–SPAM & HAM Classification–
–CA675

Name- Pranjnay Bhardwaj

Student No:- 23265772

Email:-pranjnay.bhardwaj2@mail.dcu.ie

GitLabrepoLink:-https://gitlab.computing.dcu.ie/bhardwp2/CA675_Cloud_Assignments_23265772

Cloud Platform(AWS):-https://awsacademy.instructure.com/courses/58839/modules/items/5186817

Dataset:-https://zenodo.org/records/8339691

The Dataset Named CEAS_08 has all the required columns in tabular CSV format needed for SQL-based RDBMS. It has sender, receiver, date, subject, body, label, urls. Rows Count-64824 is enough for preprocessing and Transformations using HQL.

sender	receiver	date	subject	body	label	urls
Young Esp	user4@gv	Tue, 05 Au	Never agr	Buck up,	1	1
Mok <iplir	user2.2@	Tue, 05 Au	Befriend J		1	1
Daily Top	user2.9@	Tue, 05 Au	CNN.com	>+=+=+=+:	1	1
Michael P	SpamAssa	Tue, 05 Au	Re: svn co	Would	0	1

Steps Taken:-

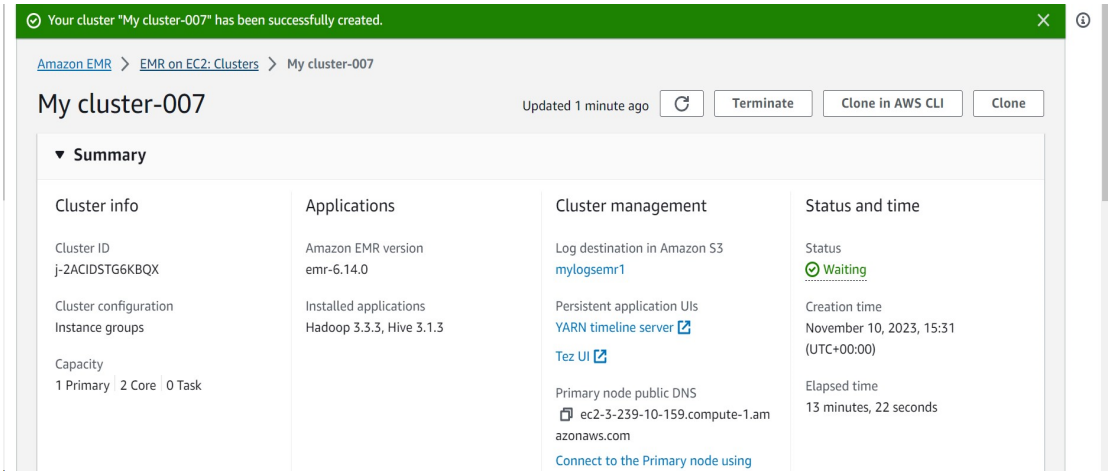
Cloud Infrastructure Setup:-

Cloud Technology Used:- AWS Cloud
Applications on Cloud premises used:- Hadoop, Hive, Spark

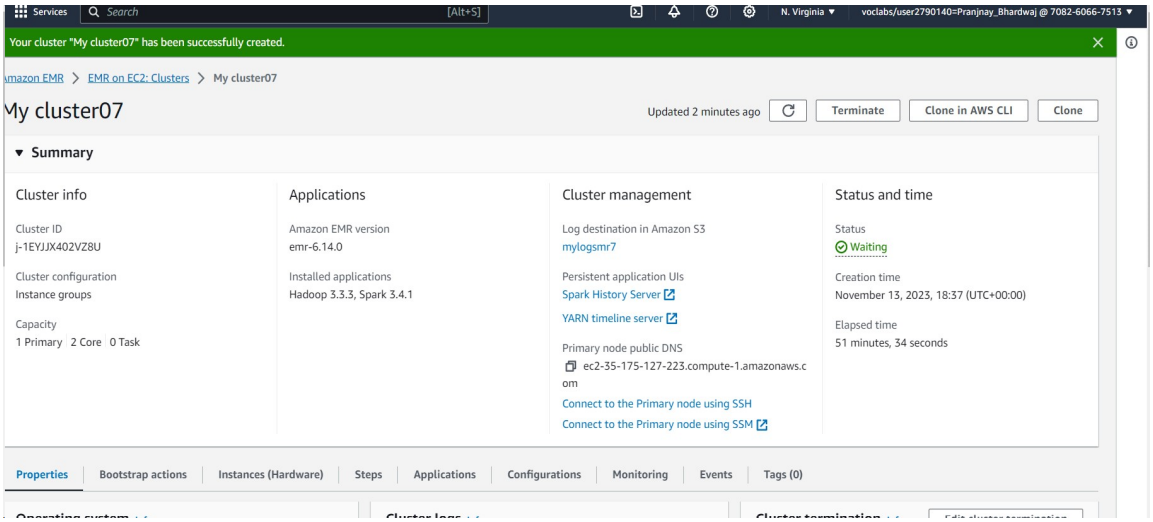
-Start Lab on Sandbox Download Pem file.

- Building AWS EMR Cluster:-

  1:-Cluster 1

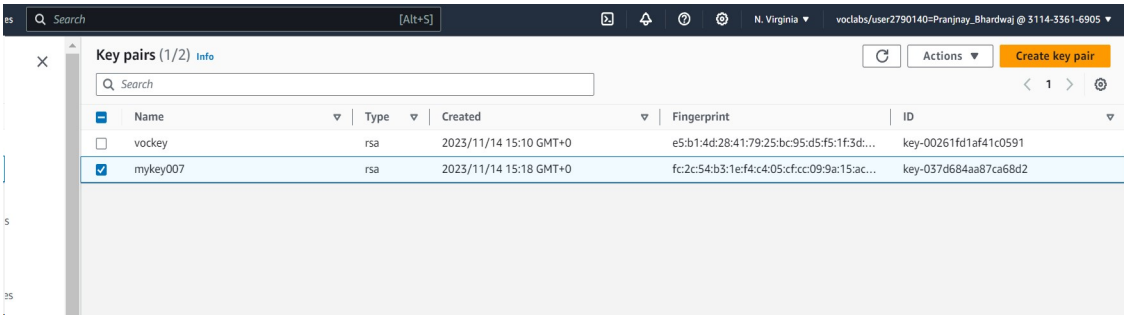


2:-Cluster 2



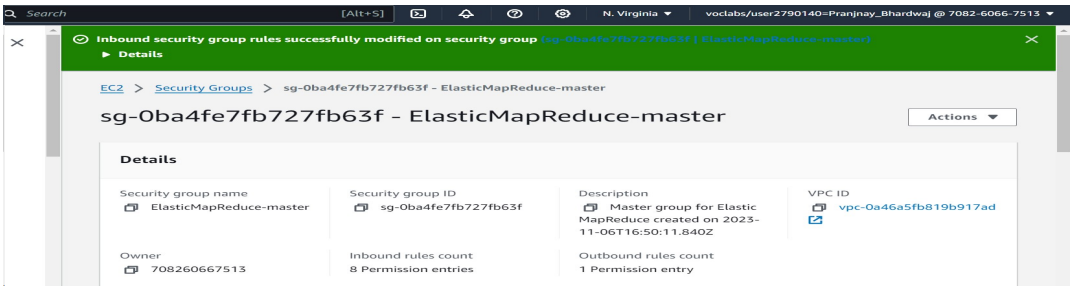
As you can see in the above screenshots the EMR cluster named My cluster07 & My cluster-007 have been created successfully with a log destination in the S3 directory mentioned above.
Specification:-Core:-2- M4large

Service role and EC2 Instance profile roles are used in creating clusters as default roles.
The key used- Vokey in Hive and while running 2nd cluster with spark -mykey007



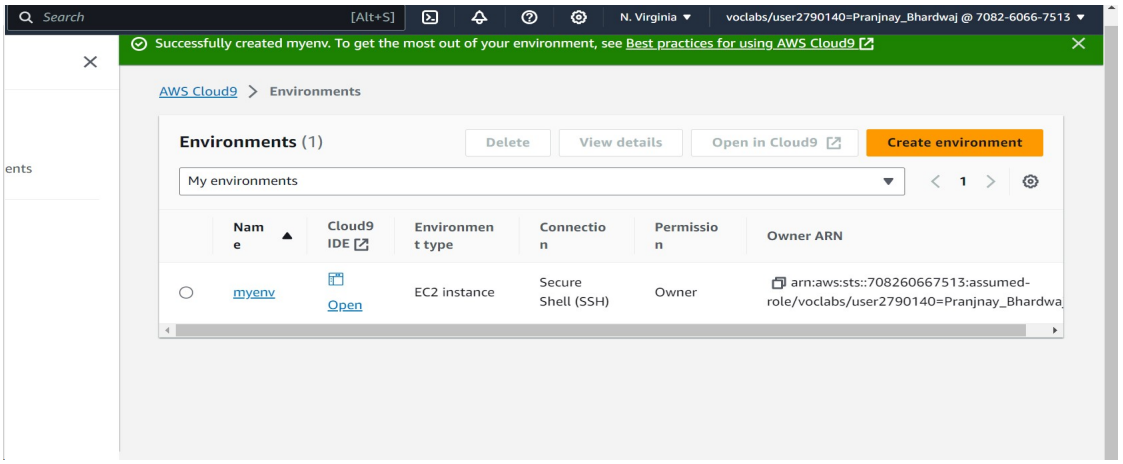
The above key is created for Putty.

Editing inbound rules:-



-Added SSH with Ipv4
-And for the 2nd Cluster with My IP.

- Once Public DNS is available with a waiting, we can move on to Creation of Cloud 9 Environment.
  - We need to select same subnet as given in cluster during creation of cloud 9 Environment



- Open Cloud 9 IDE and upload labuser.pem file and use chmod 400 labsuser.pem -To read file
  And then ssh -i labsuser.pem hadoop@<PUBLIC-DNS> -To connect
  Public DNS- copy from cluster

```
hadoop@ip-172-31-18-25 ×  Immediate
/oclabs:~/environment $ chmod 400 labsuser.pem
/oclabs:~/environment $ ssh -i labsuser.pem hadoop@ec2-54-160-174-213.compute-1.amazonaws.com
The authenticity of host 'ec2-54-160-174-213.compute-1.amazonaws.com (172.31.18.253)' can't be established.
ECDSA key fingerprint is SHA256:Apm5cJI5ZCYlvtSSBydWXJ4y1g7tkb9DEAneobh40GA.
ECDSA key fingerprint is MD5:da:9d:d0:89:12:85:5d:cc:d4:9d:78:e6:1b:fe:80:3b.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'ec2-54-160-174-213.compute-1.amazonaws.com,172.31.18.253' (ECDSA) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2
  ~~  \_#####\
  ~~     \###|       AL2 End of Life is 2025-06-30.
  ~~       \#/ ___
   ~~       V~' '->
    ~~~         /    A newer version of Amazon Linux is available!
      ~~._.   _/
         _/ _/       Amazon Linux 2023, GA and supported until 2028-03-15.
       _/m/'           https://aws.amazon.com/linux/amazon-linux-2023/

No packages needed for security; 1 packages available
Run "sudo yum update" to apply all updates.

EEEEEEEEEEEEEEEEEEE MMMMMMMM           MMMMMMMM RRRRRRRRRRRRRRR
E::::::::::::::::::E M:::::::M         M:::::::M R::::::::::::::R
E:::::EEEEEEEEE:::E M::::::::M       M::::::::M R:::::RRRRRR:::::R
  E::::E       EEEEE M:::::::::M     M:::::::::M RR::::R      R::::R
  E::::E             M::::::M:::M   M:::M::::::M   R::::R      R::::R
ECDSA key fingerprint is MD5:da:9d:d0:89:12:85:5d:cc:d4:9d:78:e6:1b:fe:80:3b.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'ec2-54-160-174-213.compute-1.amazonaws.com,172.31.18.253' (ECDSA) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2
  ~~  \_#####\
```

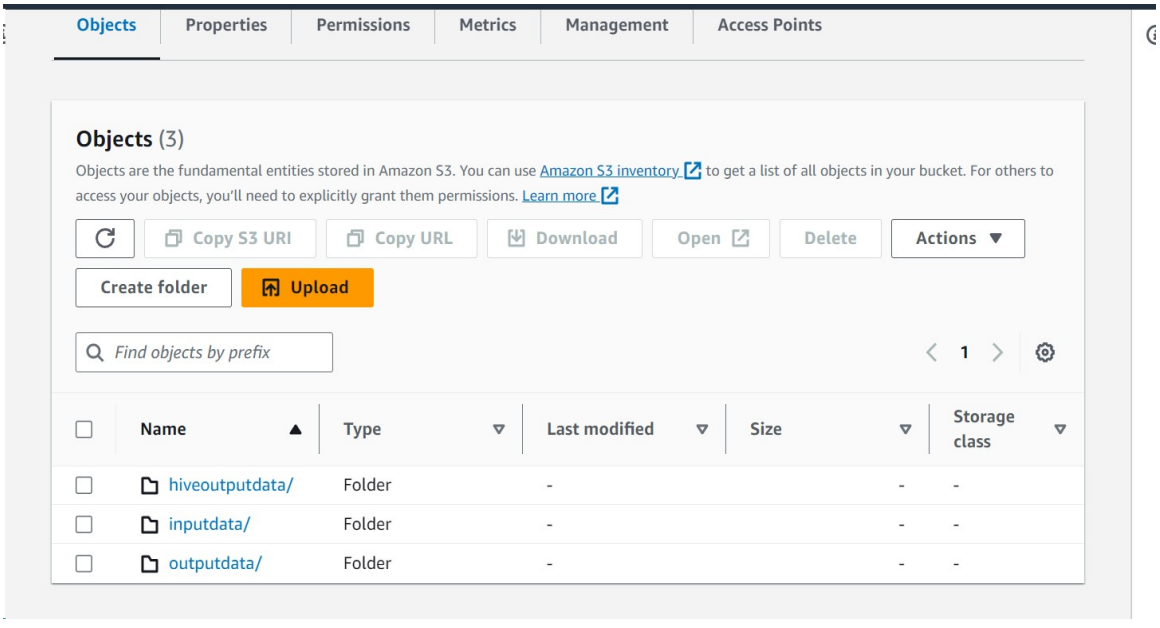
S3 Bucket Creation:-

I created 3 folders for input and output data in S3.

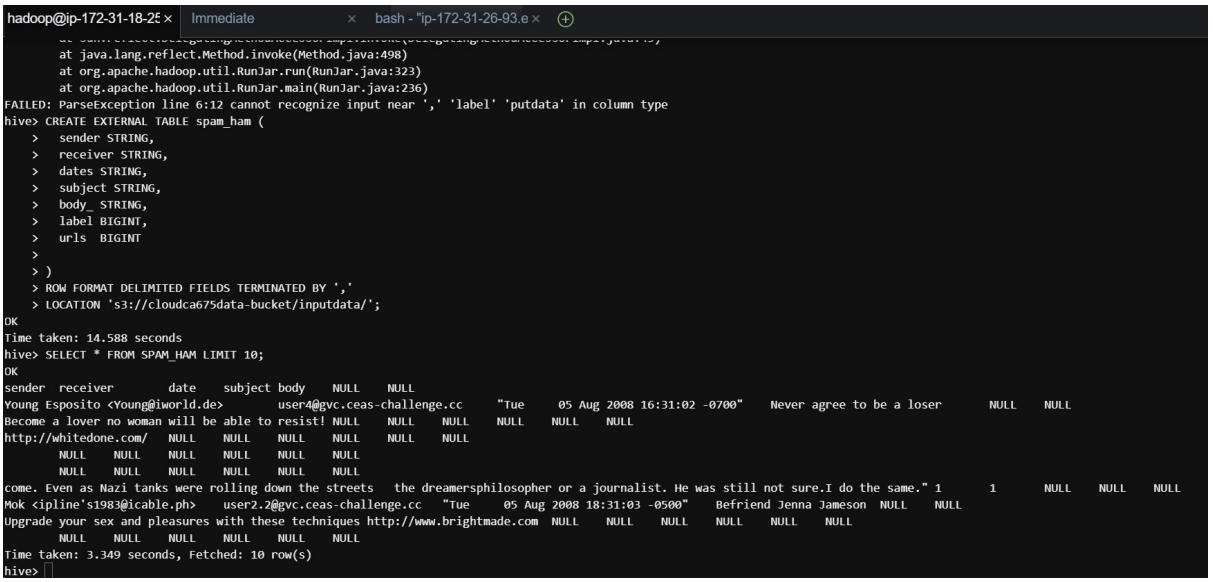
Using Commands & by using Create folder in S3 Buckets.

```
voclabs:~/environment $ aws s3api put-object --bucket cloudca675data-bucket --key inputdata/
{
    "ETag": "\"d41d8cd98f00b204e9800998ecf8427e\"",
    "ServerSideEncryption": "AES256"
}
voclabs:~/environment $ aws s3api put-object --bucket cloudca675data-bucket --key outputdata/
{
    "ETag": "\"d41d8cd98f00b204e9800998ecf8427e\"",
    "ServerSideEncryption": "AES256"
}
```

CSV file uploaded directly by Upload button in S3 folder.

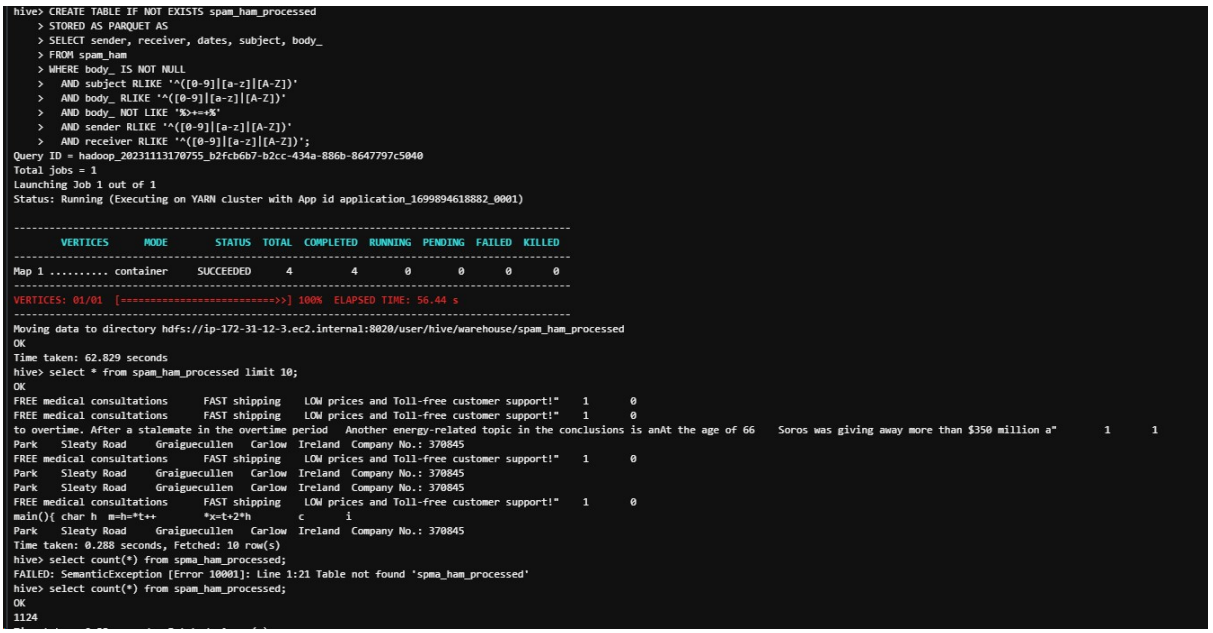


Trigger Hive:- To connect Hive
-typed hive-Got in Hive
Then I created a table using HQL for all the fields with columns as per CSV file.



The SPAM_HAM Table consists same data as per the CSV file and the data types are STRING & BIGINT.
See in above Screenshot.

Now for Cleaning & filtering- I created a separate table with the Spam_ham_processed filtering command in where clause such as RLIKE with pattern -RLIKE '^([0-9]|[a-z]|[A-Z])'; - to get rid all non-relevant text rows and NOT NULL conditions- to filter the body with no messages.



Post filtering & cleaning the count of relevant data is-1124

spam classification:-

I Created a new table spam classification on top of the spam_ham_processed table.

Then I used case statements with a set of spam words(Source:-Google) that are mostly found in spam emails.

If the word(Spam words) matches the body or subject of the sentence then it is spam otherwise it’s ham separated in the classification column of table spam_classification

See below the logic:-

```
hive> CREATE TABLE spam_classification AS
    > SELECT
    >     sender,
    >     receiver,
    >     dates,
    >     subject,
    >     body_,
    >     CASE
    >         WHEN LOWER(subject) RLIKE '.*earn.*' OR LOWER(body_) RLIKE '.*earn.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*cash.*' OR LOWER(body_) RLIKE '.*cash.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*free.*' OR LOWER(body_) RLIKE '.*free.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*cnn.*' OR LOWER(body_) RLIKE '.*cnn.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*order.*' OR LOWER(body_) RLIKE '.*order.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*credit.*' OR LOWER(body_) RLIKE '.*credit.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*debit.*' OR LOWER(body_) RLIKE '.*debit.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*sold.*' OR LOWER(body_) RLIKE '.*sold.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*sale.*' OR LOWER(body_) RLIKE '.*sale.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*100.*' OR LOWER(body_) RLIKE '.*100.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*money.*' OR LOWER(body_) RLIKE '.*money.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*urgent.*' OR LOWER(body_) RLIKE '.*urgent.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*price.*' OR LOWER(body_) RLIKE '.*price.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*welcome.*' OR LOWER(body_) RLIKE '.*welcome.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*click.*' OR LOWER(body_) RLIKE '.*click.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*amazing.*' OR LOWER(body_) RLIKE '.*amazing.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*guaranteed.*' OR LOWER(body_) RLIKE '.*guaranteed.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*benefit.*' OR LOWER(body_) RLIKE '.*benefit.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*looking.*' OR LOWER(body_) RLIKE '.*looking.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*affordable.*' OR LOWER(body_) RLIKE '.*affordable.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*save.*' OR LOWER(body_) RLIKE '.*save.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*biggest.*' OR LOWER(body_) RLIKE '.*biggest.*' THEN 'spam'
```

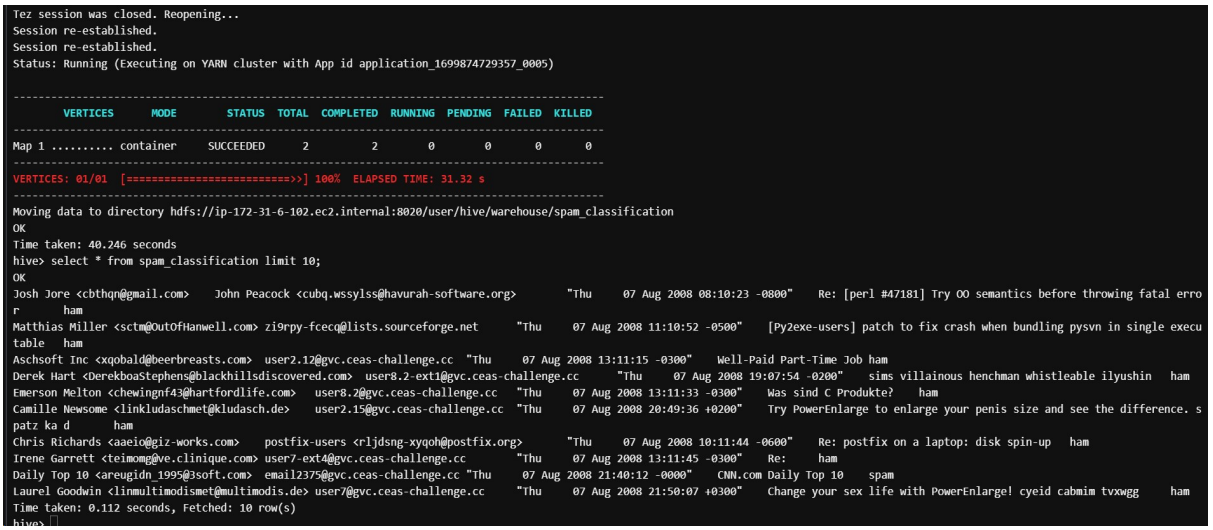
```
    >         WHEN LOWER(subject) RLIKE '.*guaranteed.*' OR LOWER(body_) RLIKE '.*guaranteed.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*benefit.*' OR LOWER(body_) RLIKE '.*benefit.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*looking.*' OR LOWER(body_) RLIKE '.*looking.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*affordable.*' OR LOWER(body_) RLIKE '.*affordable.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*save.*' OR LOWER(body_) RLIKE '.*save.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*biggest.*' OR LOWER(body_) RLIKE '.*biggest.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*mega.*' OR LOWER(body_) RLIKE '.*mega.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*get.*' OR LOWER(body_) RLIKE '.*get.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*shop.*' OR LOWER(body_) RLIKE '.*shop.*' THEN 'spam'
    >         WHEN LOWER(subject) RLIKE '.*great.*' OR LOWER(body_) RLIKE '.*great.*' THEN 'spam'
    >         ELSE 'ham'
    >     END AS classification
    > FROM spam_ham_processed;
Query ID = hadoop_20231113134026_a057496b-6147-4ea8-9b0c-5330d8cf8269
Total jobs = 1
Launching Job 1 out of 1
Tez session was closed. Reopening...
Session re-established.
Session re-established.
Status: Running (Executing on YARN cluster with App id application_1699874729357_0005)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED      2          2        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 01/01  [==========================>>] 100%  ELAPSED TIME: 31.32 s
--------------------------------------------------------------------------------
Moving data to directory hdfs://ip-172-31-6-102.ec2.internal:8020/user/hive/warehouse/spam_classification
OK
Time taken: 40.246 seconds
hive>
```

Data Check:-

After Classification

-See below the output for spam ham-

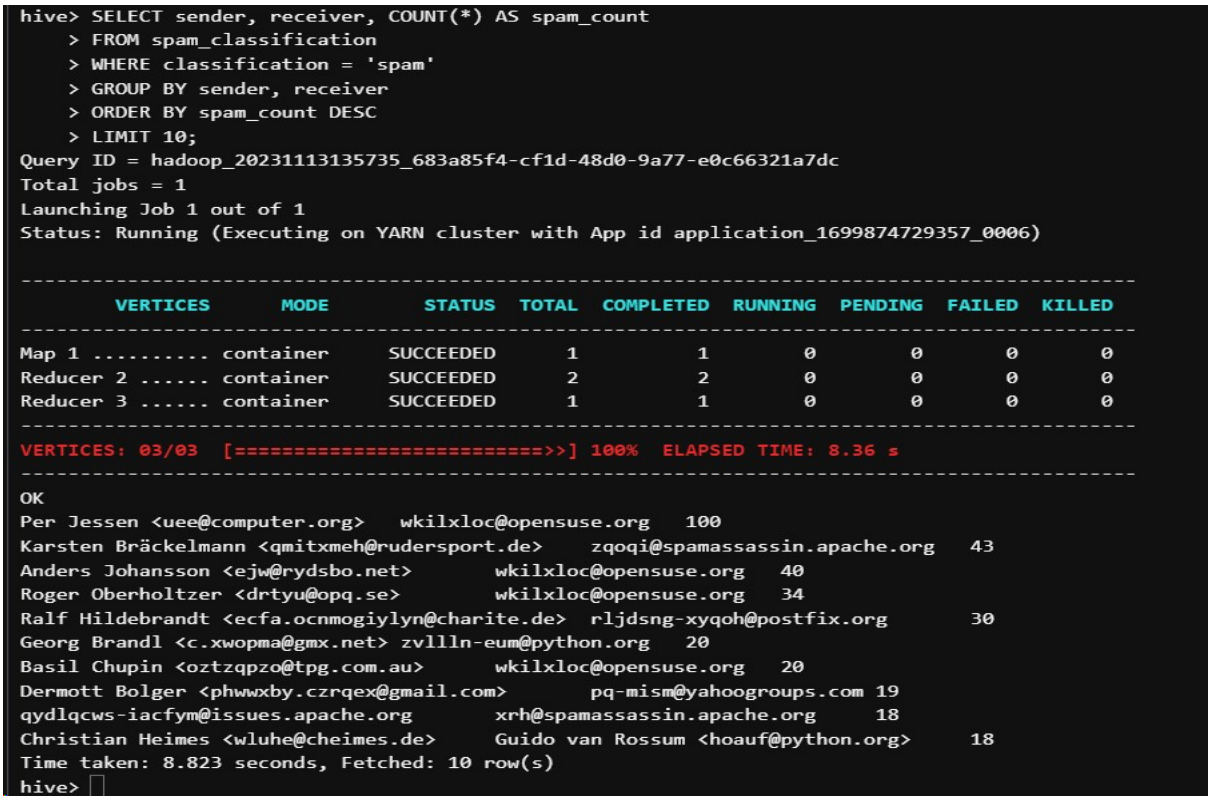
Observation:- The accuracy is quite low.



```
Tez session was closed. Reopening...
Session re-established.
Session re-established.
Status: Running (Executing on YARN cluster with App id application_1699874729357_0005)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 ......... container     SUCCEEDED      2          2        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 01/01  [==========================>>] 100%  ELAPSED TIME: 31.32 s
--------------------------------------------------------------------------------
Moving data to directory hdfs://ip-172-31-6-102.ec2.internal:8020/user/hive/warehouse/spam_classification
OK
Time taken: 40.246 seconds
hive> select * from spam_classification limit 10;
OK
Josh Jore <cbthqn@gmail.com>    John Peacock <cubq.wssylss@havurah-software.org>        "Thu     07 Aug 2008 08:10:23 -0800"    Re: [perl #47181] Try OO semantics before throwing fatal erro
r       ham
Matthias Miller <sctm@OutOfHanwell.com> zi9rpy-fcecq@lists.sourceforge.net      "Thu     07 Aug 2008 11:10:52 -0500"    [Py2exe-users] patch to fix crash when bundling pysvn in single execu
table   ham
Aschsoft Inc <xqobald@beerbreasts.com>  user2.12@gvc.ceas-challenge.cc  "Thu     07 Aug 2008 13:11:15 -0300"    Well-Paid Part-Time Job ham
Derek Hart <DerekboaStephens@blackhillsdiscovered.com>  user8.2-ext1@gvc.ceas-challenge.cc      "Thu     07 Aug 2008 19:07:54 -0200"    sims villainous henchman whistleable ilyushin   ham
Emerson Melton <chewingnf43@hartfordlife.com>   user8.2@gvc.ceas-challenge.cc   "Thu     07 Aug 2008 13:11:33 -0300"    Was sind C Produkte?    ham
Camille Newsome <linkludaschmet@kludasch.de>    user2.15@gvc.ceas-challenge.cc  "Thu     07 Aug 2008 20:49:36 +0200"    Try PowerEnlarge to enlarge your penis size and see the difference. s
patz ka d       ham
Chris Richards <aaeio@giz-works.com>    postfix-users <rljdsng-xyqoh@postfix.org>       "Thu     07 Aug 2008 10:11:44 -0600"    Re: postfix on a laptop: disk spin-up   ham
Irene Garrett <teimomg@ve.clinique.com> user7-ext4@gvc.ceas-challenge.cc        "Thu     07 Aug 2008 13:11:45 -0300"    Re:     ham
Daily Top 10 <areugidn_1995@3soft.com>  email2375@gvc.ceas-challenge.cc "Thu     07 Aug 2008 21:40:12 -0000"    CNN.com Daily Top 10    spam
Laurel Goodwin <linmultimodismet@multimodis.de> user7@gvc.ceas-challenge.cc     "Thu     07 Aug 2008 21:50:07 +0300"    Change your sex life with PowerEnlarge! cyeid cabmim tvxwgg     ham
Time taken: 0.112 seconds, Fetched: 10 row(s)
hive>
```

Top 10 Spam:-

Once we have Spam and Ham separated then using “spam” in where clause on the classification column of table spam_calssification with the count, I extracted the top 10 Spam accounts.



```
hive> SELECT sender, receiver, COUNT(*) AS spam_count
    > FROM spam_classification
    > WHERE classification = 'spam'
    > GROUP BY sender, receiver
    > ORDER BY spam_count DESC
    > LIMIT 10;
Query ID = hadoop_20231113135735_683a85f4-cf1d-48d0-9a77-e0c66321a7dc
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1699874729357_0006)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 ......... container     SUCCEEDED      1          1        0        0       0       0
Reducer 2 ..... container     SUCCEEDED      2          2        0        0       0       0
Reducer 3 ..... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 8.36 s
--------------------------------------------------------------------------------
OK
Per Jessen <uee@computer.org>   wkilxloc@opensuse.org   100
Karsten Bräckelmann <qmitxmeh@rudersport.de>    zqoqi@spamassassin.apache.org   43
Anders Johansson <ejw@rydsbo.net>       wkilxloc@opensuse.org   40
Roger Oberholtzer <drtyu@opq.se>        wkilxloc@opensuse.org   34
Ralf Hildebrandt <ecfa.ocnmogiylyn@charite.de>  rljdsng-xyqoh@postfix.org       30
Georg Brandl <c.xwopma@gmx.net> zvllln-eum@python.org   20
Basil Chupin <oztzqpzo@tpg.com.au>      wkilxloc@opensuse.org   20
Dermott Bolger <phwwxby.czrqex@gmail.com>       pq-mism@yahoogroups.com 19
qydlqcws-iacfym@issues.apache.org       xrh@spamassassin.apache.org     18
Christian Heimes <wluhe@cheimes.de>     Guido van Rossum <hoauf@python.org>     18
Time taken: 8.823 seconds, Fetched: 10 row(s)
hive>
```

TOP 10 HAMS:-

Similarly, I extracted Hams using the “Ham” keyword in the where clause on the classification column.

```
hive> SELECT sender, receiver, COUNT(*) AS ham_count
    > FROM spam_classification
    > WHERE classification = 'ham'
    > GROUP BY sender, receiver
    > ORDER BY ham_count DESC
    > LIMIT 10;
Query ID = hadoop_20231113135610_0b6f3e1b-6a3e-40a3-883e-36e022baee7d
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1699874729357_0006)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED      1          1        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      2          2        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 7.91 s
--------------------------------------------------------------------------------
OK
qydlqcws-iacfym@issues.apache.org       xrh@spamassassin.apache.org     444
Aaron Kulkis <cmiqlkx91@hotpop.com>     opensuse <wkilxloc@opensuse.org>        179
http://nl.internet.com/ct.html?rtr=on&s=1       3s6f    131
http://nl.internet.com/ct.html?rtr=on&s=1       3tej    128
http://nl.internet.com/ct.html?rtr=on&s=1       3tv8    128
http://nl.internet.com/ct.html?rtr=on&s=1       3snp    125
Perl Jobs <xycn-vtnhz@perl.org> necc@perl.org   86
SpamExperts via Twitter <uiaregi@twitter.com>   user2.1@gvc.ceas-challenge.cc   84
http://nl.internet.com/ct.html?rtr=on&s=1       3tzn    69
ysxshwee-tyrxx-liyysxs@lists.tuxonice.net       enpsfhxz-stvnz@lists.tuxonice.net       65
Time taken: 8.469 seconds, Fetched: 10 row(s)
```

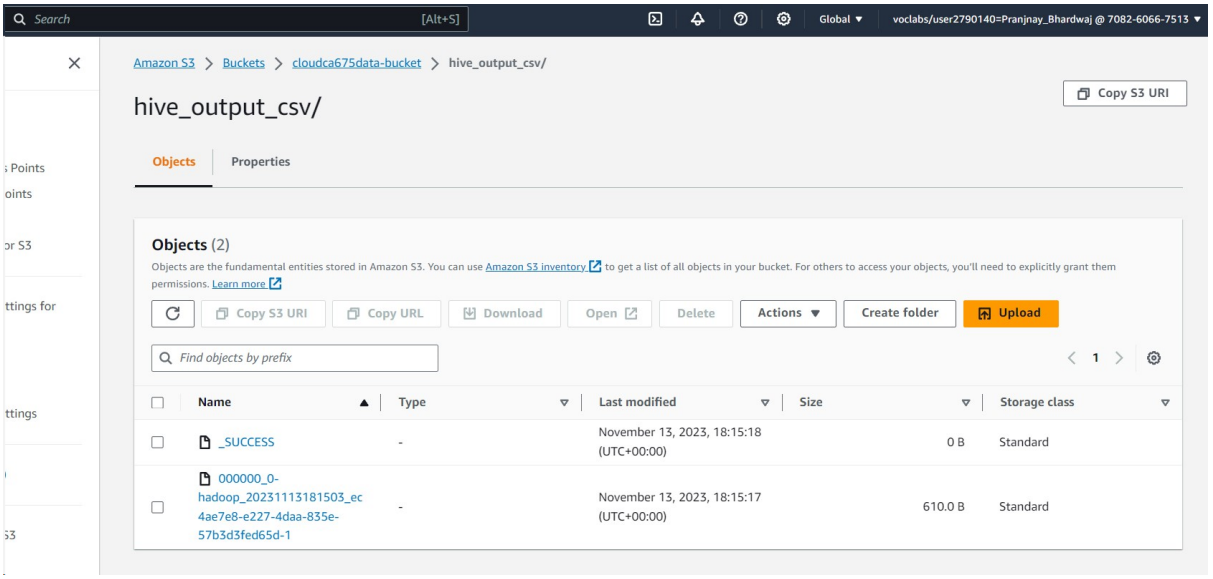
Data Extraction:-

I inserted the data into the S3 bucket folder in the hive_output_csv path with the help of the insert overwrite query.

```
hive> INSERT OVERWRITE LOCAL DIRECTORY 's3://cloudca675data-bucket/hive_output_csv/'
    > ROW FORMAT DELIMITED
    > FIELDS TERMINATED BY ','
    > SELECT sender, receiver, dates,subject,body_, COUNT(*) AS ham_count
    > FROM spam_classification
    > WHERE classification = 'ham'
    > GROUP BY sender, receiver, dates,subject,body_
    > ORDER BY ham_count DESC
    > LIMIT 10;
Query ID = hadoop_20231113181503_ec4ae7e8-e227-4daa-835e-57b3d3fed65d
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1699894618882_0002)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED      1          1        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      2          2        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 12.99 s
--------------------------------------------------------------------------------
OK
Time taken: 13.841 seconds
hive>
```

```
hive> INSERT OVERWRITE LOCAL DIRECTORY 's3://cloudca675data-bucket/hive_output_csv/'
    > ROW FORMAT DELIMITED
    > FIELDS TERMINATED BY ','
    > SELECT sender, receiver, dates,subject,body_, COUNT(*) AS spam_count
    > FROM spam_classification
    > WHERE classification = 'spam'
    > GROUP BY sender, receiver,dates,subject,body_
    > ORDER BY spam_count DESC
    > LIMIT 10;
Query ID = hadoop_20231113181010_e9bac153-df1e-4b25-958f-200b5317000e
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1699894618882_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED      1          1        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      2          2        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 12.21 s
----------------------------------------------------------------------------------------------
OK
Time taken: 13.255 seconds
hive>
```

Output file:-



Further, I downloaded and changed the file format to CSV manually.

Now this will act as input for tf idf.

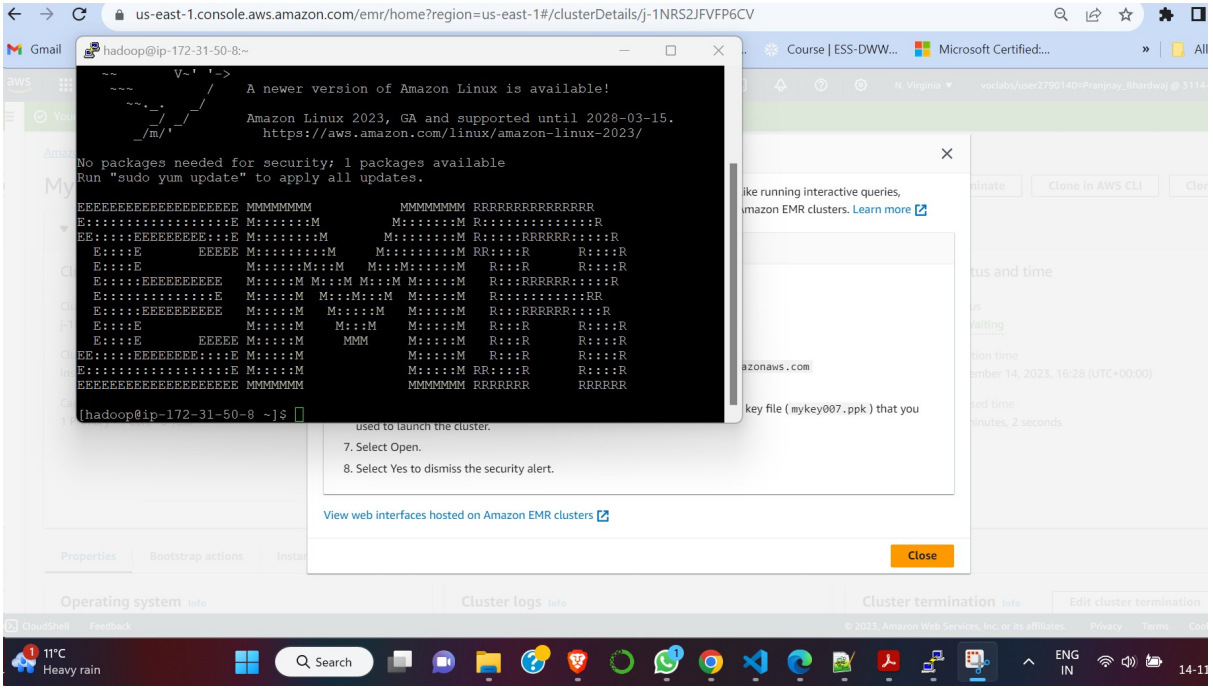
TFIDF For SPAM:-

For calculating TFIDF I used Pyspark
Pyspark has built-in ml features such as Tokenizer, HashingTF and IDF.

The tokenizer converts a text column into a text of words.
HashingTF is a feature that converts text documents to a sparse feature vector, where each word is hashed to a fixed-size index. It represents the term frequencies.

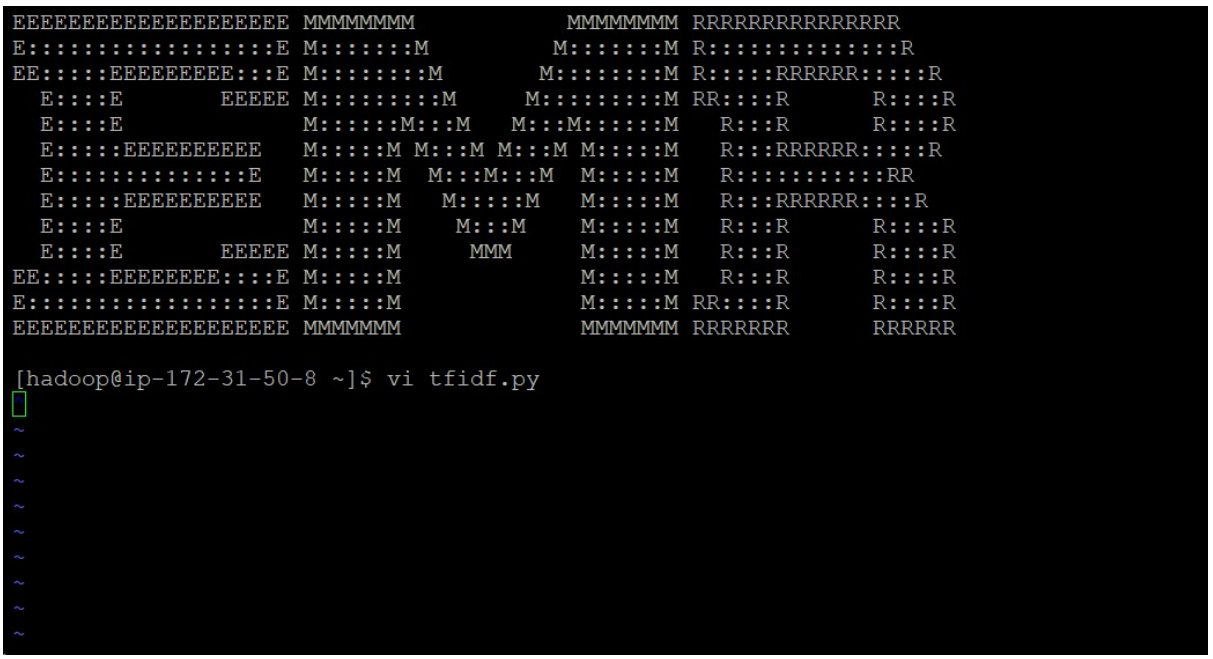
IDF is an estimator. It scales down the term frequencies computed by HashingTF and reflects the importance of words in documents.

For spark, I created a separate cluster as mentioned in page-3(cluster-2)and used putty to connect EMR:-



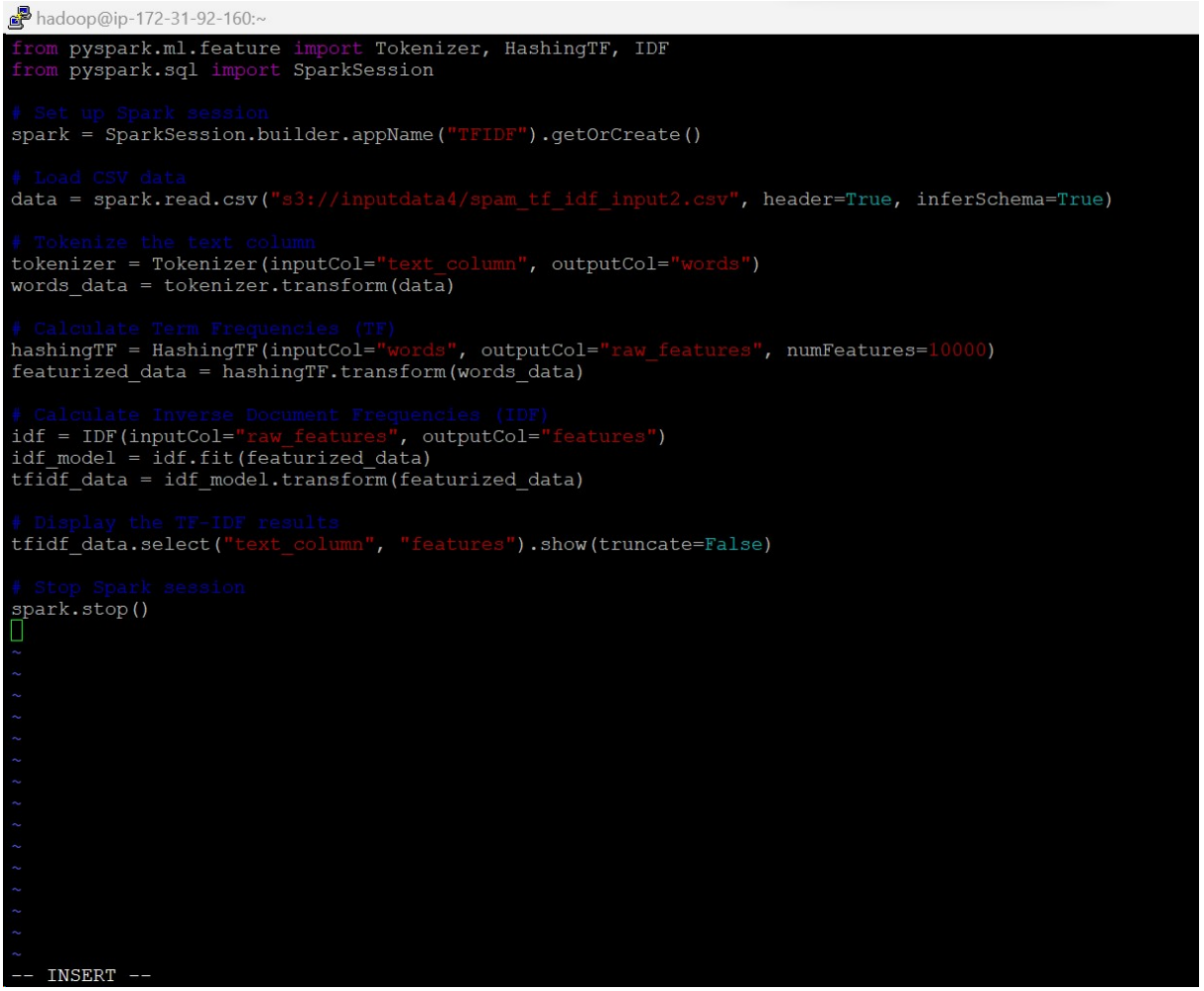
Now using vi file_name.py

We can get inside the file and place our program



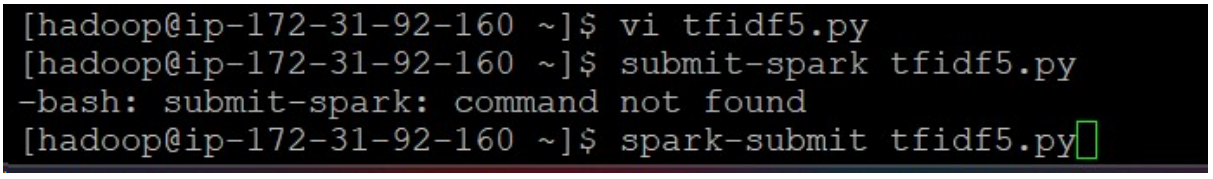
Press the I -keyword to insert the Python program

program:-https://gitlab.computing.dcu.ie/bhardwp2/CA675_Cloud_Assignments_23265772/-/blob/main/Source%20Code/pysparktfidf.py?ref_type=heads



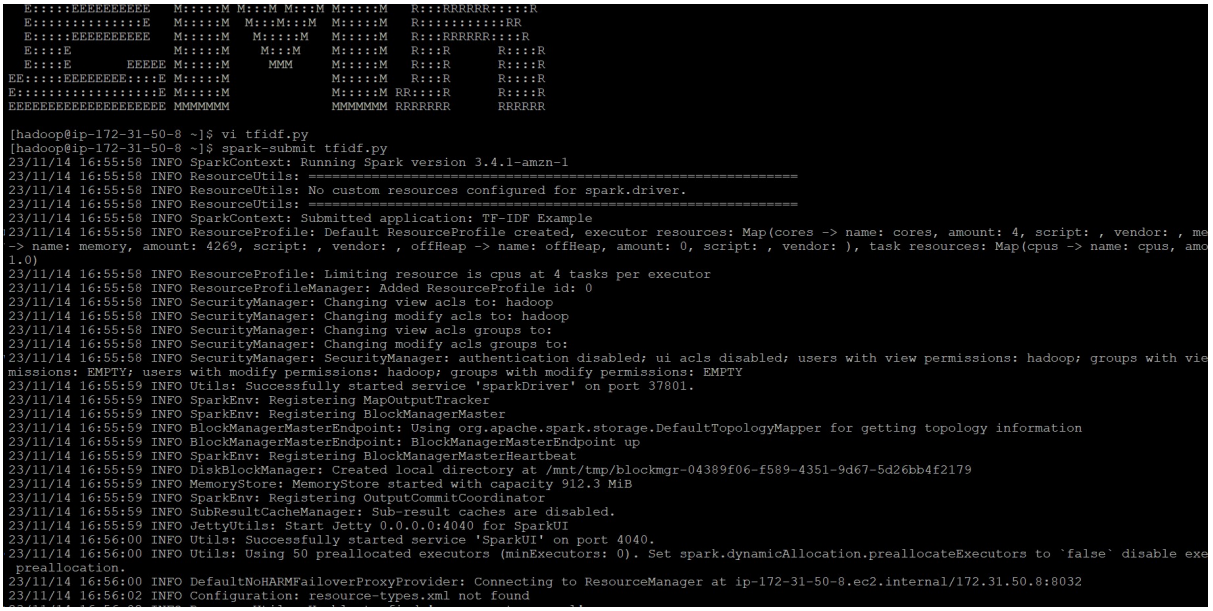
Now press escape and :wq then enter.

We are ready to submit the spark job-

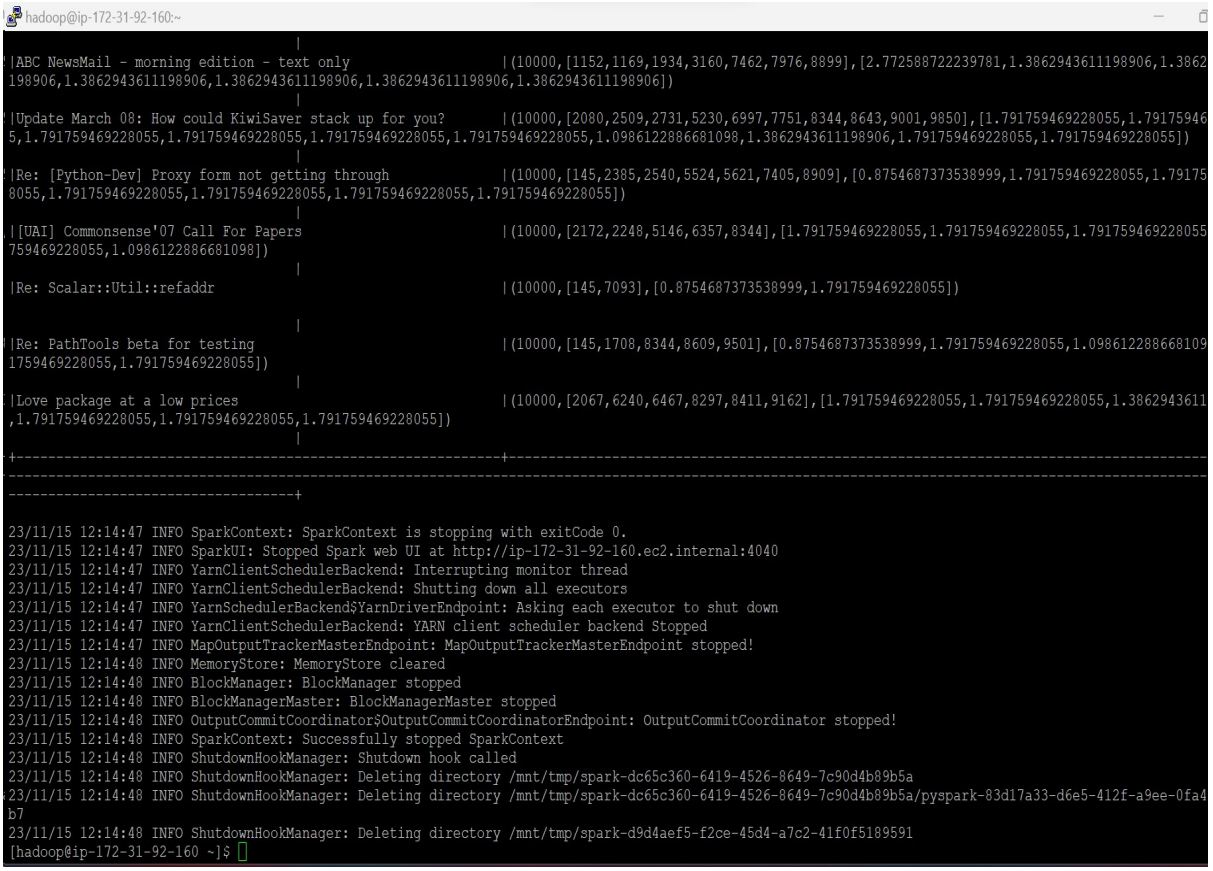


Note: The file names in the screenshots are different because I tried multiple filenames with different codes

Running:-

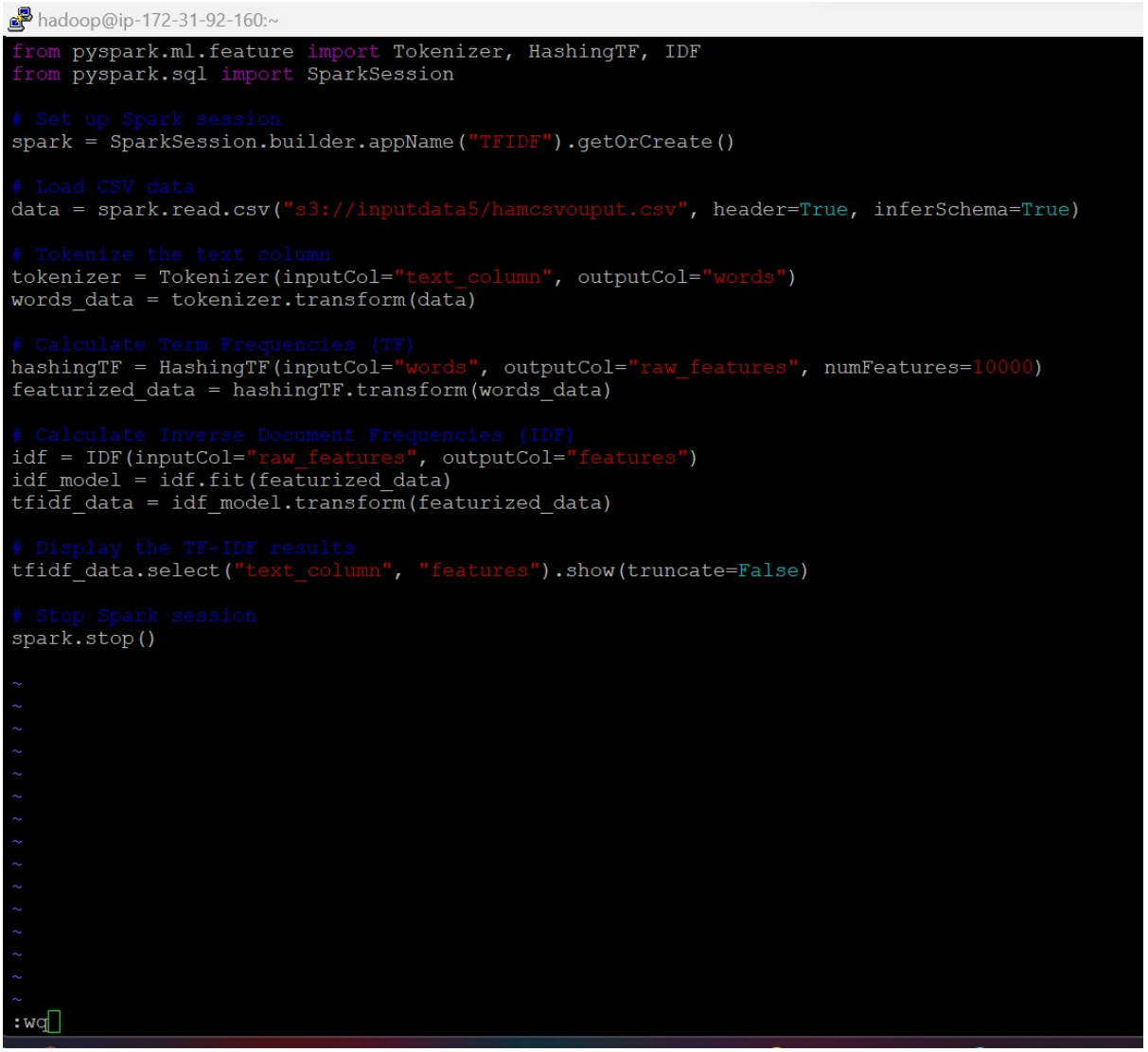


Results:-



TFIDF for Hams:-

Similarly for Hams TFIDF, I used the same program just changed the file location.



Spark job submit & Running:-

```
[hadoop@ip-172-31-92-160 ~]$ vi tfidfham.py
[hadoop@ip-172-31-92-160 ~]$ spark-submit tfidfham.py
23/11/15 12:38:11 INFO SparkContext: Running Spark version 3.4.1-amzn-2
23/11/15 12:38:11 INFO ResourceUtils: ==============================================================
23/11/15 12:38:11 INFO ResourceUtils: No custom resources configured for spark.driver.
23/11/15 12:38:11 INFO ResourceUtils: ==============================================================
23/11/15 12:38:11 INFO SparkContext: Submitted application: TFIDF
23/11/15 12:38:11 INFO ResourceProfile: Default ResourceProfile created, executor resources: Map(cores -> name: cores, amount: 4, script: , vendor: , memory
-> name: memory, amount: 4269, script: , vendor: , offHeap -> name: offHeap, amount: 0, script: , vendor: ), task resources: Map(cpus -> name: cpus, amount:
1.0)
23/11/15 12:38:11 INFO ResourceProfile: Limiting resource is cpus at 4 tasks per executor
23/11/15 12:38:11 INFO ResourceProfileManager: Added ResourceProfile id: 0
23/11/15 12:38:11 INFO SecurityManager: Changing view acls to: hadoop
23/11/15 12:38:11 INFO SecurityManager: Changing modify acls to: hadoop
23/11/15 12:38:11 INFO SecurityManager: Changing view acls groups to:
23/11/15 12:38:11 INFO SecurityManager: Changing modify acls groups to:
23/11/15 12:38:11 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users with view permissions: hadoop; groups with view per
missions: EMPTY; users with modify permissions: hadoop; groups with modify permissions: EMPTY
23/11/15 12:38:12 INFO Utils: Successfully started service 'sparkDriver' on port 45199.
23/11/15 12:38:12 INFO SparkEnv: Registering MapOutputTracker
23/11/15 12:38:12 INFO SparkEnv: Registering BlockManagerMaster
23/11/15 12:38:12 INFO BlockManagerMasterEndpoint: Using org.apache.spark.storage.DefaultTopologyMapper for getting topology information
23/11/15 12:38:12 INFO BlockManagerMasterEndpoint: BlockManagerMasterEndpoint up
23/11/15 12:38:13 INFO SparkEnv: Registering BlockManagerMasterHeartbeat
23/11/15 12:38:13 INFO DiskBlockManager: Created local directory at /mnt/tmp/blockmgr-d49e9fd1-6b17-49e6-b351-2c9c935d4f81
23/11/15 12:38:13 INFO MemoryStore: MemoryStore started with capacity 912.3 MiB
23/11/15 12:38:13 INFO SparkEnv: Registering OutputCommitCoordinator
23/11/15 12:38:13 INFO SubResultCacheManager: Sub-result caches are disabled.
23/11/15 12:38:13 INFO JettyUtils: Start Jetty 0.0.0.0:4040 for SparkUI
23/11/15 12:38:14 INFO Utils: Successfully started service 'SparkUI' on port 4040.
23/11/15 12:38:14 INFO Utils: Using 50 preallocated executors (minExecutors: 0). Set spark.dynamicAllocation.preallocateExecutors to `false` disable executor
 preallocation.
23/11/15 12:38:15 INFO DefaultNoHARMFailoverProxyProvider: Connecting to ResourceManager at ip-172-31-92-160.ec2.internal/172.31.92.160:8032
```

Output:-

```
hadoop@ip-172-31-92-160:~
arents
23/11/15 12:39:16 INFO MemoryStore: Block broadcast_7 stored as values in memory (estimated size 199.4 KiB, free 911.1 MiB)
23/11/15 12:39:16 INFO MemoryStore: Block broadcast_7_piece0 stored as bytes in memory (estimated size 21.6 KiB, free 911.1 MiB)
23/11/15 12:39:16 INFO BlockManagerInfo: Added broadcast_7_piece0 in memory on ip-172-31-92-160.ec2.internal:36819 (size: 21.6 KiB, free: 912.2 MiB)
23/11/15 12:39:16 INFO SparkContext: Created broadcast 7 from broadcast at DAGScheduler.scala:1592
23/11/15 12:39:16 INFO DAGScheduler: Submitting 1 missing tasks from ResultStage 3 (MapPartitionsRDD[21] at showString at NativeMethodAccessorImpl.java:0) (f
irst 15 tasks are for partitions Vector(0))
23/11/15 12:39:16 INFO YarnScheduler: Adding task set 3.0 with 1 tasks resource profile 0
23/11/15 12:39:16 INFO TaskSetManager: Starting task 0.0 in stage 3.0 (TID 3) (ip-172-31-88-65.ec2.internal, executor 1, partition 0, RACK_LOCAL, 8067 bytes)

23/11/15 12:39:16 INFO BlockManagerInfo: Added broadcast_7_piece0 in memory on ip-172-31-88-65.ec2.internal:33187 (size: 21.6 KiB, free: 2.1 GiB)
23/11/15 12:39:17 INFO BlockManagerInfo: Added broadcast_6_piece0 in memory on ip-172-31-88-65.ec2.internal:33187 (size: 42.3 KiB, free: 2.1 GiB)
23/11/15 12:39:18 INFO TaskSetManager: Finished task 0.0 in stage 3.0 (TID 3) in 2294 ms on ip-172-31-88-65.ec2.internal (executor 1) (1/1)
23/11/15 12:39:18 INFO DAGScheduler: ResultStage 3 (showString at NativeMethodAccessorImpl.java:0) finished in 2.320 s
23/11/15 12:39:18 INFO DAGScheduler: Job 3 is finished. Cancelling potential speculative or zombie tasks for this job
23/11/15 12:39:18 INFO YarnScheduler: Removed TaskSet 3.0, whose tasks have all completed, from pool
23/11/15 12:39:18 INFO YarnScheduler: Killing all running tasks in stage 3: Stage finished
23/11/15 12:39:18 INFO DAGScheduler: Job 3 finished: showString at NativeMethodAccessorImpl.java:0, took 2.326102 s
23/11/15 12:39:18 INFO CodeGenerator: Code generated in 40.559035 ms
+----------------------------------------+--------------------------------------------------------------------------------------------------------------------
----------------+
|text_column                             |features
                |
+----------------------------------------+--------------------------------------------------------------------------------------------------------------------
----------------+
|main char h                             |(10000,[1637,2486,9033],[1.7047480922384253,1.7047480922384253,1.7047480922384253])
                |
|Park with slides and More               |(10000,[2891,6629,7650,9234,9346],[1.7047480922384253,1.2992829841302609,1.2992829841302609,1.7047480922384253,1.7
047480922384253])|
|FREE medical consultations              |(10000,[1073,2660,8268],[1.7047480922384253,1.7047480922384253,1.7047480922384253])
                |
|http://nl.internet.com/ct.html?rtr=on&s=1|(10000,[1331],[0.6061358035703155])
                |
|More than 10 features                   |(10000,[3261,6629,7953,9755],[1.7047480922384253,1.2992829841302609,1.7047480922384253,1.7047480922384253])
                |
|http://nl.internet.com/ct.html?rtr=on&s=1|(10000,[1331],[0.6061358035703155])
                |
|Duke University with                    |(10000,[3229,5357,7650],[1.7047480922384253,1.7047480922384253,1.2992829841302609])
                |
|http://nl.internet.com/ct.html?rtr=on&s=1|(10000,[1331],[0.6061358035703155])
                |
|http://nl.internet.com/ct.html?rtr=on&s=1|(10000,[1331],[0.6061358035703155])
                |
|http://nl.internet.com/ct.html?rtr=on&s=1|(10000,[1331],[0.6061358035703155])
```

All other relevant screenshots can be found here:-https://gitlab.computing.dcu.ie/bhardwp2/CA675_Cloud_Assignments_23265772/-/tree/main/Screensnips?ref_type=heads

Appendix:-

AWS
All the tasks are done on the AWS Cloud instance running EMR. All the configurations are done manually.
References

1. TF-IDF: https://towardsdatascience.com/tf-idf-calculation-using-map-reduce-algorithm-in-pyspark-e89b5758e64c

2. Apache Hive: https://www.tutorialspoint.com/hive/index.htm

3. Stack Overflow: https://stackoverflow.com/

4:-Chatgpt:-chat.openai.com

Acknowledgement:-

I thank prof. Micheal Scriney for guidance.