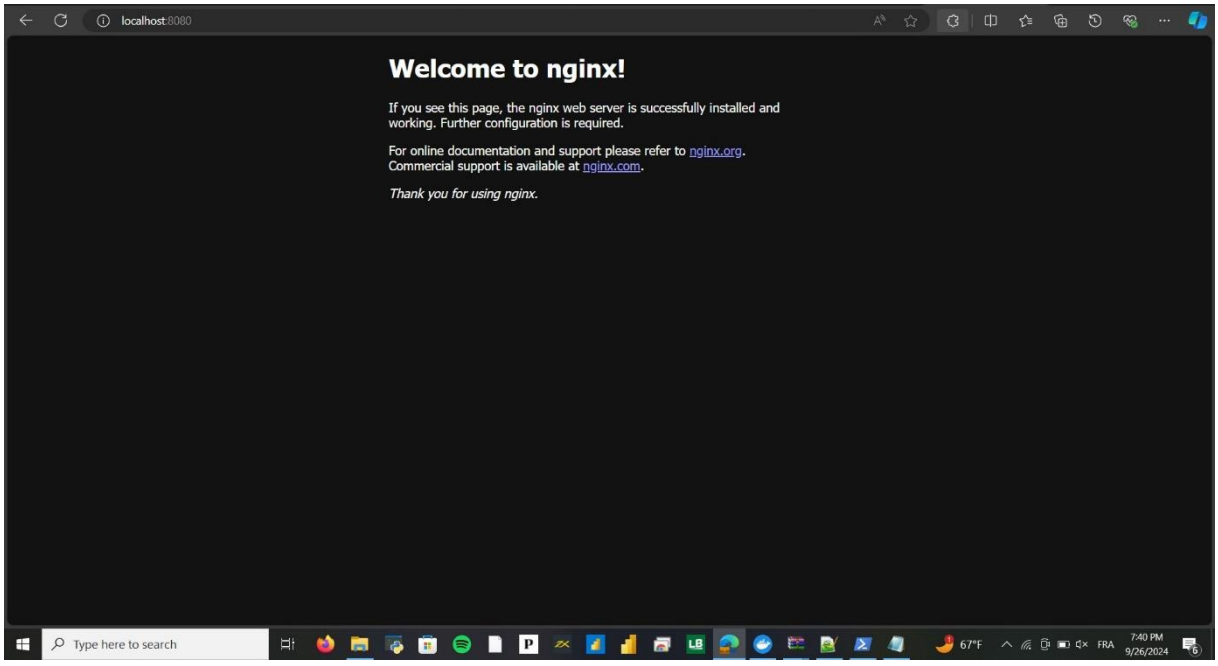

Deploy Hadoop Namenode fsima
Docker Desktop redirect | Docker
ChatGPT
Namenode information
localhost:9870/dfshealth.html#tab-datanode
Hadoop
Overview
Datanodes
Datanode Volume Failures
Snapshot
Startup Progress
Utilities
Datanode Information
In service
Down
Decommissioned
Decommissioned & dead
Datanode usage histogram
1
0
10
20
30
40
50
60
70
80
90
100
Disk usage of each DataNode (%)
In operation
Show 25 entries
Search:
Node
Http Address
Last contact
Capacity
Blocks
Block pool used
Version
7be1fa5ce64c:50010 (172.17.0.2:50010)
http://7be1fa5ce64c:50075
0s
1006.85 GB
0
28 KB (0%)
2.8.2
Type here to search
75°F
FRA
6:09 PM
9/26/2024

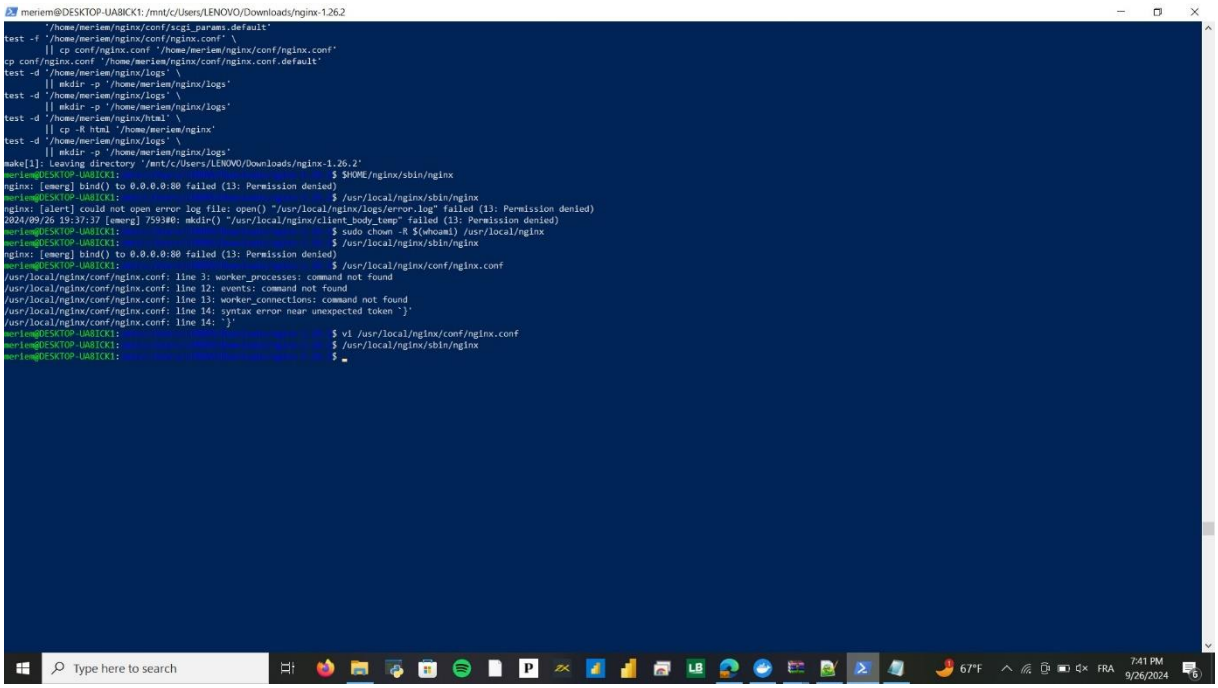

Deploy Hadoop Namenode fsima
Docker Desktop redirect | Docker
ChatGPT
Namenode information
localhost:9870/dfshealth.html#tab-startup-progress
Hadoop
Overview
Datanodes
Datanode Volume Failures
Snapshot
Startup Progress
Utilities
Startup Progress
Elapsed Time: 0 sec, Percent Complete: 100%
Phase
Completion
Elapsed Time
Loading fsimage /tmp/hadoop-root/dfs/name/current/fsimage_0000000000000000004 321 B
100%
0 sec
inodes (1/1)
100%
delegation tokens (0/0)
100%
cache pools (0/0)
100%
Loading edits
100%
0 sec
/tmp/hadoop-root/dfs/name/current/edits_0000000000000000005-0000000000000000005 1 MB (1/1)
100%
Saving checkpoint
100%
0 sec
Safe mode
100%
0 sec
awaiting reported blocks (0/0)
100%
Hadoop, 2017.
localhost:9870/dfshealth.html#tab-startup-progress
Type here to search
75°F
FRA
6:09 PM
9/26/2024

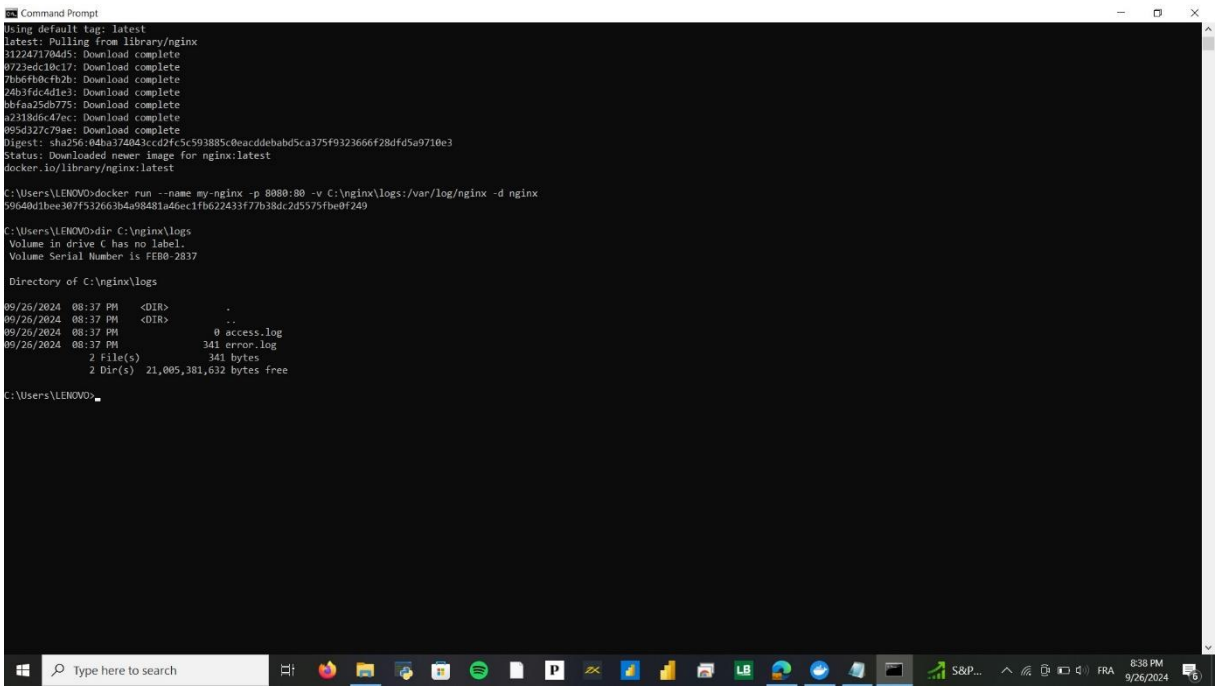
Task 6: Real-World Data Manipulation with Nginx Logs

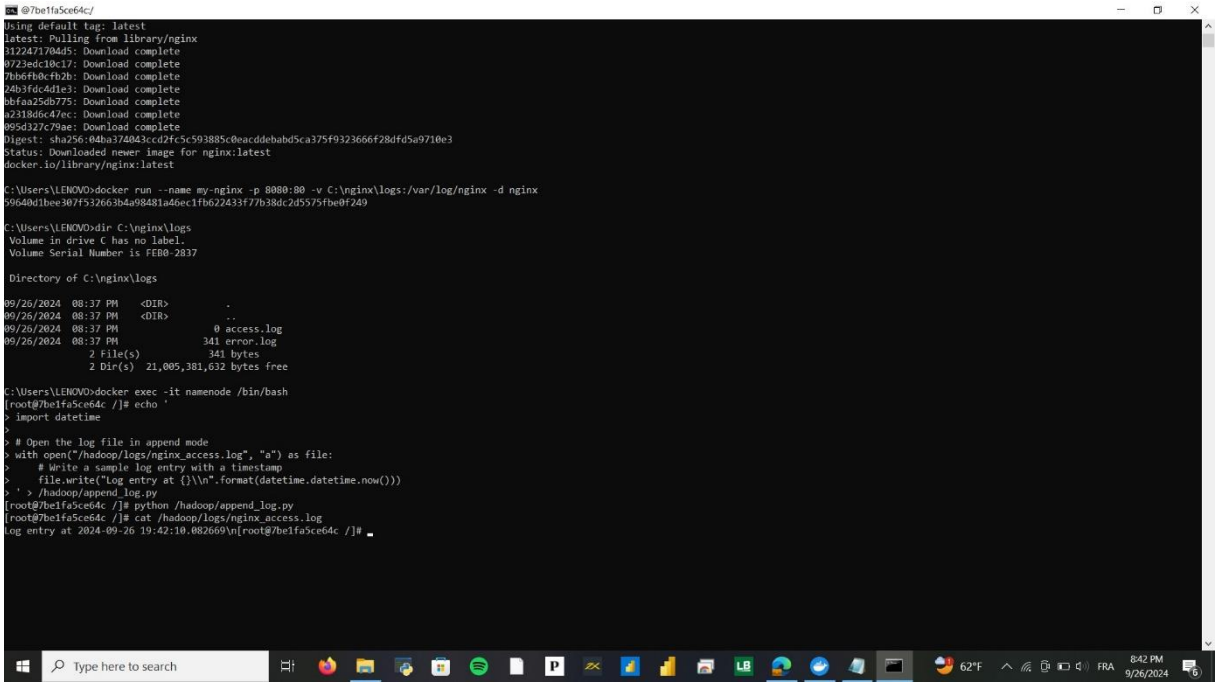
I used a combination of the echo command in the command prompt and Python scripting to interact with my system. First, I ran the echo command to quickly display or pass data to my Python script.






meriem@DESKTOP-UA8ICK1: /mnt/c/Users/LENOVO/Downloads/nginx-1.26.2
'/home/meriem/nginx/conf/scgi_params.default'
test -f '/home/meriem/nginx/conf/nginx.conf' \
|| cp conf/nginx.conf '/home/meriem/nginx/conf/nginx.conf'
cp conf/nginx.conf '/home/meriem/nginx/conf/nginx.conf.default'
test -d '/home/meriem/nginx/logs' \
|| mkdir -p '/home/meriem/nginx/logs'
test -d '/home/meriem/nginx/logs' \
|| mkdir -p '/home/meriem/nginx/logs'
test -d '/home/meriem/nginx/html' \
|| cp -R html '/home/meriem/nginx'
test -d '/home/meriem/nginx/logs' \
|| mkdir -p '/home/meriem/nginx/logs'
make[1]: Leaving directory '/mnt/c/Users/LENOVO/Downloads/nginx-1.26.2'
$ $HOME/nginx/sbin/nginx
nginx: [emerg] bind() to 0.0.0.0:80 failed (13: Permission denied)
$ /usr/local/nginx/sbin/nginx
nginx: [alert] could not open error log file: open() "/usr/local/nginx/logs/error.log" failed (13: Permission denied)
2024/09/26 19:37:37 [emerg] 7593#0: mkdir() "/usr/local/nginx/client_body_temp" failed (13: Permission denied)
$ sudo chown -R ${whoami} /usr/local/nginx
$ /usr/local/nginx/sbin/nginx
nginx: [emerg] bind() to 0.0.0.0:80 failed (13: Permission denied)
$ /usr/local/nginx/conf/nginx.conf
/usr/local/nginx/conf/nginx.conf: line 3: worker_processes: command not found
/usr/local/nginx/conf/nginx.conf: line 12: events: command not found
/usr/local/nginx/conf/nginx.conf: line 13: worker_connections: command not found
/usr/local/nginx/conf/nginx.conf: line 14: syntax error near unexpected token `}'
/usr/local/nginx/conf/nginx.conf: line 14: `}'
$ vi /usr/local/nginx/conf/nginx.conf
$ /usr/local/nginx/sbin/nginx
$
Type here to search
67°F
FRA
7:41 PM
9/26/2024

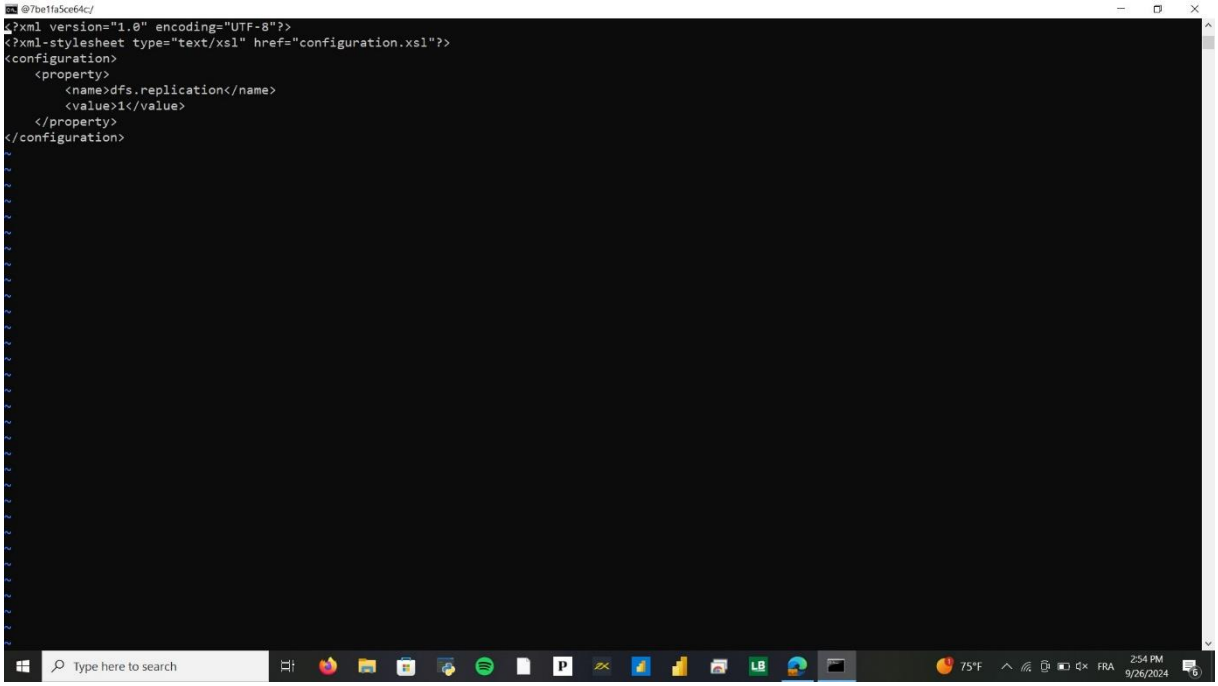

Command Prompt
Using default tag: latest
latest: Pulling from library/nginx
3122471704d5: Download complete
0723edc10c17: Download complete
7bb6fb0cfb2b: Download complete
24b3fdc4d1e3: Download complete
bbfaa25db775: Download complete
a2318d6c47ec: Download complete
005d327c79ae: Download complete
Digest: sha256:04ba374043ccd2fc5c593885c0eacddebabd5ca375f9323666f28dfd5a9710e3
Status: Downloaded newer image for nginx:latest
docker.io/library/nginx:latest
C:\Users\LENOVO>docker run --name my-nginx -p 8080:80 -v C:\nginx\logs:/var/log/nginx -d nginx
59640d1bee307f532663b4a98481a46ec1fb622433f77b38dc2d5575fbe0f249
C:\Users\LENOVO>dir C:\nginx\logs
Volume in drive C has no label.
Volume Serial Number is FEB0-2837
Directory of C:\nginx\logs
09/26/2024 08:37 PM <DIR> .
09/26/2024 08:37 PM <DIR> ..
09/26/2024 08:37 PM 0 access.log
09/26/2024 08:37 PM 341 error.log
2 File(s) 341 bytes
2 Dir(s) 21,005,381,632 bytes free
C:\Users\LENOVO>
Type here to search
S&P...
FRA
8:38 PM
9/26/2024


@7be1fa5ce64c:/
Using default tag: latest
latest: Pulling from library/nginx
3122471704d5: Download complete
0723edc10c17: Download complete
7bb6fb0cfb2b: Download complete
24b3fdc4d1e3: Download complete
bbfaa25db775: Download complete
a2318d6c47ec: Download complete
095d327c79ae: Download complete
Digest: sha256:04ba374043ccd2fc5c593885c0eacddebabd5ca375f9323666f28dfd5a9710e3
Status: Downloaded newer image for nginx:latest
docker.io/library/nginx:latest
C:\Users\LENOVO>docker run --name my-nginx -p 8080:80 -v C:\nginx\logs:/var/log/nginx -d nginx
59640d1bee307f532663b4a98481a46ec1fb622433f77b38dc2d5575fbe0f249
C:\Users\LENOVO>dir C:\nginx\logs
Volume in drive C has no label.
Volume Serial Number is FEB0-2837
Directory of C:\nginx\logs
09/26/2024 08:37 PM <DIR> .
09/26/2024 08:37 PM <DIR> ..
09/26/2024 08:37 PM 0 access.log
09/26/2024 08:37 PM 341 error.log
2 File(s) 341 bytes
2 Dir(s) 21,005,381,632 bytes free
C:\Users\LENOVO>docker exec -it namenode /bin/bash
[root@7be1fa5ce64c /]# echo '
> import datetime
>
> # Open the log file in append mode
> with open("/hadoop/logs/nginx_access.log", "a") as file:
> # Write a sample log entry with a timestamp
> file.write("Log entry at {}\\n".format(datetime.datetime.now()))
> ' > /hadoop/append_log.py
[root@7be1fa5ce64c /]# python /hadoop/append_log.py
[root@7be1fa5ce64c /]# cat /hadoop/logs/nginx_access.log
Log entry at 2024-09-26 19:42:10.082669\n[root@7be1fa5ce64c /]#
Type here to search
62°F
FRA
8:42 PM
9/26/2024

Challenges and conclusion

Throughout this project, I encountered several challenges, particularly in locating the necessary log files. The process involved installing and uninstalling Nginx multiple times, which was compounded by technical difficulties that necessitated a switch back to using the terminal. I couldn’t find the log files easily; I had to install and uninstall nginx and then switch again to terminal.

The following picture is a bug of terminal that I have faced, for hits reason I switched to power shell, where I could past eeasily command in case I made mistakes



Despite the obstacles, this assignment has been instrumental in enhancing my understanding of Hadoop's operational environment and its deployment using Docker. I successfully navigated through various configurations of Namenodes and Datanodes, utilized the command line and web interfaces to extract detailed file system information, and managed real-world data with Nginx logs.

References:

1. Etextbook: Big Data: Concepts, Technology, and Architecture by Balamurugan Balusamy, Nandhini Abirami R, Seifedine Kadry, Amir H. Gandomi Links to an external site.

   "Using Hadoop in Standalone Mode," DataFlair - Standalone Mode Hadoop, 2022.

2. https://data-flair.training/blogs/hadoop-tutorials-home/
3. Creating a Hadoop Pseudo-Distributed Environment | by District Data Labs | District Insights | Medium
4. Hadoop - Different Modes of Operation - GeeksforGeeks
5. **Hortonworks unveils roadmap to make Hadoop cloud-native | ZDNET**
6. **youtube.com/watch?v=hLnB0uzGvDI**
7. **Hadoop&cie - 02 - Installation de Hadoop avec Docker (youtube.com)**