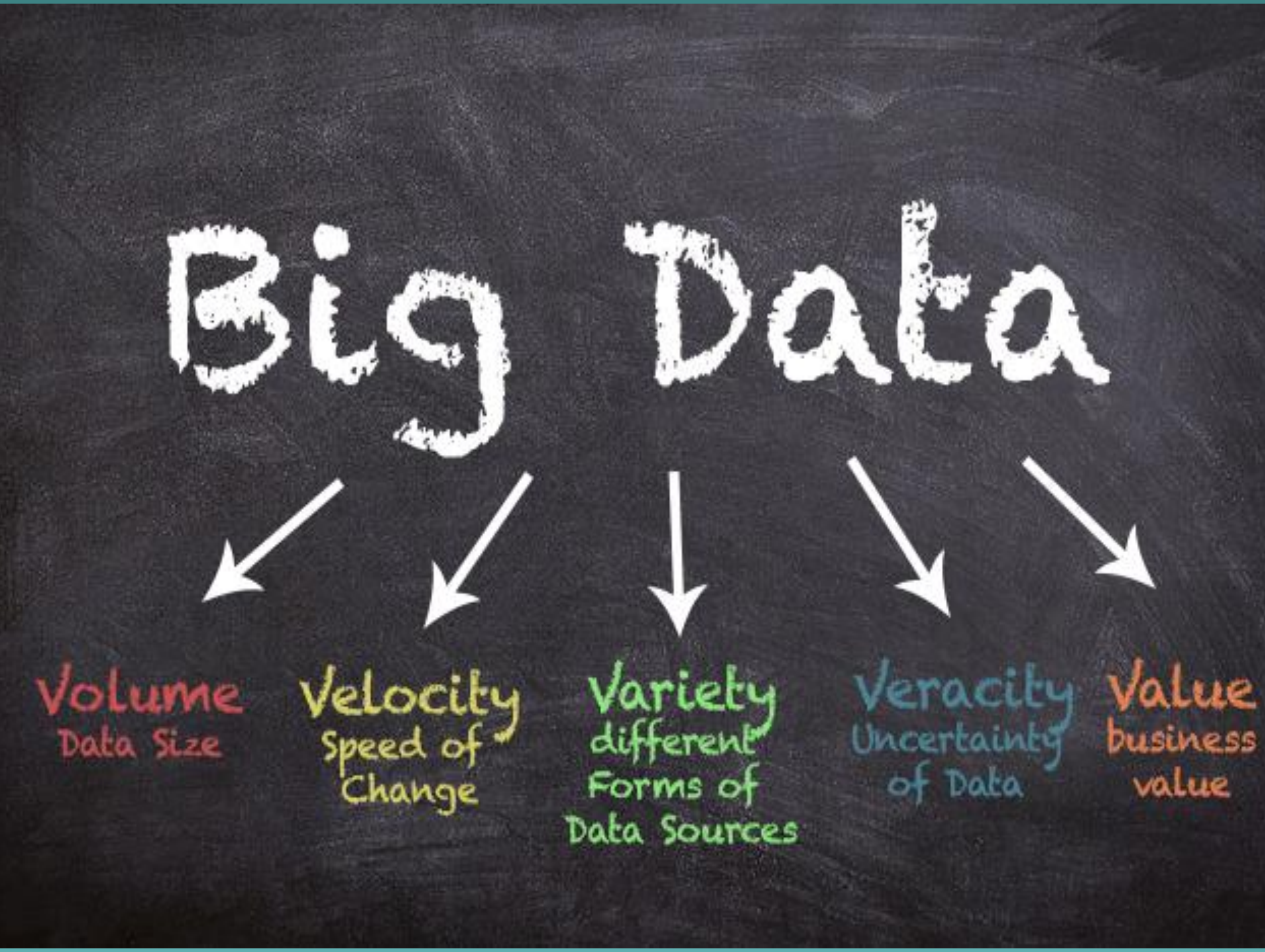
13/01/2019 | By: Ajit K Prasad



Big Data Engineering with Hadoop & Spark

Final Assignment

Music Data Analysis

Acadgild

Final Assignment

Music Data Analysis

This assignment is aimed at consolidating the concepts that was learnt during the entire course of Big Data Engineering with Hadoop & Spark.

Objectives:

1. Data simulation using python scripts
2. Launch all necessary daemons
3. Populate look up tables into HBase
4. Perform Data Enrichment filter
5. Perform Data Formatting
6. Perform Data Enrichment and Cleaning
7. Perform Data Analysis

1. Data simulation using Python scripts:

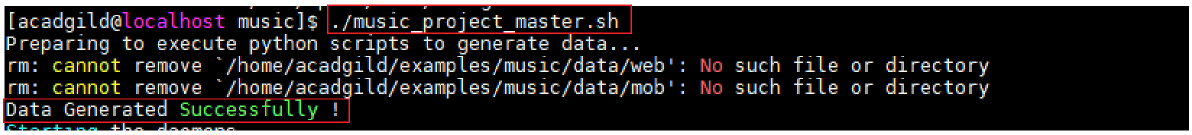
To generated data following python scripts were used.

- *generate_web_data.py*
- *generate_mob_data.py*
    - Data generated from web applications were stored in */home/acadgild/examples/music/data/web* as ***xml format***.
    - Whereas, Data generated from mobile applications were stored in */home/acadgild/examples/music/data/mob* as ***text format***.

A master batch file ***"music_project_master.sh"*** was created which was used to perform data simulation through python scripts. Provided below is a part of the script used for data generation**:**

```
# Create data

echo "Preparing to execute python scripts to generate data..."

rm -r /home/acadgild/examples/music/data/web

rm -r /home/acadgild/examples/music/data/mob

mkdir -p /home/acadgild/examples/music/data/web

mkdir -p /home/acadgild/examples/music/data/mob

python /home/acadgild/examples/music/generate_web_data.py

python /home/acadgild/examples/music/generate_mob_data.py

echo "Data Generated Successfully !"
```

- The script when initiated will first remove ***web*** and ***mob*** directories, if they are present already at ***"/home/acadgild/examples/music/data"***
- It will then recreate the ***web*** and ***mob*** directories at the provided path ***"/home/acadgild/examples/music/data"***
- Finally, it will generate data using the python script provided



```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
rm: cannot remove `/home/acadgild/examples/music/data/web': No such file or directory
rm: cannot remove `/home/acadgild/examples/music/data/mob': No such file or directory
Data Generated Successfully !
Starting the daemons
```

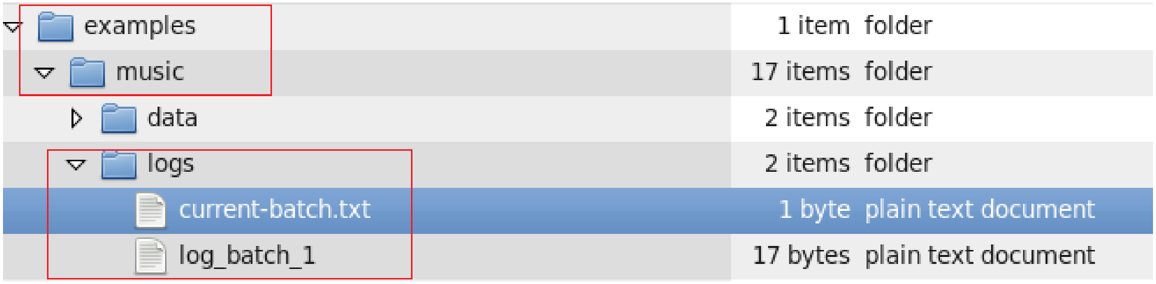
2. Launch all necessary daemons:

Once the data simulation is complete, we need to start all Hadoop daemons. To perform this task, we have created a batch file *"**start-daemon.sh**"*.
Please is the script for the same:

```
#!/bin/bash
rm -r /home/acadgild/examples/music/logs
mkdir -p /home/acadgild/examples/music/logs

if [ -f "/home/acadgild/examples/music/logs/current-batch.txt" ]
then
        echo "Batch File Found!"
else
        echo -n "1" > "/home/acadgild/examples/music/logs/current- batch.txt"
fi

chmod 775 /home/acadgild/examples/music/logs/current-batch.txt
echo "After chmod"

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`
echo "After batchid-->> "$batchid

LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid
echo "Starting daemons" >> $LOGFILE

start-all.sh
start-hbase.sh
mr-jobhistory-daemon.sh start historyserver

cat /home/acadgild/examples/music/logs/current-batch.txt
```

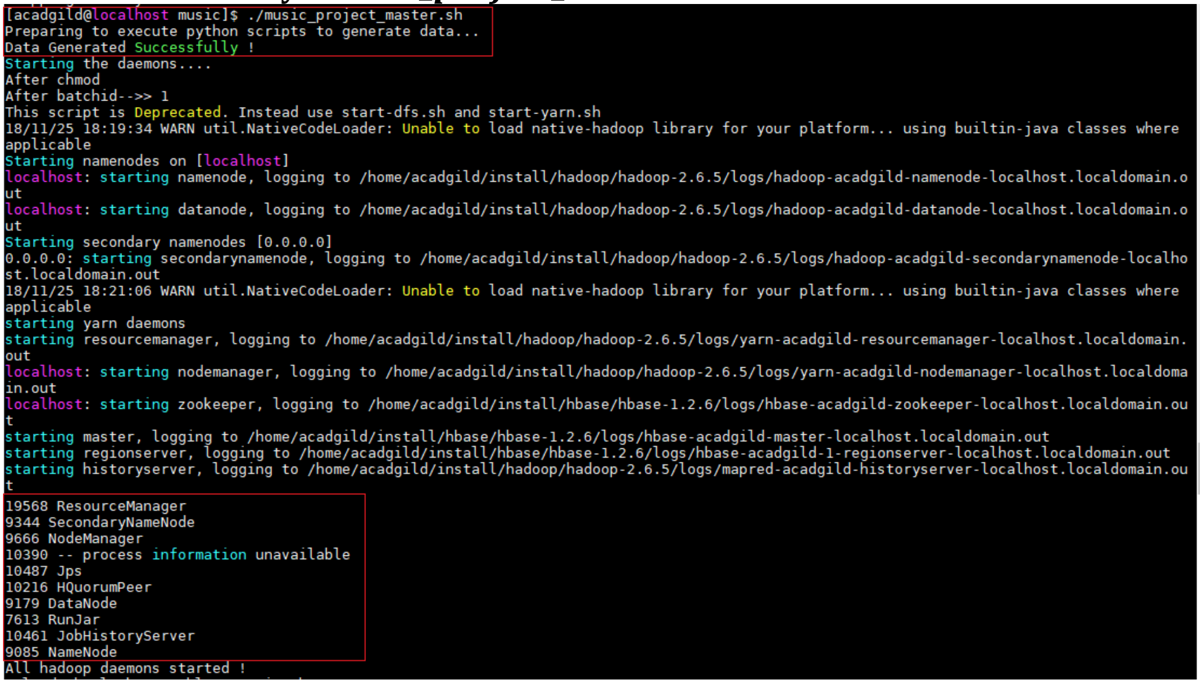
- It will first remove **logs** directory, if they already exist at ***"/home/acadgild/examples/music/"***
- Then it will create **logs** directory ***"/home/acadgild/examples/music/"***
- After this, it will search for **current-batch.txt** file inside directory ***"/home/acadgild/examples/music/logs"***
- If it is present, then message will be generated as ***"Batch File Found"***, else it will create ***current-batch.txt*** file inside directory ***"/home/acadgild/examples/music/logs"*** with content as **'1'**
- Then required permissions would be given for this file
- Then batchid would be content of ***current-batch.txt*** file. i.e., **1**
- Next, ***log_batch_1*** file as Logfile would be created inside directory ***"/home/acadgild/examples/music/logs/"***

Below you could see that ***current_batch.txt*** and ***log_batch_1*** files are present inside directory: ***"/home/acadgild/examples/music/logs"***



examples	1 item	folder
music	17 items	folder
data	2 items	folder
logs	2 items	folder
current-batch.txt	1 byte	plain text document
log_batch_1	17 bytes	plain text document

Finally, the script will start all Hadoop daemons. ***"start-daemon.sh"*** batch file will be initiated by ***"music_project_master.sh"*** batch file.



```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
Data Generated Successfully !
Starting the daemons....
After chmod
After batchid-->> 1
This script is Deprecated. Instead use start-dfs.sh and start-yarn.sh
18/11/25 18:19:34 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
Starting namenodes on [localhost]
localhost: starting namenode, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/hadoop-acadgild-namenode-localhost.localdomain.o
ut
localhost: starting datanode, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/hadoop-acadgild-datanode-localhost.localdomain.o
ut
Starting secondary namenodes [0.0.0.0]
0.0.0.0: starting secondarynamenode, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/hadoop-acadgild-secondarynamenode-localho
st.localdomain.out
18/11/25 18:21:06 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
starting yarn daemons
starting resourcemanager, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/yarn-acadgild-resourcemanager-localhost.localdomain.
out
localhost: starting nodemanager, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/yarn-acadgild-nodemanager-localhost.localdoma
in.out
localhost: starting zookeeper, logging to /home/acadgild/install/hbase/hbase-1.2.6/logs/hbase-acadgild-zookeeper-localhost.localdomain.ou
t
starting master, logging to /home/acadgild/install/hbase/hbase-1.2.6/logs/hbase-acadgild-master-localhost.localdomain.out
starting regionserver, logging to /home/acadgild/install/hbase/hbase-1.2.6/logs/hbase-acadgild-1-regionserver-localhost.localdomain.out
starting historyserver, logging to /home/acadgild/install/hadoop/hadoop-2.6.5/logs/mapred-acadgild-historyserver-localhost.localdomain.ou
t
19568 ResourceManager
9344 SecondaryNameNode
9666 NodeManager
10390 -- process information unavailable
10487 Jps
10216 HQuorumPeer
9179 DataNode
7613 RunJar
10461 JobHistoryServer
9085 NameNode
All hadoop daemons started !
```

Here, we have executed **music_project_master** batch file which will execute **start-daemon.sh** script internally and you could see that data generated and all daemons are started successfully.

3. Populate look up tables into HBase:

By using the **“populate-lookup.sh”** script, we will create below lookup tables in HBase. These tables we are using for Data formatting, Data enrichment and Analysis stage.

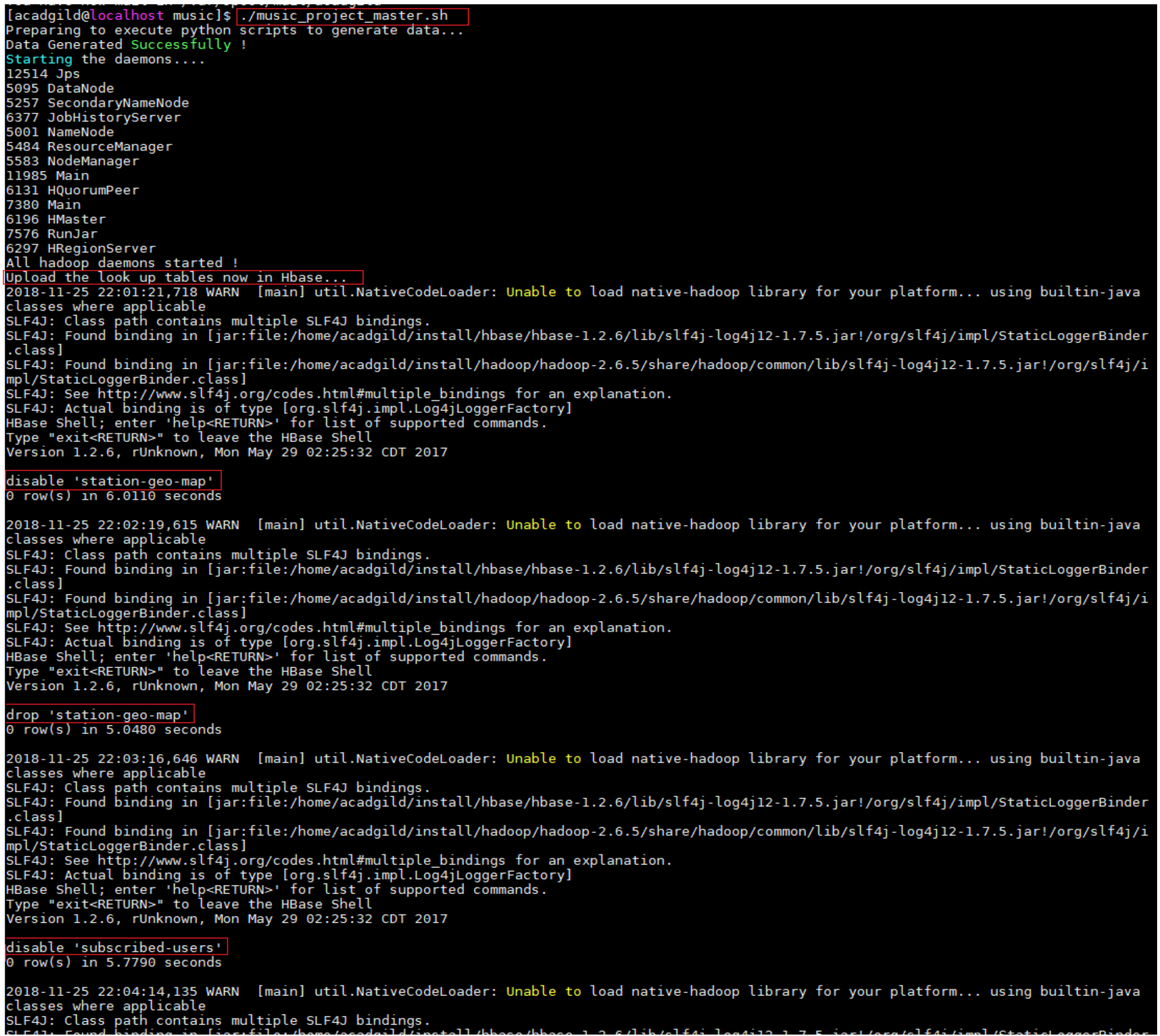
Sr #	Table name	Descripion	Related file
1	Station_geo_map	Contains mapping of a geo_cd with station_id	stn-geocd.txt
2	Subscribed_users	Contains **user_id, subscription_start_date** and **subscription_end_date**. Contains details only for subscribed users user-subscn.txt	user-subscn.txt
3	Song_artist_map	Contains mapping of song_id with artist_id Along with royalty associated with each play of the song	song-artist.txt
4	User_artists	Contains an array of artist_id(s) followed by user_id	User_artists.txt

The ***“populate-lookup.sh”*** shell script creates above lookup tables in HBase and populates data into the lookup tables from dataset files. Below is the script for ***populate-lookup.sh***:

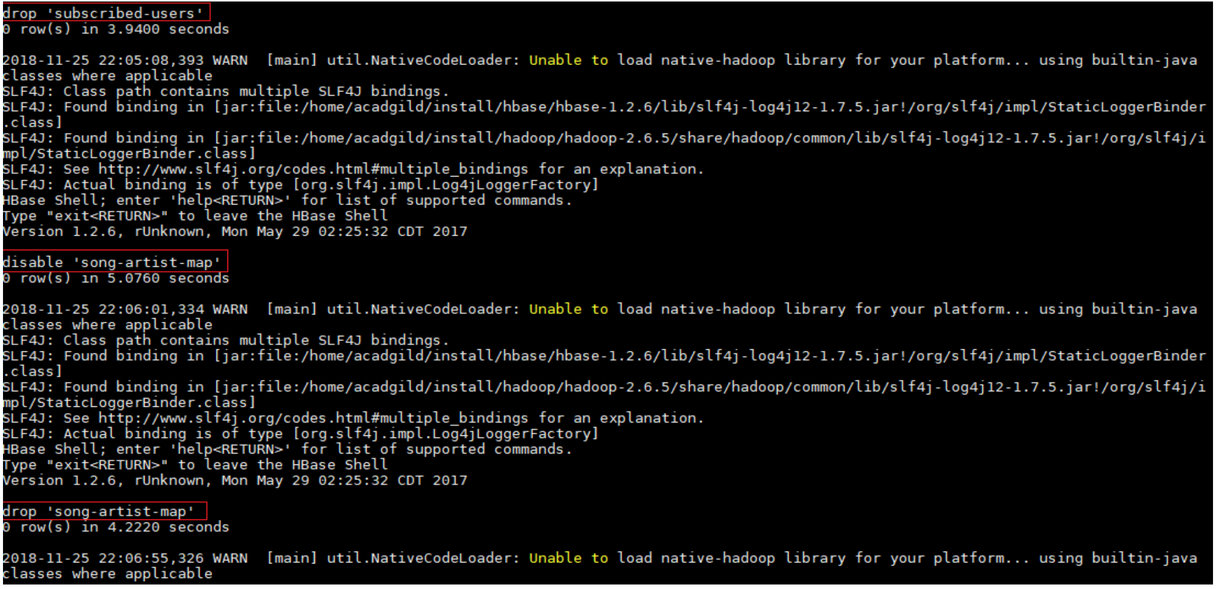
```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`
LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid

echo "Creating LookUp Tables" >> $LOGFILE

echo "disable 'station-geo-map'" | hbase shell
echo "drop 'station-geo-map'" | hbase shell
echo "disable 'subscribed-users'" | hbase shell
echo "drop 'subscribed-users'" | hbase shell
echo "disable 'song-artist-map'" | hbase shell
echo "drop 'song-artist-map'" | hbase shell

echo "create 'station-geo-map', 'geo'" | hbase shell
echo "create 'subscribed-users', 'subscn'" | hbase shell
 echo "create 'song-artist-map', 'artist'" | hbase shell
 echo "Populating LookUp Tables" >> $LOGFILE
```

```
file="/home/acadgild/examples/music/lookupfiles/stn-geocd.txt"
while IFS= read -r line
do
        stnid=`echo $line | cut -d',' -f1`
        geocd=`echo $line | cut -d',' -f2`
echo "put 'station-geo-map', '$stnid', 'geo:geo_cd', '$geocd'" | hbase shell
done <"$file"

file="/home/acadgild/examples/music/lookupfiles/song-artist.txt"
while IFS= read -r line
do
        songid=`echo $line | cut -d',' -f1`
        artistid=`echo $line | cut -d',' -f2`
echo "put 'song-artist-map', '$songid', 'artist:artistid', '$artistid'" | hbase shell
done <"$file"

file="/home/acadgild/examples/music/lookupfiles/user-subscn.txt"
while IFS= read -r line
do
        userid=`echo $line | cut -d',' -f1`
        startdt=`echo $line | cut -d',' -f2`
         enddt=`echo $line | cut -d',' -f3`
echo "put 'subscribed-users', '$userid', 'subscn:startdt', '$startdt'" | hbase shell
echo "put 'subscribed-users', '$userid', 'subscn:enddt', '$enddt'" | hbase shell
done <"$file"
```

Below screenshots shows tables creation and population of data in HBase. Here we are executing ***populate-lookup.sh*** via ***music_project_master.sh*** batch file. We are disabling these HBase tables first and then we are dropping it.

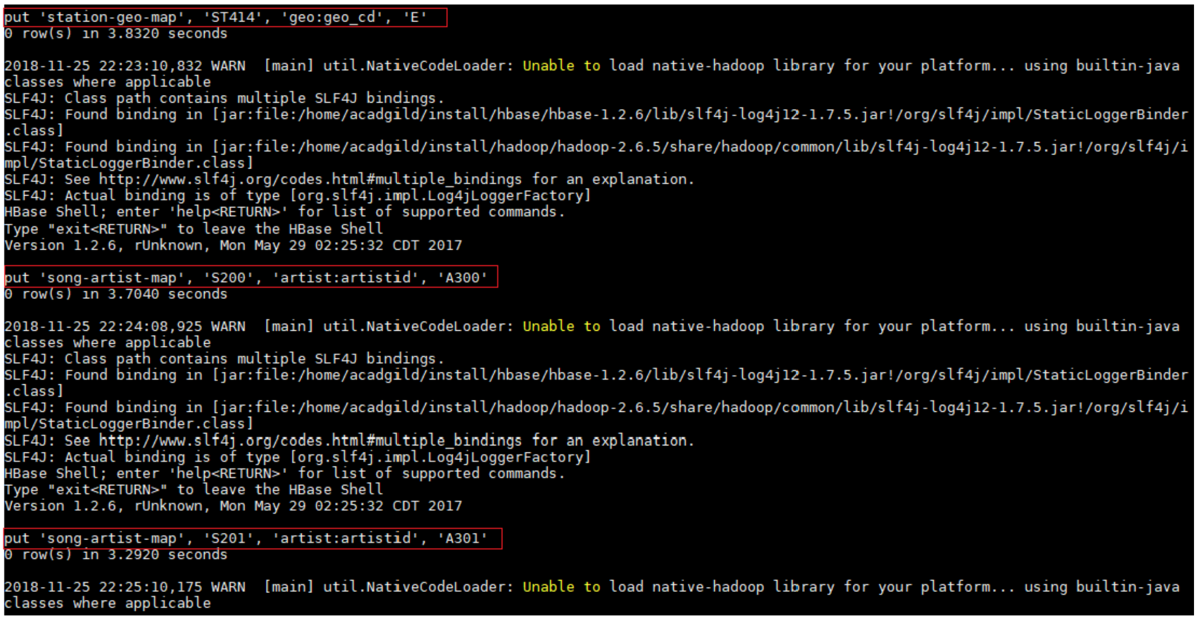


```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
Data Generated Successfully !
Starting the daemons....
12514 Jps
5095 DataNode
5257 SecondaryNameNode
6377 JobHistoryServer
5001 NameNode
5484 ResourceManager
5583 NodeManager
11985 Main
6131 HQuorumPeer
7380 Main
6196 HMaster
7576 RunJar
6297 HRegionServer
All hadoop daemons started !
Upload the look up tables now in Hbase...
2018-11-25 22:01:21,718 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

disable 'station-geo-map'
0 row(s) in 6.0110 seconds

2018-11-25 22:02:19,615 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

drop 'station-geo-map'
0 row(s) in 5.0480 seconds

2018-11-25 22:03:16,646 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

disable 'subscribed-users'
0 row(s) in 5.7790 seconds

2018-11-25 22:04:14,135 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
```

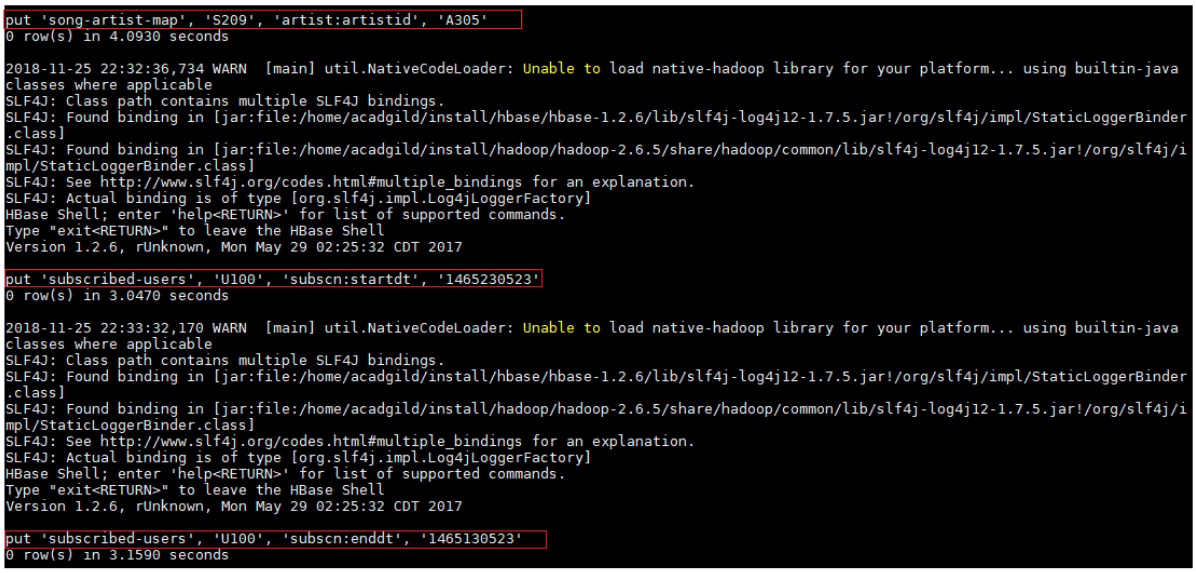


```
drop 'subscribed-users'
0 row(s) in 3.9400 seconds

2018-11-25 22:05:08,393 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

disable 'song-artist-map'
0 row(s) in 5.0760 seconds

2018-11-25 22:06:01,334 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

drop 'song-artist-map'
0 row(s) in 4.2220 seconds

2018-11-25 22:06:55,326 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
```

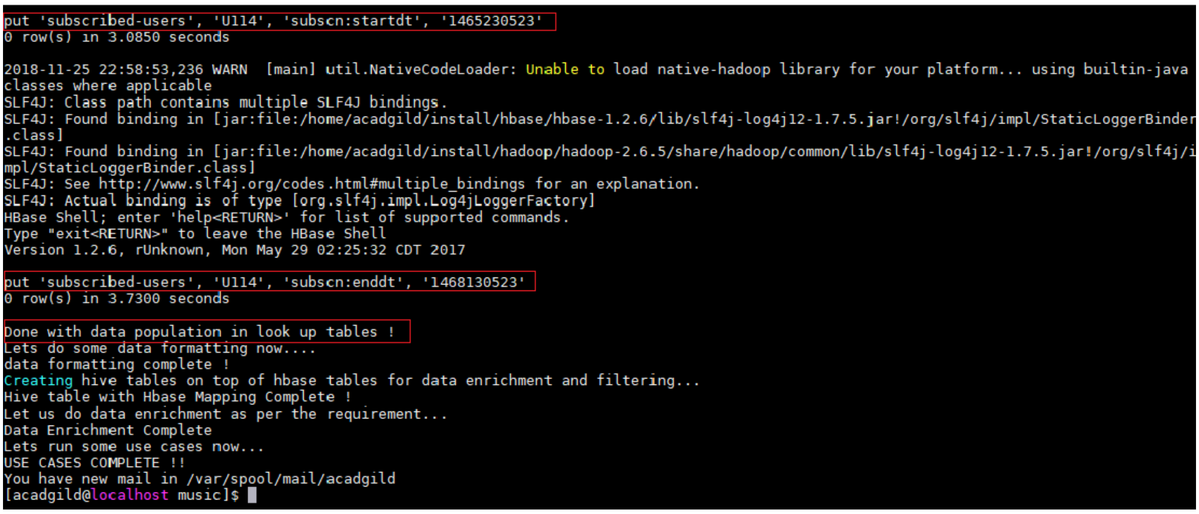
Below we have created HBase tables: song-artist-map, station-geo-map and subscribed-users successfully. We are populating values into these HBase tables as shown below:



```
put 'station-geo-map', 'ST414', 'geo:geo_cd', 'E'
0 row(s) in 3.8320 seconds

2018-11-25 22:23:10,832 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

put 'song-artist-map', 'S200', 'artist:artistid', 'A300'
0 row(s) in 3.7040 seconds

2018-11-25 22:24:08,925 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

put 'song-artist-map', 'S201', 'artist:artistid', 'A301'
0 row(s) in 3.2920 seconds

2018-11-25 22:25:10,175 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
```

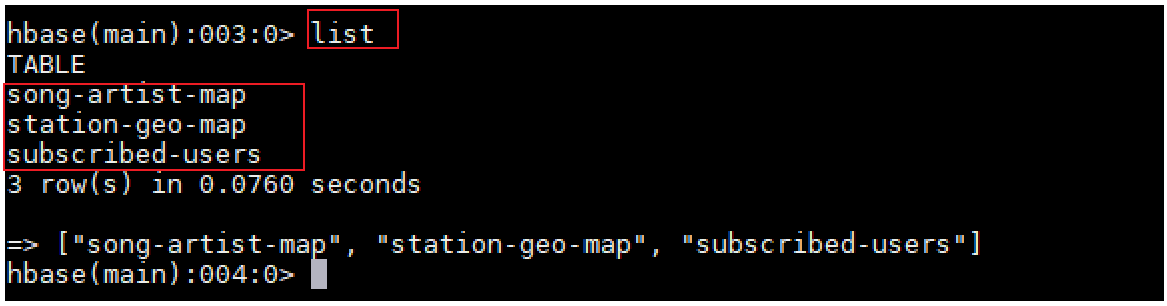


```
put 'song-artist-map', 'S209', 'artist:artistid', 'A305'
0 row(s) in 4.0930 seconds

2018-11-25 22:32:36,734 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

put 'subscribed-users', 'U100', 'subscn:startdt', '1465230523'
0 row(s) in 3.0470 seconds

2018-11-25 22:33:32,170 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

put 'subscribed-users', 'U100', 'subscn:enddt', '1465130523'
0 row(s) in 3.1590 seconds
```



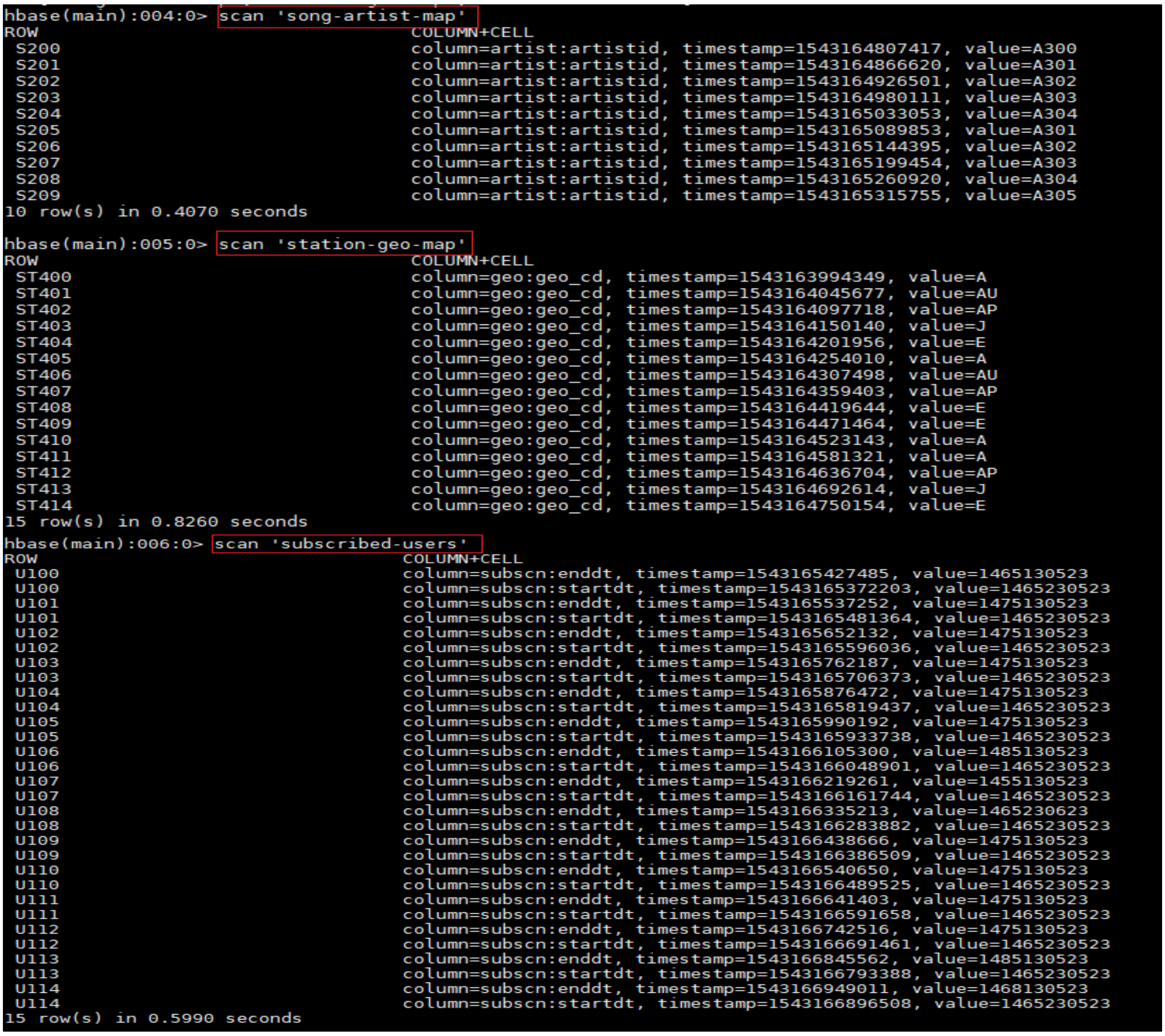
```
put 'subscribed-users', 'U114', 'subscn:startdt', '1465230523'
0 row(s) in 3.0850 seconds

2018-11-25 22:58:53,236 WARN  [main] util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
classes where applicable
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 1.2.6, rUnknown, Mon May 29 02:25:32 CDT 2017

put 'subscribed-users', 'U114', 'subscn:enddt', '1468130523'
0 row(s) in 3.7300 seconds

Done with data population in look up tables !
Lets do some data formatting now....
data formatting complete !
Creating hive tables on top of hbase tables for data enrichment and filtering...
Hive table with Hbase Mapping Complete !
Let us do data enrichment as per the requirement...
Data Enrichment Complete
Lets run some use cases now...
USE CASES COMPLETE !!
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost music]$
```

In HBase shell, by using **list** command you could verify that HBase tables: song-artist-map, station- geo-map and subscribed-users are created successfully.



```
hbase(main):003:0> list
TABLE
song-artist-map
station-geo-map
subscribed-users
3 row(s) in 0.0760 seconds

=> ["song-artist-map", "station-geo-map", "subscribed-users"]
hbase(main):004:0>
```

In HBase shell, by using **scan** command we could verify that HBase tables: song-artist-map, station- geo-map and subscribed-users are populated successfully.



```
hbase(main):004:0> scan 'song-artist-map'
ROW                                COLUMN+CELL
 S200                              column=artist:artistid, timestamp=1543164807417, value=A300
 S201                              column=artist:artistid, timestamp=1543164866620, value=A301
 S202                              column=artist:artistid, timestamp=1543164926501, value=A302
 S203                              column=artist:artistid, timestamp=1543164980111, value=A303
 S204                              column=artist:artistid, timestamp=1543165033053, value=A304
 S205                              column=artist:artistid, timestamp=1543165089853, value=A301
 S206                              column=artist:artistid, timestamp=1543165144395, value=A302
 S207                              column=artist:artistid, timestamp=1543165199454, value=A303
 S208                              column=artist:artistid, timestamp=1543165260920, value=A304
 S209                              column=artist:artistid, timestamp=1543165315755, value=A305
10 row(s) in 0.4070 seconds

hbase(main):005:0> scan 'station-geo-map'
ROW                                COLUMN+CELL
 ST400                             column=geo:geo_cd, timestamp=1543163994349, value=A
 ST401                             column=geo:geo_cd, timestamp=1543164045677, value=AU
 ST402                             column=geo:geo_cd, timestamp=1543164097718, value=AP
 ST403                             column=geo:geo_cd, timestamp=1543164150140, value=J
 ST404                             column=geo:geo_cd, timestamp=1543164201956, value=E
 ST405                             column=geo:geo_cd, timestamp=1543164254010, value=A
 ST406                             column=geo:geo_cd, timestamp=1543164307498, value=AU
 ST407                             column=geo:geo_cd, timestamp=1543164359403, value=AP
 ST408                             column=geo:geo_cd, timestamp=1543164419644, value=E
 ST409                             column=geo:geo_cd, timestamp=1543164471464, value=E
 ST410                             column=geo:geo_cd, timestamp=1543164523143, value=A
 ST411                             column=geo:geo_cd, timestamp=1543164581321, value=A
 ST412                             column=geo:geo_cd, timestamp=1543164636704, value=AP
 ST413                             column=geo:geo_cd, timestamp=1543164692614, value=J
 ST414                             column=geo:geo_cd, timestamp=1543164750154, value=E
15 row(s) in 0.8260 seconds
hbase(main):006:0> scan 'subscribed-users'
ROW                               COLUMN+CELL
 U100                             column=subscn:enddt, timestamp=1543165427485, value=1465130523
 U100                             column=subscn:startdt, timestamp=1543165372203, value=1465230523
 U101                             column=subscn:enddt, timestamp=1543165537252, value=1475130523
 U101                             column=subscn:startdt, timestamp=1543165481364, value=1465230523
 U102                             column=subscn:enddt, timestamp=1543165652132, value=1475130523
 U102                             column=subscn:startdt, timestamp=1543165596036, value=1465230523
 U103                             column=subscn:enddt, timestamp=1543165762187, value=1475130523
 U103                             column=subscn:startdt, timestamp=1543165706373, value=1465230523
 U104                             column=subscn:enddt, timestamp=1543165876472, value=1475130523
 U104                             column=subscn:startdt, timestamp=1543165819437, value=1465230523
 U105                             column=subscn:enddt, timestamp=1543165990192, value=1475130523
 U105                             column=subscn:startdt, timestamp=1543165933738, value=1465230523
 U106                             column=subscn:enddt, timestamp=1543166105300, value=1485130523
 U106                             column=subscn:startdt, timestamp=1543166048901, value=1465230523
 U107                             column=subscn:enddt, timestamp=1543166219261, value=1455130523
 U107                             column=subscn:startdt, timestamp=1543166161744, value=1465230523
 U108                             column=subscn:enddt, timestamp=1543166335213, value=1465230623
 U108                             column=subscn:startdt, timestamp=1543166283882, value=1465230523
 U109                             column=subscn:enddt, timestamp=1543166438666, value=1475130523
 U109                             column=subscn:startdt, timestamp=1543166386509, value=1465230523
 U110                             column=subscn:enddt, timestamp=1543166540650, value=1475130523
 U110                             column=subscn:startdt, timestamp=1543166489525, value=1465230523
 U111                             column=subscn:enddt, timestamp=1543166641403, value=1475130523
 U111                             column=subscn:startdt, timestamp=1543166591658, value=1465230523
 U112                             column=subscn:enddt, timestamp=1543166742516, value=1475130523
 U112                             column=subscn:startdt, timestamp=1543166691461, value=1465230523
 U113                             column=subscn:enddt, timestamp=1543166845562, value=1485130523
 U113                             column=subscn:startdt, timestamp=1543166793388, value=1465230523
 U114                             column=subscn:enddt, timestamp=1543166949011, value=1468130523
 U114                             column=subscn:startdt, timestamp=1543166896508, value=1465230523
15 row(s) in 0.5990 seconds
```

By this way we have successfully created the lookup tables in the HBase.

4. Perform Data Enrichment filtering:

Now we need to link theses lookup tables in hive using the HBase Storage Handler. With the help of ***"data_enrichment_filtering_schema.sh"*** file we will create hive tables on the top of Hbase tables using ***"create_hive_hbase_lookup.hql"***.

Creating Hive Tables on the top of HBase:

With the help of HBase storage handler & SerDe properties, we are creating the hive external tables by matching the columns of HBase tables to hive tables. ***data_enrichment_filtering_schema.sh*** script will run the ***"create_hive_hbase_lookup.hql"*** which will create the HIVE external tables with the help of HBase storage handler & SerDe properties. The hive external tables will match the columns of Hbase tables to HIVE tables.

Script for **data_enrichment_filtering_schema.sh**:

```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`

LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid

echo "Creating hive tables on top of hbase tables for data enrichment and
filtering..." >> $LOGFILE

hive -f /home/acadgild/examples/music/create_hive_hbase_lookup.hql
```

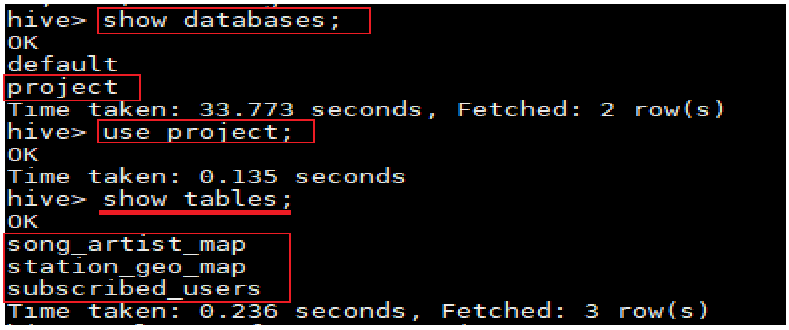
Script for **create_hive_hbase_lookup.hql**:

```
CREATE DATABASE IF NOT EXISTS project;
USE project;

create external table if not exists station_geo_map
(
station_id String,
geo_cd string
) STORED BY 'org.apache.hadoop.hive.hbase.HBaseStorageHandler' with
serdeproperties ("hbase.columns.mapping"=":key,geo:geo_cd")
tblproperties("hbase.table.name"="station-geo-map");

create external table if not exists subscribed_users
(
user_id STRING,
subscn_start_dt STRING,
subscn_end_dt STRING
) STORED BY 'org.apache.hadoop.hive.hbase.HBaseStorageHandler' with
serdeproperties ("hbase.columns.mapping"=":key,subscn:startdt,subscn:enddt")
tblproperties("hbase.table.name"="subscribed-users");
```

```
create external table if not exists song_artist_map
(
song_id STRING,
artist_id STRING
) STORED BY 'org.apache.hadoop.hive.hbase.HBaseStorageHandler' with serdeproperties ("hbase.columns.mapping"=":key,artist:artistid") tblproperties("hbase.table.name"="song-artist-map");
```

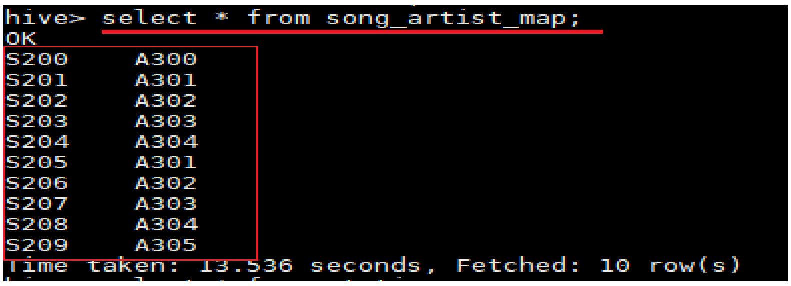
- We are running ***data_enrichment_filtering_schema.sh*** script through the execution of ***music_project_master.sh*** script.
- The below screenshot we can see tables are getting created in hive by running the "***data_enrichement_filtering_schema.sh*** file".
- Below you could see that three tables are created in project database in hive. They are: **Song_artist_map, Station_geo_map, Subscribed_users**

hive> show tables;



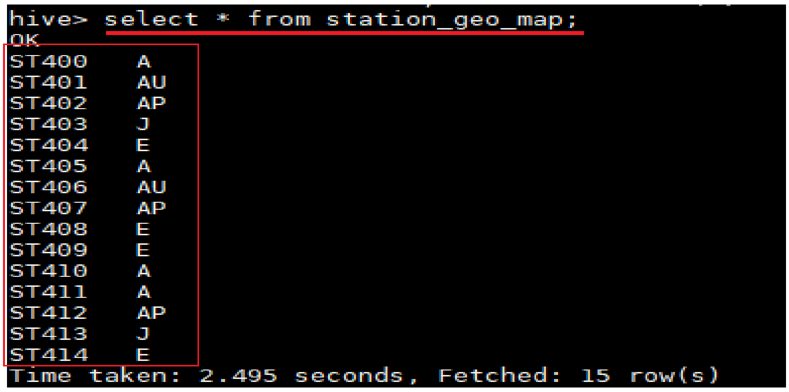
```
hive> show databases;
OK
default
project
Time taken: 33.773 seconds, Fetched: 2 row(s)
hive> use project;
OK
Time taken: 0.135 seconds
hive> show tables;
OK
song_artist_map
station_geo_map
subscribed_users
Time taken: 0.236 seconds, Fetched: 3 row(s)
```

hive> select * from song_artist_map;



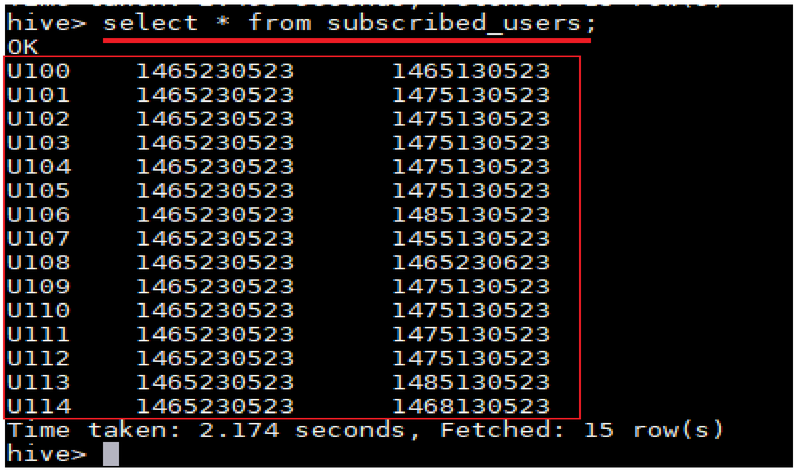
```
hive> select * from song_artist_map;
OK
S200    A300
S201    A301
S202    A302
S203    A303
S204    A304
S205    A301
S206    A302
S207    A303
S208    A304
S209    A305
Time taken: 13.536 seconds, Fetched: 10 row(s)
```

hive> select * from station_geo_map;



```
hive> select * from station_geo_map;
OK
ST400   A
ST401   AU
ST402   AP
ST403   J
ST404   E
ST405   A
ST406   AU
ST407   AP
ST408   E
ST409   E
ST410   A
ST411   A
ST412   AP
ST413   J
ST414   E
Time taken: 2.495 seconds, Fetched: 15 row(s)
```

*hive> select * from subscribed_users*



```
hive> select * from subscribed_users;
OK
U100    1465230523      1465130523
U101    1465230523      1475130523
U102    1465230523      1475130523
U103    1465230523      1475130523
U104    1465230523      1475130523
U105    1465230523      1475130523
U106    1465230523      1485130523
U107    1465230523      1455130523
U108    1465230523      1465230623
U109    1465230523      1475130523
U110    1465230523      1475130523
U111    1465230523      1475130523
U112    1465230523      1475130523
U113    1465230523      1485130523
U114    1465230523      1468130523
Time taken: 2.174 seconds, Fetched: 15 row(s)
hive>
```

5. Data Formatting:

In this stage, we are merging the data coming from both web applications and mobile applications and create a common table for analysing purpose and create partitioned data based on batchid, since we are running this scripts for every 3 hours.

Script for **dataformatting.sh**:

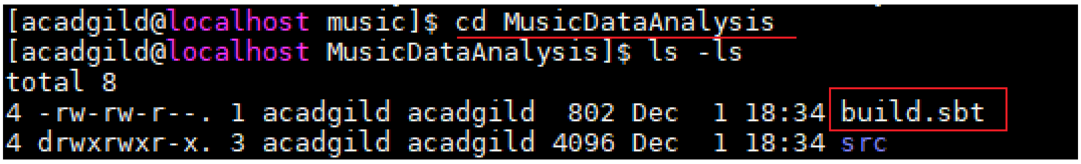
```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`

LOGFILE=/home/acadgild/examples/music /logs/log_batch_$batchid

echo "Running script for data formatting..." >> $LOGFILE

spark-submit --packages com.databricks:spark-xml_2.10:0.4.1 \
--class DataFormatting \
--master local[2] \
/home/acadgild/examples/music/MusicDataAnalysis/target/scala-2.11/musicdataanalysis_2.11-1.0.jar $batchid
```

Source code for **DataFormatting.scala:**

```
import org.apache.spark.{SparkConf, SparkContext}
import org.apache.spark.sql

object DataFormatting {
  def main(args: Array[String]): Unit = {
    val conf = new SparkConf().setAppName("Data Formatting")
    val sc = new SparkContext(conf)
    val sqlContext = new org.apache.spark.sql.hive.HiveContext(sc)
    val batchId = args(0)
    val create_hive_table = """CREATE TABLE IF NOT EXISTS project.formatted_input
                            (
                            User_id STRING,
                            Song_id STRING,
                            Artist_id STRING,
                            Timestamp STRING,
                            Start_ts STRING,
                            End_ts STRING,
                            Geo_cd STRING,
                            Station_id STRING,
                            Song_end_type INT,
                            Like INT,
                            Dislike INT
                            )
                            PARTITIONED BY
                            (batchid INT)
```

```
                    ROW FORMAT DELIMITED
                    FIELDS TERMINATED BY ','
                    """

   val load_mob_data = s"""LOAD DATA LOCAL INPATH
'/home/acadgild/examples/music/data/mob/file.txt'
                    INTO TABLE project.formatted_input PARTITION
(batchid='$batchId')"""

   val load_web_data = s"""INSERT INTO project.formatted_input
                    PARTITION(batchid='$batchId')
                    SELECT user_id,
                    song_id,
                    artist_id,
                    unix_timestamp(timestamp,'yyyy-MM-dd HH:mm:ss') AS
timestamp,
                    unix_timestamp(start_ts,'yyyy-MM-dd HH:mm:ss') AS start_ts,
                    unix_timestamp(end_ts,'yyyy-MM-dd HH:mm:ss') AS end_ts,
                    geo_cd,
                    station_id,
                    song_end_type,
                    like,
                    dislike
                    FROM web_data
                    """

   try {
      val xmlData =
sqlContext.read.format("com.databricks.spark.xml").option("rowTag",
"record").load("file:///home/acadgild/examples/music/data/web/file.xml")
      xmlData.createOrReplaceTempView("web_data")

      sqlContext.sql(create_hive_table)
      sqlContext.sql(load_mob_data)
      sqlContext.sql(load_web_data)
     }
    catch{
     case e: Exception=>e.printStackTrace()
    }
 }
}
```

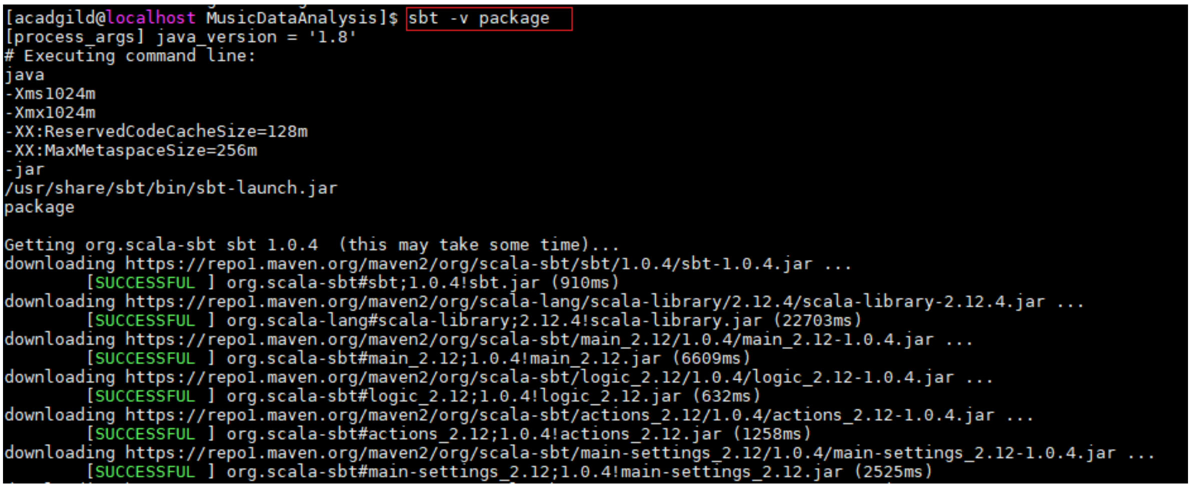
We have ***build.sbt*** file inside **MusicDataAnalysis** folder to create jar file:



```
[acadgild@localhost music]$ cd MusicDataAnalysis
[acadgild@localhost MusicDataAnalysis]$ ls -ls
total 8
4 -rw-rw-r--. 1 acadgild acadgild  802 Dec  1 18:34 build.sbt
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:34 src
```

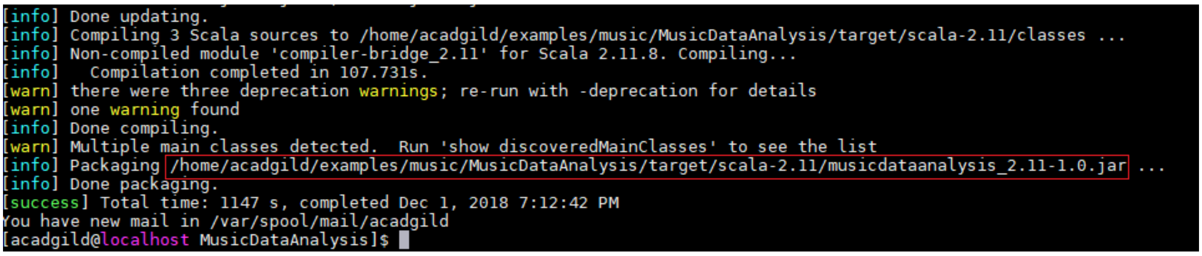
Below is the command to create jar file in verbose mode:

sbt -v package



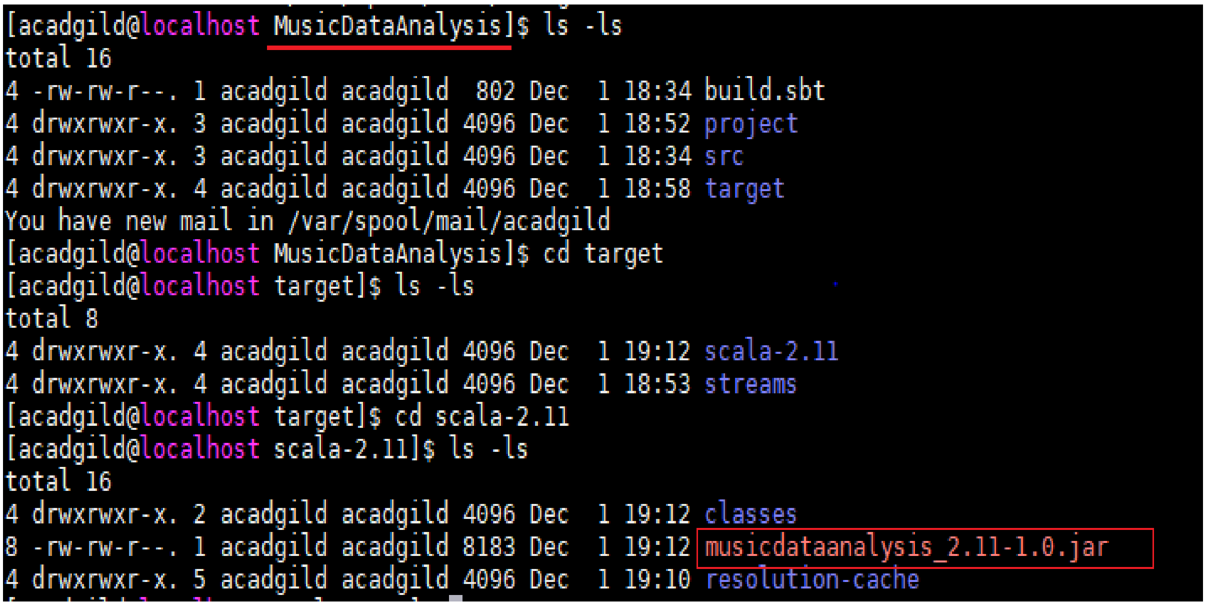
```
[acadgild@localhost MusicDataAnalysis]$ sbt -v package
[process_args] java_version = '1.8'
# Executing command line:
java
-Xms1024m
-Xmx1024m
-XX:ReservedCodeCacheSize=128m
-XX:MaxMetaspaceSize=256m
-jar
/usr/share/sbt/bin/sbt-launch.jar
package

Getting org.scala-sbt sbt 1.0.4  (this may take some time)...
downloading https://repo1.maven.org/maven2/org/scala-sbt/sbt/1.0.4/sbt-1.0.4.jar ...
        [SUCCESSFUL ] org.scala-sbt#sbt;1.0.4!sbt.jar (910ms)
downloading https://repo1.maven.org/maven2/org/scala-lang/scala-library/2.12.4/scala-library-2.12.4.jar ...
        [SUCCESSFUL ] org.scala-lang#scala-library;2.12.4!scala-library.jar (22703ms)
downloading https://repo1.maven.org/maven2/org/scala-sbt/main_2.12/1.0.4/main_2.12-1.0.4.jar ...
        [SUCCESSFUL ] org.scala-sbt#main_2.12;1.0.4!main_2.12.jar (6609ms)
downloading https://repo1.maven.org/maven2/org/scala-sbt/logic_2.12/1.0.4/logic_2.12-1.0.4.jar ...
        [SUCCESSFUL ] org.scala-sbt#logic_2.12;1.0.4!logic_2.12.jar (632ms)
downloading https://repo1.maven.org/maven2/org/scala-sbt/actions_2.12/1.0.4/actions_2.12-1.0.4.jar ...
        [SUCCESSFUL ] org.scala-sbt#actions_2.12;1.0.4!actions_2.12.jar (1258ms)
downloading https://repo1.maven.org/maven2/org/scala-sbt/main-settings_2.12/1.0.4/main-settings_2.12-1.0.4.jar ...
        [SUCCESSFUL ] org.scala-sbt#main-settings_2.12;1.0.4!main-settings_2.12.jar (2525ms)
```

Finally Jar file gets created as highlighted below:



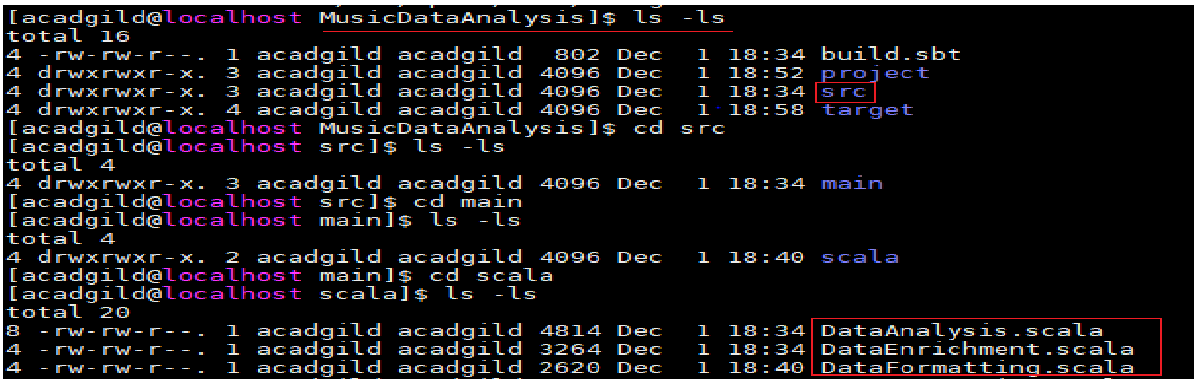
```
[info] Done updating.
[info] Compiling 3 Scala sources to /home/acadgild/examples/music/MusicDataAnalysis/target/scala-2.11/classes ...
[info] Non-compiled module 'compiler-bridge_2.11' for Scala 2.11.8. Compiling...
[info]   Compilation completed in 107.731s.
[warn] there were three deprecation warnings; re-run with -deprecation for details
[warn] one warning found
[info] Done compiling.
[warn] Multiple main classes detected.  Run 'show discoveredMainClasses' to see the list
[info] Packaging /home/acadgild/examples/music/MusicDataAnalysis/target/scala-2.11/musicdataanalysis_2.11-1.0.jar ...
[info] Done packaging.
[success] Total time: 1147 s, completed Dec 1, 2018 7:12:42 PM
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost MusicDataAnalysis]$
```

Below is the location of Jar file which gets created under ***/MusicDataAnalysis/target/scala-2.11***:



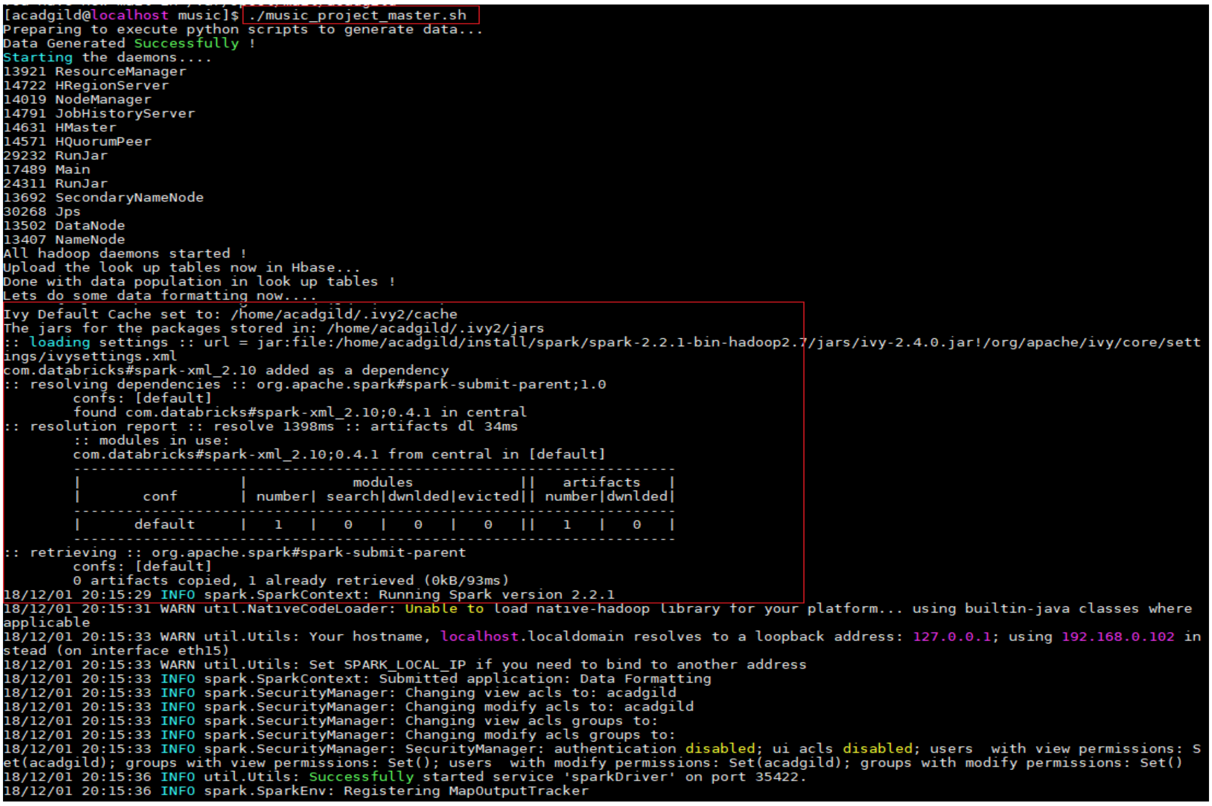
```
[acadgild@localhost MusicDataAnalysis]$ ls -ls
total 16
4 -rw-rw-r--. 1 acadgild acadgild  802 Dec  1 18:34 build.sbt
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:52 project
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:34 src
4 drwxrwxr-x. 4 acadgild acadgild 4096 Dec  1 18:58 target
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost MusicDataAnalysis]$ cd target
[acadgild@localhost target]$ ls -ls
total 8
4 drwxrwxr-x. 4 acadgild acadgild 4096 Dec  1 19:12 scala-2.11
4 drwxrwxr-x. 4 acadgild acadgild 4096 Dec  1 18:53 streams
[acadgild@localhost target]$ cd scala-2.11
[acadgild@localhost scala-2.11]$ ls -ls
total 16
4 drwxrwxr-x. 2 acadgild acadgild 4096 Dec  1 19:12 classes
8 -rw-rw-r--. 1 acadgild acadgild 8183 Dec  1 19:12 musicdataanalysis_2.11-1.0.jar
4 drwxrwxr-x. 5 acadgild acadgild 4096 Dec  1 19:10 resolution-cache
```

Scala programs related to data lies in the location below:

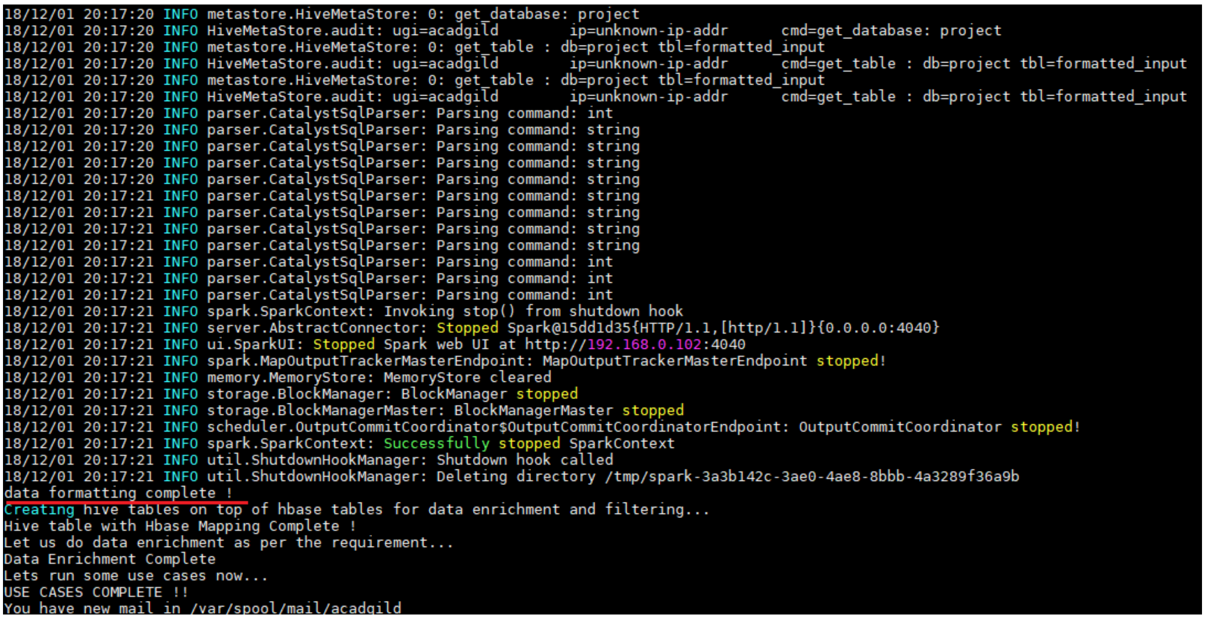


```
[acadgild@localhost MusicDataAnalysis]$ ls -ls
total 16
4 -rw-rw-r--. 1 acadgild acadgild  802 Dec  1 18:34 build.sbt
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:52 project
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:34 src
4 drwxrwxr-x. 4 acadgild acadgild 4096 Dec  1 18:58 target
[acadgild@localhost MusicDataAnalysis]$ cd src
[acadgild@localhost src]$ ls -ls
total 4
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  1 18:34 main
[acadgild@localhost src]$ cd main
[acadgild@localhost main]$ ls -ls
total 4
4 drwxrwxr-x. 2 acadgild acadgild 4096 Dec  1 18:40 scala
[acadgild@localhost main]$ cd scala
[acadgild@localhost scala]$ ls -ls
total 20
8 -rw-rw-r--. 1 acadgild acadgild 4814 Dec  1 18:34 DataAnalysis.scala
4 -rw-rw-r--. 1 acadgild acadgild 3264 Dec  1 18:34 DataEnrichment.scala
4 -rw-rw-r--. 1 acadgild acadgild 2620 Dec  1 18:40 DataFormatting.scala
```

We are executing master script which internally calls ***dataformatting.sh*** which performs data formatting:



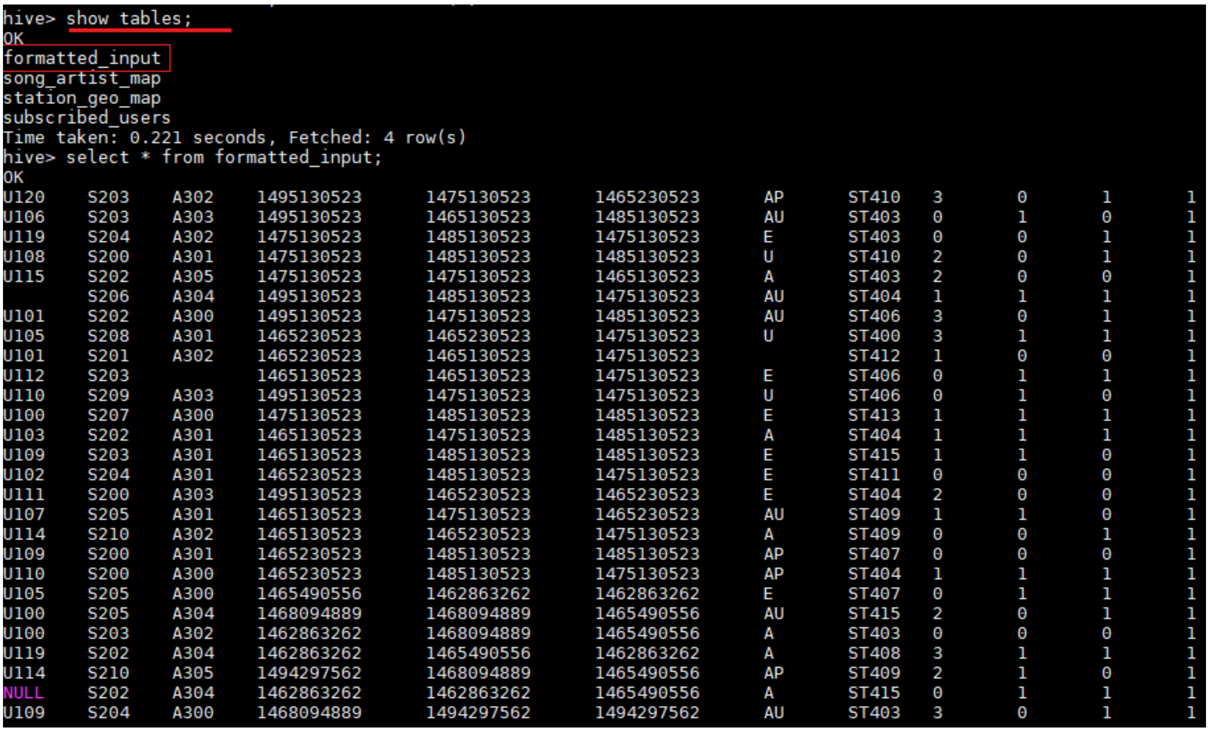
```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
Data Generated Successfully !
Starting the daemons....
13921 ResourceManager
14722 HRegionServer
14019 NodeManager
14791 JobHistoryServer
14631 HMaster
14571 HQuorumPeer
29232 RunJar
17489 Main
24311 RunJar
13692 SecondaryNameNode
30268 Jps
13502 DataNode
13407 NameNode
All hadoop daemons started !
Upload the look up tables now in Hbase...
Done with data population in look up tables !
Lets do some data formatting now....
Ivy Default Cache set to: /home/acadgild/.ivy2/cache
The jars for the packages stored in: /home/acadgild/.ivy2/jars
:: loading settings :: url = jar:file:/home/acadgild/install/spark/spark-2.2.1-bin-hadoop2.7/jars/ivy-2.4.0.jar!/org/apache/ivy/core/sett
ings/ivysettings.xml
com.databricks#spark-xml_2.10 added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent;1.0
        confs: [default]
        found com.databricks#spark-xml_2.10;0.4.1 in central
:: resolution report :: resolve 1398ms :: artifacts dl 34ms
        :: modules in use:
        com.databricks#spark-xml_2.10;0.4.1 from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   1   |   0   |   0   |   0   ||   1   |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent
        confs: [default]
        0 artifacts copied, 1 already retrieved (0kB/93ms)
18/12/01 20:15:29 INFO spark.SparkContext: Running Spark version 2.2.1
18/12/01 20:15:31 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/01 20:15:33 WARN util.Utils: Your hostname, localhost.localdomain resolves to a loopback address: 127.0.0.1; using 192.168.0.102 in
stead (on interface eth15)
18/12/01 20:15:33 WARN util.Utils: Set SPARK_LOCAL_IP if you need to bind to another address
18/12/01 20:15:33 INFO spark.SparkContext: Submitted application: Data Formatting
18/12/01 20:15:33 INFO spark.SecurityManager: Changing view acls to: acadgild
18/12/01 20:15:33 INFO spark.SecurityManager: Changing modify acls to: acadgild
18/12/01 20:15:33 INFO spark.SecurityManager: Changing view acls groups to:
18/12/01 20:15:33 INFO spark.SecurityManager: Changing modify acls groups to:
18/12/01 20:15:33 INFO spark.SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissions: S
et(acadgild); groups with view permissions: Set(); users  with modify permissions: Set(acadgild); groups with modify permissions: Set()
18/12/01 20:15:36 INFO util.Utils: Successfully started service 'sparkDriver' on port 35422.
18/12/01 20:15:36 INFO spark.SparkEnv: Registering MapOutputTracker
```



```
18/12/01 20:17:20 INFO metastore.HiveMetaStore: 0: get_database: project
18/12/01 20:17:20 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_database: project
18/12/01 20:17:20 INFO metastore.HiveMetaStore: 0: get_table : db=project tbl=formatted_input
18/12/01 20:17:20 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_table : db=project tbl=formatted_input
18/12/01 20:17:20 INFO metastore.HiveMetaStore: 0: get_table : db=project tbl=formatted_input
18/12/01 20:17:20 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_table : db=project tbl=formatted_input
18/12/01 20:17:20 INFO parser.CatalystSqlParser: Parsing command: int
18/12/01 20:17:20 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:20 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:20 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:20 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: string
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: int
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: int
18/12/01 20:17:21 INFO parser.CatalystSqlParser: Parsing command: int
18/12/01 20:17:21 INFO spark.SparkContext: Invoking stop() from shutdown hook
18/12/01 20:17:21 INFO server.AbstractConnector: Stopped Spark@15dd1d35{HTTP/1.1,[http/1.1]}{0.0.0.0:4040}
18/12/01 20:17:21 INFO ui.SparkUI: Stopped Spark web UI at http://192.168.0.102:4040
18/12/01 20:17:21 INFO spark.MapOutputTrackerMasterEndpoint: MapOutputTrackerMasterEndpoint stopped!
18/12/01 20:17:21 INFO memory.MemoryStore: MemoryStore cleared
18/12/01 20:17:21 INFO storage.BlockManager: BlockManager stopped
18/12/01 20:17:21 INFO storage.BlockManagerMaster: BlockManagerMaster stopped
18/12/01 20:17:21 INFO scheduler.OutputCommitCoordinator$OutputCommitCoordinatorEndpoint: OutputCommitCoordinator stopped!
18/12/01 20:17:21 INFO spark.SparkContext: Successfully stopped SparkContext
18/12/01 20:17:21 INFO util.ShutdownHookManager: Shutdown hook called
18/12/01 20:17:21 INFO util.ShutdownHookManager: Deleting directory /tmp/spark-3a3b142c-3ae0-4ae8-8bbb-4a3289f36a9b
data formatting complete !
Creating hive tables on top of hbase tables for data enrichment and filtering...
Hive table with Hbase Mapping Complete !
Let us do data enrichment as per the requirement...
Data Enrichment Complete
Lets run some use cases now...
USE CASES COMPLETE !!
You have new mail in /var/spool/mail/acadgild
```

Below Hive table ***formatted_input*** gets created which contains all data which gets merged from web and mobile applications (file.txt and file.xml):

hive> select * from formatted_input;



```
hive> show tables;
OK
formatted_input
song_artist_map
station_geo_map
subscribed_users
Time taken: 0.221 seconds, Fetched: 4 row(s)
hive> select * from formatted_input;
OK
U120    S203    A302    1495130523      1475130523      1465230523      AP      ST410   3       0       1       1
U106    S203    A303    1495130523      1465130523      1485130523      AU      ST403   0       1       0       1
U119    S204    A302    1475130523      1485130523      1475130523      E       ST403   0       0       1       1
U108    S200    A301    1475130523      1485130523      1485130523      U       ST410   2       0       1       1
U115    S202    A305    1475130523      1475130523      1465130523      A       ST403   2       0       0       1
        S206    A304    1495130523      1485130523      1475130523      AU      ST404   1       1       1       1
U101    S202    A300    1495130523      1475130523      1485130523      AU      ST406   3       0       1       1
U105    S208    A301    1465230523      1465230523      1475130523      U       ST400   3       1       1       1
U101    S201    A302    1465230523      1465130523      1475130523              ST412   1       0       0       1
U112    S203            1465130523      1465130523      1475130523      E       ST406   0       1       1       1
U110    S209    A303    1495130523      1475130523      1475130523      U       ST406   0       1       0       1
U100    S207    A300    1475130523      1485130523      1485130523      E       ST413   1       1       1       1
U103    S202    A301    1465130523      1475130523      1485130523      A       ST404   1       1       1       1
U109    S203    A301    1465130523      1485130523      1485130523      E       ST415   1       1       0       1
U102    S204    A301    1465230523      1485130523      1475130523      E       ST411   0       0       0       1
U111    S200    A303    1495130523      1465230523      1465230523      E       ST404   2       0       0       1
U107    S205    A301    1465130523      1475130523      1465230523      AU      ST409   1       1       0       1
U114    S210    A302    1465130523      1465230523      1475130523      A       ST409   0       0       1       1
U109    S200    A301    1465230523      1485130523      1485130523      AP      ST407   0       0       0       1
U110    S200    A300    1465230523      1485130523      1475130523      AP      ST404   1       1       1       1
U105    S205    A300    1465490556      1462863262      1462863262      E       ST407   0       1       1       1
U100    S205    A304    1468094889      1468094889      1465490556      AU      ST415   2       0       1       1
U100    S203    A302    1462863262      1468094889      1465490556      A       ST403   0       0       0       1
U119    S202    A304    1462863262      1465490556      1462863262      A       ST408   3       1       1       1
U114    S210    A305    1494297562      1468094889      1465490556      AP      ST409   2       1       0       1
NULL    S202    A304    1462863262      1462863262      1465490556      A       ST415   0       1       1       1
U109    S204    A300    1468094889      1494297562      1494297562      AU      ST403   3       0       1       1
```

In the above screenshot, we could see that formatted input data with some **null** values in user_id, aritist_id and geo_cd columns which we will fill the enrichment script based on rules of enrichment for artist_id and geo_cd only.

Data Formatting phase is executed successfully by loading both mobile and web data and partitioned based on batchid.

6. Perform Data Enrichment and Cleaning:

In this phase we will enrich the data coming from web and mobile applications using the lookup table stored in Hbase and divide the records based on the enrichment rules into ‘pass’ and ‘fail’ records.

Rules for data enrichment:

1. If any of like or dislike is NULL or absent, consider it as 0.
2. If fields like Geo_cd and Artist_id are NULL or absent, consult the lookup tables for fields Station_id and Song_id respectively to get the values of Geo_cd and Artist_id.
3. If corresponding lookup entry is not found, consider that record to be invalid

So, based on the enrichment rules we will fill the null geo_cd and artist_id values with the help of corresponding lookup values in song-artist-map and station-geo-map tables in Hive-HBase tables.

Script for **Data_enrichment.sh:**

```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`
LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid
VALIDDIR=/home/acadgild/examples/music/processed_dir/valid/batch_$batc
hid
INVALIDDIR=/home/acadgild/examples/music/processed_dir/invalid/batch_$
batch  id

echo "Running script for data enrichment and filtering..." >> $LOGFILE

spark-submit --class DataEnrichment \
--master local[2] \
--jars /home/acadgild/install/hive/apache-hive-2.3.2-bin/lib/hive-hbase-
handler-2.3.2.jar,/home/acadgild/install/hive/apache-hive-2.3.2-
bin/lib/hbase-client-1.1.1.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-
bin/lib/hbase-common-1.1.1.jar,/home/acadgild/install/hive/apache- hive-
2.3.2-bin/lib/hbase-hadoop-compat-
1.1.1.jar,/home/acadgild/install/hive/apache-hive-2.3.2-bin/lib/hbase- server-
1.1.1.jar,/home/acadgild/install/hive/apache-hive-2.3.2- bin/lib/hbase-
protocol-1.1.1.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-
bin/lib/zookeeper-3.4.6.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-
bin/lib/guava-14.0.1.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-
bin/lib/htrace-core-3.1.0-incubating.jar \
/home/acadgild/examples/music/MusicDataAnalysis/target/scala-
2.11/musicdataanalysis_2.11-1.0.jar $batchid

if [ ! -d "$VALIDDIR" ]
```

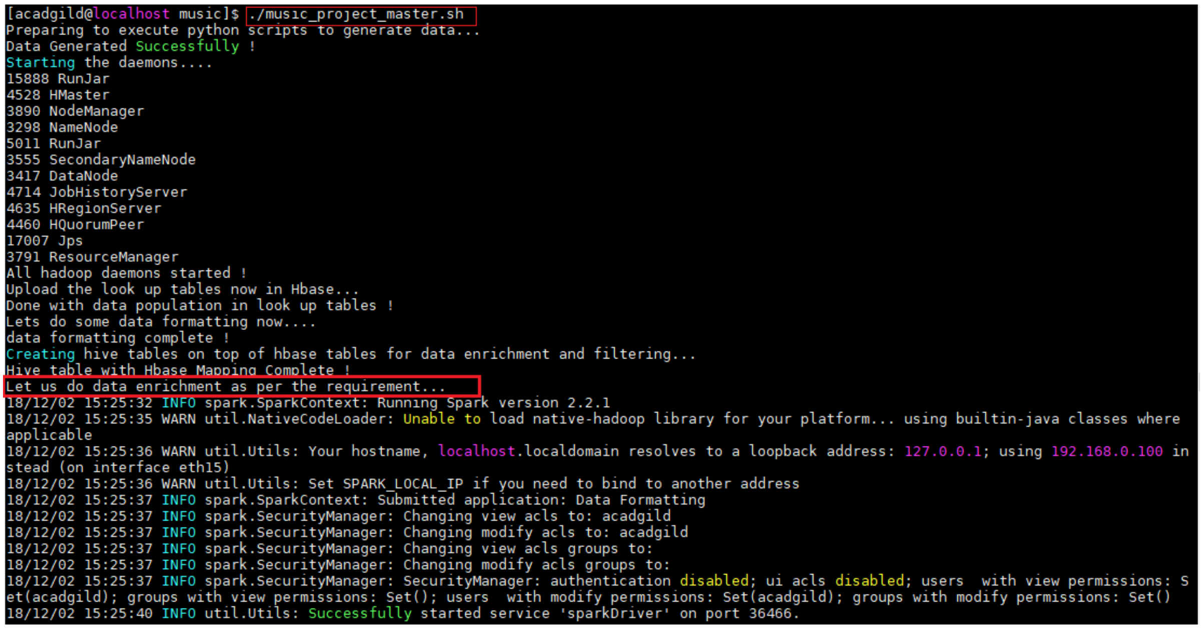
```
then
mkdir -p "$VALIDDIR" fi

if [ ! -d "$INVALIDDIR" ]
then
mkdir -p "$INVALIDDIR"
 fi

echo "Copying valid and invalid records in local file system..." >>
$LOGFILE

hadoop fs -get
/user/hive/warehouse/project.db/enriched_data/batchid=$batchid/status=pa
ss/* $VALIDDIR

hadoop fs -get
/user/hive/warehouse/project.db/enriched_data/batchid=$batchid/status=fai
l/* $INVALIDDIR

echo "Deleting older valid and invalid records from local file system..."
>> $LOGFILE

find /home/acadgild/examples/music/processed_dir/ -mtime +7 -exec rm {} \;
```

<u>Source code for **DataEnrichment.scala:**</u>

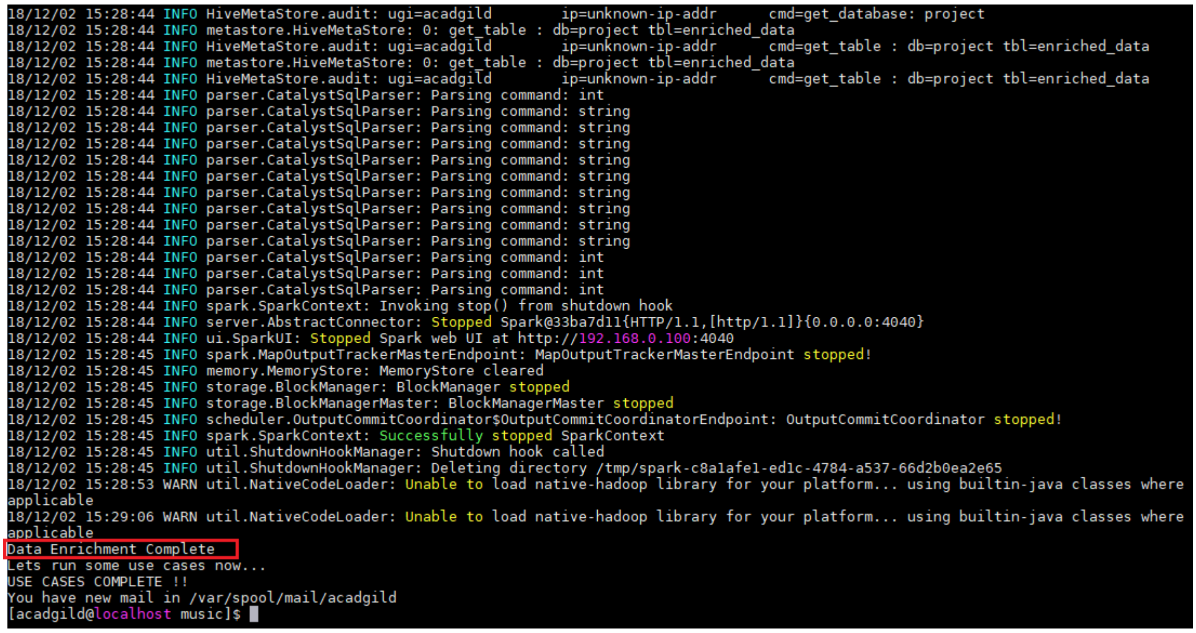
```
import org.apache.spark.{SparkConf, SparkContext}
import org.apache.spark.sql

object DataEnrichment {
  def main(args: Array[String]): Unit = {
    val conf = new SparkConf().setAppName("Data Formatting")
    val sc = new SparkContext(conf)
    val sqlContext = new org.apache.spark.sql.hive.HiveContext(sc)
    val batchId = args(0)
    val create_hive_table = """CREATE TABLE IF NOT EXISTS enriched_data
                         (
                         User_id STRING,
                         Song_id STRING,
                         Artist_id STRING,
                         Timestamp STRING,
                         Start_ts STRING,
                         End_ts STRING,
                         Geo_cd STRING,
                         Station_id STRING,
                         Song_end_type INT,
                         Like INT,
                         Dislike INT
                         )
                         PARTITIONED BY
                         (batchid INT,
                         status STRING)
                         STORED AS ORC
                         """

    val load_data = s"""INSERT OVERWRITE TABLE enriched_data
                    PARTITION (batchid, status)
                    SELECT
                    i.user_id,
                    i.song_id,
                    sa.artist_id,
                    i.timestamp,
                    i.start_ts,
                    i.end_ts,
                    sg.geo_cd,
                    i.station_id,
                    IF (i.song_end_type IS NULL, 3, i.song_end_type) AS song_end_type,
                    IF (i.like IS NULL, 0, i.like) AS like,
                    IF (i.dislike IS NULL, 0, i.dislike) AS dislike,
                    i.batchid,
                    IF((i.like=1 AND i.dislike=1)
                    OR i.user_id IS NULL
                    OR i.song_id IS NULL
                    OR i.timestamp IS NULL
                    OR i.start_ts IS NULL
                    OR i.end_ts IS NULL
                    OR i.geo_cd IS NULL
                    OR i.user_id=''
                    OR i.song_id=''
                    OR i.timestamp=''
                    OR i.start_ts=''
                    OR i.end_ts=''
                    OR i.geo_cd=''
                    OR sg.geo_cd IS NULL
                    OR sg.geo_cd=''
                    OR sa.artist_id IS NULL
                    OR sa.artist_id='', 'fail', 'pass') AS status
                    FROM formatted_input i LEFT OUTER JOIN station_geo_map sg ON i.station_id = sg.station_id
                    LEFT OUTER JOIN song_artist_map sa ON i.song_id = sa.song_id
                    WHERE i.batchid=$batchId
                    """
```

```
    try {

        sqlContext.sql("SET hive.auto.convert.join=false")
        sqlContext.sql("SET hive.exec.dynamic.partition.mode=nonstrict")
        sqlContext.sql("USE project")

        sqlContext.sql(create_hive_table)
        sqlContext.sql(load_data)
      }
     catch{
      case e: Exception=>e.printStackTrace()
     }
 }
}
```

We have executed data_enrichment.sh script by calling ***music_project_master.sh*** batch file as shown below:



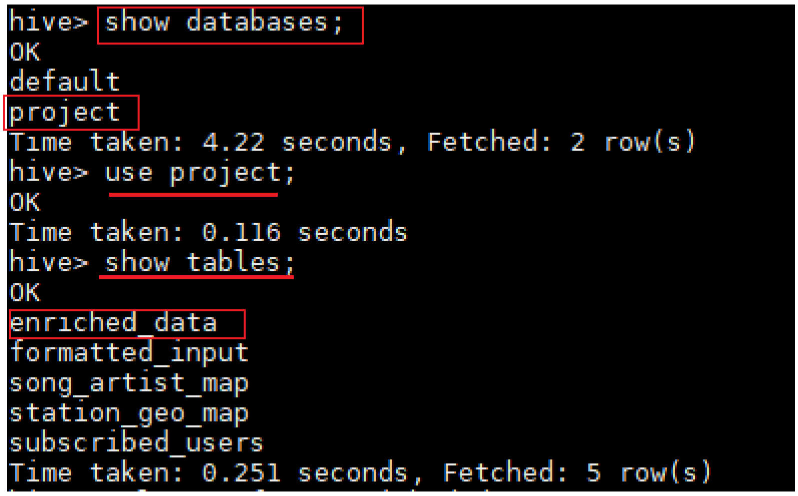
```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
Data Generated Successfully !
Starting the daemons....
15888 RunJar
4528 HMaster
3890 NodeManager
3298 NameNode
5011 RunJar
3555 SecondaryNameNode
3417 DataNode
4714 JobHistoryServer
4635 HRegionServer
4460 HQuorumPeer
17007 Jps
3791 ResourceManager
All hadoop daemons started !
Upload the look up tables now in Hbase...
Done with data population in look up tables !
Lets do some data formatting now....
data formatting complete !
Creating hive tables on top of hbase tables for data enrichment and filtering...
Hive table with Hbase Mapping Complete !
Let us do data enrichment as per the requirement...
18/12/02 15:25:32 INFO spark.SparkContext: Running Spark version 2.2.1
18/12/02 15:25:35 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/02 15:25:36 WARN util.Utils: Your hostname, localhost.localdomain resolves to a loopback address: 127.0.0.1; using 192.168.0.100 in
stead (on interface eth15)
18/12/02 15:25:36 WARN util.Utils: Set SPARK_LOCAL_IP if you need to bind to another address
18/12/02 15:25:37 INFO spark.SparkContext: Submitted application: Data Formatting
18/12/02 15:25:37 INFO spark.SecurityManager: Changing view acls to: acadgild
18/12/02 15:25:37 INFO spark.SecurityManager: Changing modify acls to: acadgild
18/12/02 15:25:37 INFO spark.SecurityManager: Changing view acls groups to:
18/12/02 15:25:37 INFO spark.SecurityManager: Changing modify acls groups to:
18/12/02 15:25:37 INFO spark.SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissions: S
et(acadgild); groups with view permissions: Set(); users  with modify permissions: Set(acadgild); groups with modify permissions: Set()
18/12/02 15:25:40 INFO util.Utils: Successfully started service 'sparkDriver' on port 36466.
```



```
18/12/02 15:28:44 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_database: project
18/12/02 15:28:44 INFO metastore.HiveMetaStore: 0: get_table : db=project tbl=enriched_data
18/12/02 15:28:44 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_table : db=project tbl=enriched_data
18/12/02 15:28:44 INFO metastore.HiveMetaStore: 0: get_table : db=project tbl=enriched_data
18/12/02 15:28:44 INFO HiveMetaStore.audit: ugi=acadgild        ip=unknown-ip-addr      cmd=get_table : db=project tbl=enriched_data
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: int
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: string
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: int
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: int
18/12/02 15:28:44 INFO parser.CatalystSqlParser: Parsing command: int
18/12/02 15:28:44 INFO spark.SparkContext: Invoking stop() from shutdown hook
18/12/02 15:28:44 INFO server.AbstractConnector: Stopped Spark@33ba7d11{HTTP/1.1,[http/1.1]}{0.0.0.0:4040}
18/12/02 15:28:44 INFO ui.SparkUI: Stopped Spark web UI at http://192.168.0.100:4040
18/12/02 15:28:45 INFO spark.MapOutputTrackerMasterEndpoint: MapOutputTrackerMasterEndpoint stopped!
18/12/02 15:28:45 INFO memory.MemoryStore: MemoryStore cleared
18/12/02 15:28:45 INFO storage.BlockManager: BlockManager stopped
18/12/02 15:28:45 INFO storage.BlockManagerMaster: BlockManagerMaster stopped
18/12/02 15:28:45 INFO scheduler.OutputCommitCoordinator$OutputCommitCoordinatorEndpoint: OutputCommitCoordinator stopped!
18/12/02 15:28:45 INFO spark.SparkContext: Successfully stopped SparkContext
18/12/02 15:28:45 INFO util.ShutdownHookManager: Shutdown hook called
18/12/02 15:28:45 INFO util.ShutdownHookManager: Deleting directory /tmp/spark-c8a1afe1-ed1c-4784-a537-66d2b0ea2e65
18/12/02 15:28:53 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/02 15:29:06 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
Data Enrichment Complete
Lets run some use cases now...
USE CASES COMPLETE !!
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost music]$ 
```

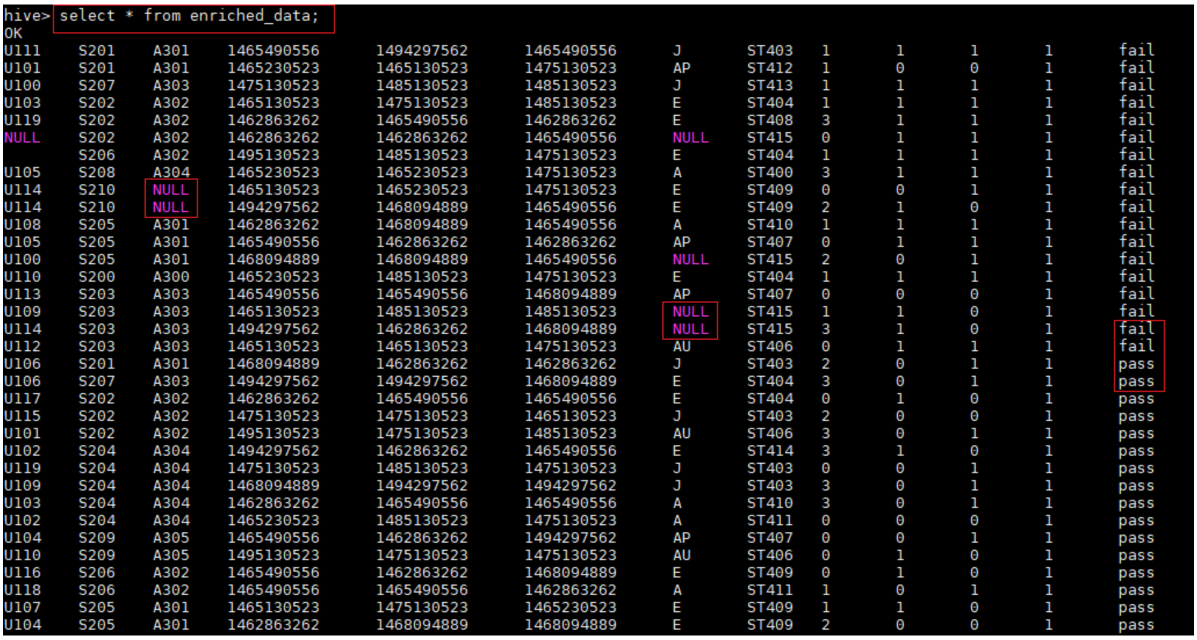
In the above step Data Enrichment is completed.

Let’s have a look at the data enrichment table that got created.



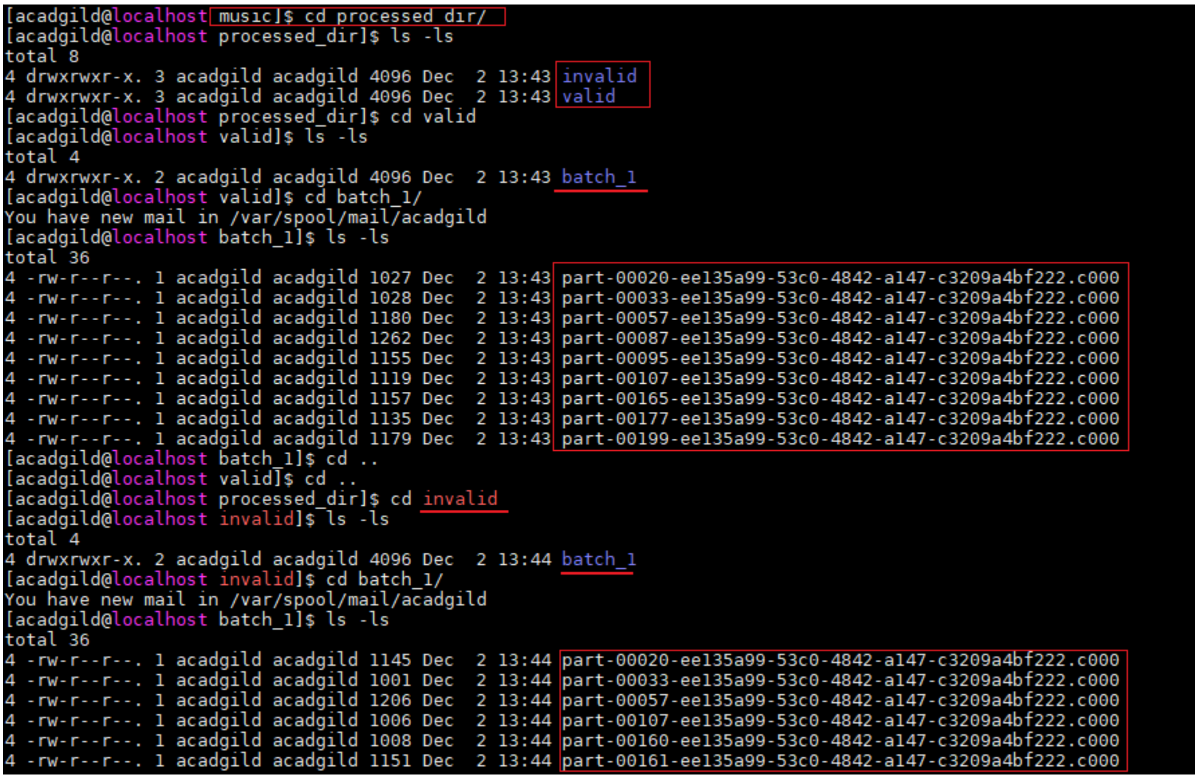
```
hive> show databases;
OK
default
project
Time taken: 4.22 seconds, Fetched: 2 row(s)
hive> use project;
OK
Time taken: 0.116 seconds
hive> show tables;
OK
enriched_data
formatted_input
song_artist_map
station_geo_map
subscribed_users
Time taken: 0.251 seconds, Fetched: 5 row(s)
```

In the below screenshot, we have data for data enrichment table where we filled the null values of ***artist_id*** and ***geo_cd*** of formatted input with the help of lookup tables



```
hive> select * from enriched_data;
OK
U111    S201    A301    1465490556      1494297562      1465490556      J       ST403   1       1       1       1       fail
U101    S201    A301    1465230523      1465130523      1475130523      AP      ST412   1       0       0       1       fail
U100    S207    A303    1475130523      1485130523      1485130523      J       ST413   1       1       1       1       fail
U103    S202    A302    1465130523      1475130523      1485130523      E       ST404   1       1       1       1       fail
U119    S202    A302    1462863262      1465490556      1462863262      E       ST408   3       1       1       1       fail
NULL    S202    A302    1462863262      1462863262      1465490556      NULL    ST415   0       1       1       1       fail
        S206    A302    1495130523      1485130523      1475130523      E       ST404   1       1       1       1       fail
U105    S208    A304    1465230523      1465230523      1475130523      A       ST400   3       1       1       1       fail
U114    S210    NULL    1465130523      1465230523      1475130523      E       ST409   0       0       1       1       fail
U114    S210    NULL    1494297562      1468094889      1465490556      E       ST409   2       1       0       1       fail
U108    S205    A301    1462863262      1468094889      1465490556      A       ST410   1       1       1       1       fail
U105    S205    A301    1465490556      1462863262      1462863262      AP      ST407   0       1       1       1       fail
U100    S205    A301    1468094889      1468094889      1465490556      NULL    ST415   2       0       1       1       fail
U110    S200    A300    1465230523      1485130523      1475130523      E       ST404   1       1       1       1       fail
U113    S203    A303    1465490556      1465490556      1468094889      AP      ST407   0       0       0       1       fail
U109    S203    A303    1465130523      1485130523      1485130523      NULL    ST415   1       1       0       1       fail
U114    S203    A303    1494297562      1462863262      1468094889      NULL    ST415   3       1       0       1       fail
U112    S203    A303    1465130523      1465130523      1475130523      AU      ST406   0       1       1       1       fail
U106    S201    A301    1468094889      1462863262      1462863262      J       ST403   2       0       1       1       pass
U106    S207    A303    1494297562      1494297562      1468094889      E       ST404   3       0       1       1       pass
U117    S202    A302    1462863262      1465490556      1465490556      E       ST404   0       1       0       1       pass
U115    S202    A302    1475130523      1475130523      1465130523      J       ST403   2       0       0       1       pass
U101    S202    A302    1495130523      1475130523      1485130523      AU      ST406   3       0       1       1       pass
U102    S204    A304    1494297562      1462863262      1465490556      E       ST414   3       1       0       1       pass
U119    S204    A304    1475130523      1485130523      1475130523      J       ST403   0       0       1       1       pass
U109    S204    A304    1468094889      1494297562      1494297562      J       ST403   3       0       1       1       pass
U103    S204    A304    1462863262      1465490556      1465490556      A       ST410   3       0       1       1       pass
U102    S204    A304    1465230523      1485130523      1475130523      A       ST411   0       0       0       1       pass
U104    S209    A305    1465490556      1462863262      1494297562      AP      ST407   0       0       1       1       pass
U110    S209    A305    1495130523      1475130523      1475130523      AU      ST406   0       1       0       1       pass
U116    S206    A302    1465490556      1462863262      1468094889      E       ST409   0       1       0       1       pass
U118    S206    A302    1465490556      1465490556      1462863262      A       ST411   1       0       1       1       pass
U107    S205    A301    1465130523      1475130523      1465230523      E       ST409   1       1       0       1       pass
U104    S205    A301    1462863262      1468094889      1468094889      E       ST409   2       0       0       1       pass
```

At the end, script will automatically divide the records based on status **pass & fail** and dump the result into **processed_dir** folder with **valid** and **invalid** folders as shown below:



```
[acadgild@localhost music]$ cd processed_dir/
[acadgild@localhost processed_dir]$ ls -ls
total 8
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  2 13:43 invalid
4 drwxrwxr-x. 3 acadgild acadgild 4096 Dec  2 13:43 valid
[acadgild@localhost processed_dir]$ cd valid
[acadgild@localhost valid]$ ls -ls
total 4
4 drwxrwxr-x. 2 acadgild acadgild 4096 Dec  2 13:43 batch_1
[acadgild@localhost valid]$ cd batch_1/
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost batch_1]$ ls -ls
total 36
4 -rw-r--r--. 1 acadgild acadgild 1027 Dec  2 13:43 part-00020-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1028 Dec  2 13:43 part-00033-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1180 Dec  2 13:43 part-00057-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1262 Dec  2 13:43 part-00087-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1155 Dec  2 13:43 part-00095-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1119 Dec  2 13:43 part-00107-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1157 Dec  2 13:43 part-00165-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1135 Dec  2 13:43 part-00177-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1179 Dec  2 13:43 part-00199-ee135a99-53c0-4842-a147-c3209a4bf222.c000
[acadgild@localhost batch_1]$ cd ..
[acadgild@localhost valid]$ cd ..
[acadgild@localhost processed_dir]$ cd invalid
[acadgild@localhost invalid]$ ls -ls
total 4
4 drwxrwxr-x. 2 acadgild acadgild 4096 Dec  2 13:44 batch_1
[acadgild@localhost invalid]$ cd batch_1/
You have new mail in /var/spool/mail/acadgild
[acadgild@localhost batch_1]$ ls -ls
total 36
4 -rw-r--r--. 1 acadgild acadgild 1145 Dec  2 13:44 part-00020-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1001 Dec  2 13:44 part-00033-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1206 Dec  2 13:44 part-00057-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1006 Dec  2 13:44 part-00107-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1008 Dec  2 13:44 part-00160-ee135a99-53c0-4842-a147-c3209a4bf222.c000
4 -rw-r--r--. 1 acadgild acadgild 1151 Dec  2 13:44 part-00161-ee135a99-53c0-4842-a147-c3209a4bf222.c000
```

Enrichment phase is executed successfully by applying all the rules of enrichment.

7. Perform Data Analysis (using Spark)

In this stage, we will do analysis on enriched data using Spark SQL and run the program using **Spark- Submit** command.

Script for **Data_analysis.sh:**

```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`
LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid

echo "Running script for data analysis..." >> $LOGFILE

spark-submit
--class DataAnalysis --master local[2] \
--jars
/home/acadgild/install/hive/apache-hive-2.3.2-bin/lib/hive- hbase-handler-
2.3.2.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-bin/lib/hbase-client-
1.1.1.jar,/home/acadgild/install/hive/apache-hive-2.3.2- bin/lib/hbase-
common-1.1.1.jar,/home/acadgild/install/hive/apache- hive-2.3.2-
bin/lib/hbase-hadoop-compat- 1.1.1.jar,/home/acadgild/install/hive/apache-
hive-2.3.2- bin/lib/hbase-server-1.1.1.jar,/home/acadgild/install/hive/apache-
hive-2.3.2-bin/lib/hbase-protocol-
1.1.1.jar,/home/acadgild/install/hive/apache-hive-2.3.2- bin/lib/zookeeper-
3.4.6.jar,/home/acadgild/install/hive/apache-hive- 2.3.2-bin/lib/guava-
14.0.1.jar,/home/acadgild/install/hive/apache- hive-2.3.2-bin/lib/htrace-core-
3.1.0-incubating.jar \
/home/acadgild/examples/music/MusicDataAnalysis/target/scala-
2.11/musicdataanalysis_2.11-1.0.jar $batchid

sh /home/acadgild/examples/music/data_export.sh

echo "Incrementing batchid..." >> $LOGFILE

 batchid=`expr $batchid + 1`
echo -n $batchid > /home/acadgild/examples/music/logs/current- batch.txt
```

Problem Statements

1. Determine top 10 station_id(s) where maximum number of songs were played, which were liked by unique users.
2. Determine total duration of songs played by each type of user, where type of user can be 'subscribed' or 'unsubscribed'. An unsubscribed user is the one whose record is either not present in Subscribed_users lookup table or has subscription_end_date earlier than the timestamp of the song played by him.
3. Determine top 10 connected artists. Connected artists are those whose songs are most listened by the unique users who follow them.
4. Determine top 10 songs who have generated the maximum revenue. Royalty applies to a song only if it was liked or was completed successfully or both.
5. Determine top 10 unsubscribed users who listened to the songs for the longest duration.

Spark Source Code:

We have created below Scala file for creating tables for each query (problem statement wise).

DataAnalysis.scala:

```
import org.apache.spark.{SparkConf, SparkContext}
import org.apache.spark.sql

object DataAnalysis {
  def main(args: Array[String]): Unit = {
    val conf = new SparkConf().setAppName("Data Analysis")
    val sc = new SparkContext(conf)
    val sqlContext = new org.apache.spark.sql.hive.HiveContext(sc)
    val batchId = args(0)

/***Problem 1: Determine top 10 station_id(s) where maximum number
of songs were played, which were liked by unique users***/

val create_top_10_stations = """CREATE TABLE IF NOT EXISTS top_10_stations
(
station_id STRING,
total_distinct_songs_played INT,
distinct_user_count INT
)
PARTITIONED BY (batchid INT)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE"""

val load_top_10_stations = s"""INSERT OVERWRITE TABLE top_10_stations
```

```
PARTITION(batchid='$batchId')
SELECT
station_id,
COUNT(DISTINCT song_id) AS total_distinct_songs_played,
COUNT(DISTINCT user_id) AS distinct_user_count
FROM enriched_data
WHERE status='pass'
AND batchid='$batchId'
AND like=1
GROUP BY station_id
ORDER BY total_distinct_songs_played DESC
LIMIT 10"""
```

/*Problem 2: Determine total duration of songs played by each type of user, where type of user can be 'subscribed' or 'unsubscribed'. An unsubscribed user is the one whose record is either not present in Subscribed_users lookup table or has subscription_end_date earlier than the timestamp of the song played by him***/**

```
val create_users_behaviour = """CREATE TABLE IF NOT EXISTS
users_behaviour
(
user_type STRING,
duration INT
)
PARTITIONED BY (batchid INT)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE"""

val load_users_behaviour = s"""INSERT OVERWRITE TABLE users_behaviour
PARTITION(batchid='$batchId')
SELECT
CASE WHEN (su.user_id IS NULL OR CAST(ed.timestamp AS DECIMAL(20,0))
> CAST(su.subscn_end_dt AS DECIMAL(20,0))) THEN 'UNSUBSCRIBED'
WHEN (su.user_id IS NOT NULL AND CAST(ed.timestamp AS DECIMAL(20,0))
<= CAST(su.subscn_end_dt AS DECIMAL(20,0))) THEN 'SUBSCRIBED'
END AS user_type,
SUM(ABS(CAST(ed.end_ts AS DECIMAL(20,0))-CAST(ed.start_ts AS
DECIMAL(20,0)))) AS duration
FROM enriched_data ed
LEFT OUTER JOIN subscribed_users su
ON ed.user_id=su.user_id
WHERE ed.status='pass'
AND ed.batchid='$batchId'
```

```
GROUP BY CASE WHEN (su.user_id IS NULL OR CAST(ed.timestamp AS DECIMAL(20,0)) > CAST(su.subscn_end_dt AS DECIMAL(20,0))) THEN 'UNSUBSCRIBED'
WHEN (su.user_id IS NOT NULL AND CAST(ed.timestamp AS DECIMAL(20,0)) <= CAST(su.subscn_end_dt AS DECIMAL(20,0))) THEN 'SUBSCRIBED' END"""
```

/*Problem 3: Determine top 10 connected artists. Connected artists are those whose songs are most listened by the unique users who follow them***/**

```
val create_connected_artists = """CREATE TABLE IF NOT EXISTS connected_artists
(
artist_id STRING,
user_count INT
)
PARTITIONED BY (batchid INT)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE"""

val load_connected_artists = s"""INSERT OVERWRITE TABLE connected_artists
PARTITION(batchid='$batchId')
SELECT
ua.artist_id,
COUNT(DISTINCT ua.user_id) AS user_count
FROM
(
SELECT user_id, artist_id FROM users_artists
LATERAL VIEW explode(artists_array) artists AS artist_id
) ua
INNER JOIN
(
SELECT artist_id, song_id, user_id
FROM enriched_data
WHERE status='pass'
AND batchid='$batchId'
) ed
ON ua.artist_id=ed.artist_id
AND ua.user_id=ed.user_id
GROUP BY ua.artist_id
ORDER BY user_count DESC
LIMIT 10"""
```

/*Problem 4: Determine top 10 songs who have generated the maximum revenue. Royalty applies to a song only if it was liked or was completed successfully or both***/**

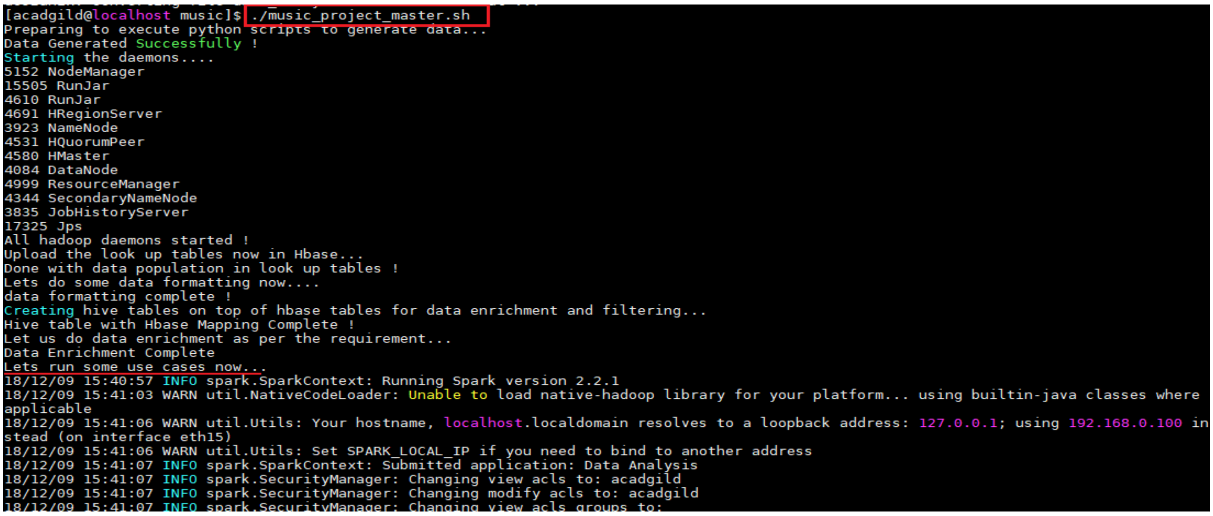
```
val create_top_10_royalty_songs = """CREATE TABLE IF NOT EXISTS
top_10_royalty_songs
(
song_id STRING,
duration INT
)
PARTITIONED BY (batchid INT)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE"""

val load_top_10_royalty_songs = s"""INSERT OVERWRITE TABLE
top_10_royalty_songs
PARTITION(batchid='$batchId')
SELECT song_id,
SUM(ABS(CAST(end_ts AS DECIMAL(20,0))-CAST(start_ts AS
DECIMAL(20,0)))) AS duration
FROM enriched_data
WHERE status='pass'
AND batchid='$batchId'
AND (like=1 OR song_end_type=0)
GROUP BY song_id
ORDER BY duration DESC
LIMIT 10"""
```

/*Problem 5: Determine top 10 unsubscribed users who listened to the songs for the longest duration***/**

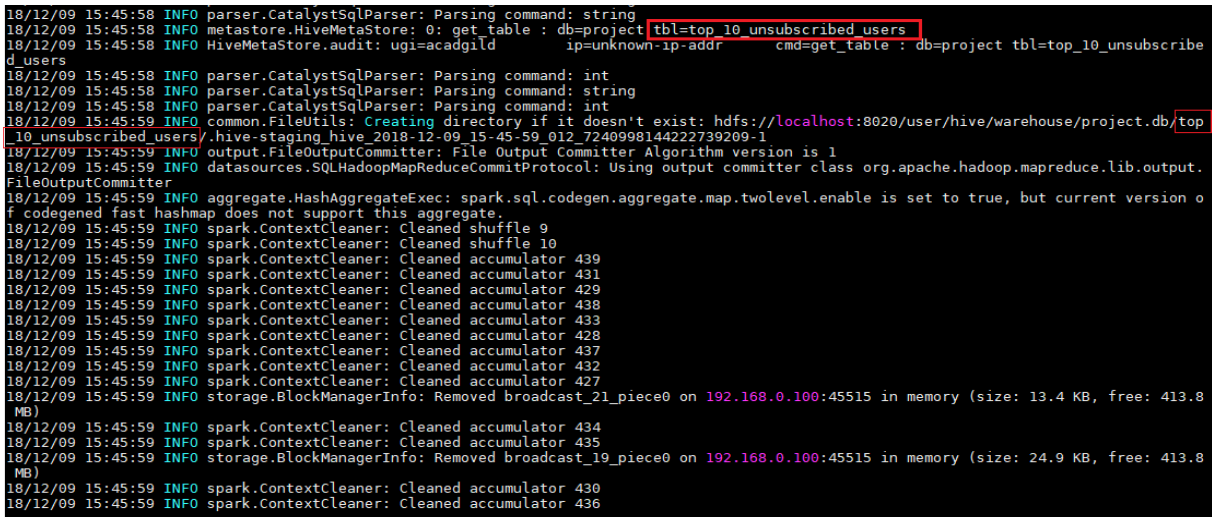
```
val create_top_10_unsubscribed_users = """CREATE TABLE IF NOT EXISTS
top_10_unsubscribed_users
(
user_id STRING,
duration INT
)
PARTITIONED BY (batchid INT)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE"""

val load_top_10_unsubscribed_users = s"""INSERT OVERWRITE TABLE
top_10_unsubscribed_users
PARTITION(batchid='$batchId')
SELECT
```

```
ed.user_id,
SUM(ABS(CAST(ed.end_ts AS DECIMAL(20,0))-CAST(ed.start_ts AS
DECIMAL(20,0)))) AS duration
FROM enriched_data ed
LEFT OUTER JOIN subscribed_users su
ON ed.user_id=su.user_id
WHERE ed.status='pass'
AND ed.batchid='$batchId'
AND (su.user_id IS NULL OR (CAST(ed.timestamp AS DECIMAL(20,0)) >
CAST(su.subscn_end_dt AS DECIMAL(20,0))))
GROUP BY ed.user_id
ORDER BY duration DESC
LIMIT 10"""


  try {
     sqlContext.sql("SET hive.auto.convert.join=false")
     sqlContext.sql("USE project")
     sqlContext.sql(create_top_10_stations)
     sqlContext.sql(load_top_10_stations)
     sqlContext.sql(create_users_behaviour)
     sqlContext.sql(load_users_behaviour)
     sqlContext.sql(create_connected_artists)
     sqlContext.sql(load_connected_artists)
     sqlContext.sql(create_top_10_royalty_songs)
     sqlContext.sql(load_top_10_royalty_songs)
     sqlContext.sql(create_top_10_unsubscribed_users)
     sqlContext.sql(load_top_10_unsubscribed_users)
    }
   catch{
    case e: Exception=>e.printStackTrace()
   }
 }
}
```

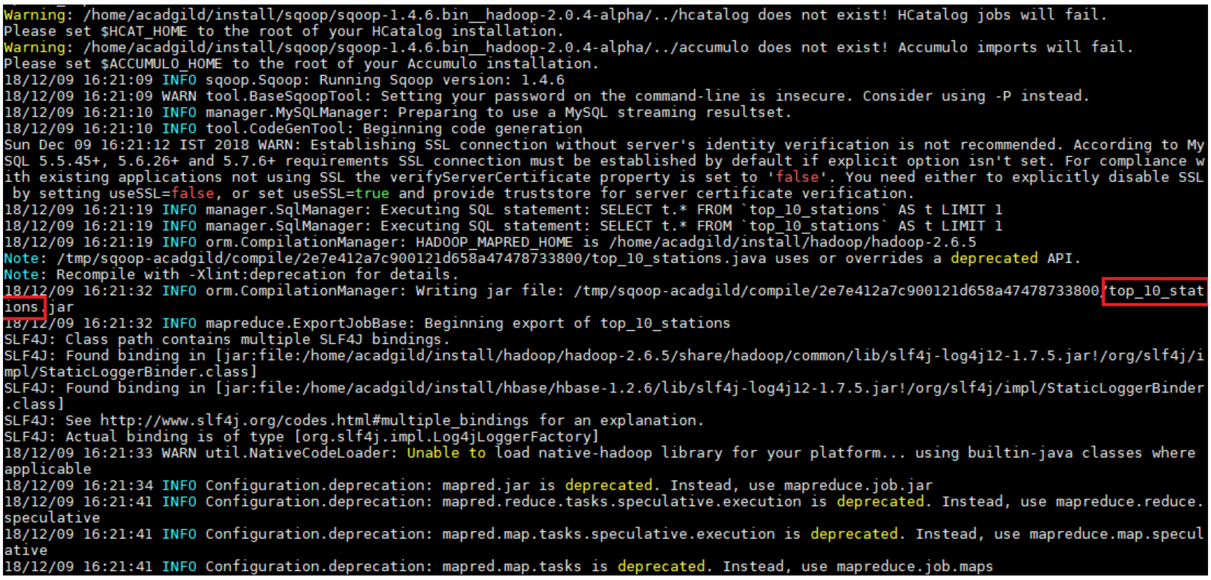
We are executing ***Data_analysis.sh*** script by running ***music_project_master.sh*** script file.



```
[acadgild@localhost music]$ ./music_project_master.sh
Preparing to execute python scripts to generate data...
Data Generated Successfully !
Starting the daemons....
5152 NodeManager
15505 RunJar
4610 RunJar
4691 HRegionServer
3923 NameNode
4531 HQuorumPeer
4580 HMaster
4084 DataNode
4999 ResourceManager
4344 SecondaryNameNode
3835 JobHistoryServer
17325 Jps
All hadoop daemons started !
Upload the look up tables now in Hbase...
Done with data population in look up tables !
Lets do some data formatting now....
data formatting complete !
Creating hive tables on top of hbase tables for data enrichment and filtering...
Hive table with Hbase Mapping Complete !
Let us do data enrichment as per the requirement...
Data Enrichment Complete
Lets run some use cases now...
18/12/09 15:40:57 INFO spark.SparkContext: Running Spark version 2.2.1
18/12/09 15:41:03 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/09 15:41:06 WARN util.Utils: Your hostname, localhost.localdomain resolves to a loopback address: 127.0.0.1; using 192.168.0.100 in
stead (on interface eth15)
18/12/09 15:41:06 WARN util.Utils: Set SPARK_LOCAL_IP if you need to bind to another address
18/12/09 15:41:07 INFO spark.SparkContext: Submitted application: Data Analysis
18/12/09 15:41:07 INFO spark.SecurityManager: Changing view acls to: acadgild
18/12/09 15:41:07 INFO spark.SecurityManager: Changing modify acls to: acadgild
18/12/09 15:41:07 INFO spark.SecurityManager: Changing view acls groups to:
```



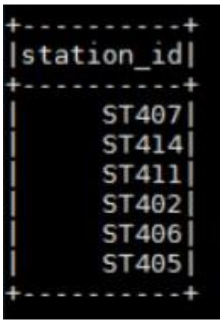
```
18/12/09 15:45:58 INFO parser.CatalystSqlParser: Parsing command: string
18/12/09 15:45:58 INFO metastore.HiveMetaStore: 0: get_table : db=project tbl=top_10_unsubscribed_users
18/12/09 15:45:58 INFO HiveMetaStore.audit: ugi=acadgild       ip=unknown-ip-addr      cmd=get_table : db=project tbl=top_10_unsubscribe
d_users
18/12/09 15:45:58 INFO parser.CatalystSqlParser: Parsing command: int
18/12/09 15:45:58 INFO parser.CatalystSqlParser: Parsing command: string
18/12/09 15:45:58 INFO parser.CatalystSqlParser: Parsing command: int
18/12/09 15:45:59 INFO common.FileUtils: Creating directory if it doesn't exist: hdfs://localhost:8020/user/hive/warehouse/project.db/top
_10_unsubscribed_users/.hive-staging_hive_2018-12-09_15-45-59_012_7240998144222739209-1
18/12/09 15:45:59 INFO output.FileOutputCommitter: File Output Committer Algorithm version is 1
18/12/09 15:45:59 INFO datasources.SQLHadoopMapReduceCommitProtocol: Using output committer class org.apache.hadoop.mapreduce.lib.output.
FileOutputCommitter
18/12/09 15:45:59 INFO aggregate.HashAggregateExec: spark.sql.codegen.aggregate.map.twolevel.enable is set to true, but current version o
f codegened fast hashmap does not support this aggregate.
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned shuffle 9
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned shuffle 10
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 439
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 431
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 429
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 438
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 433
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 428
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 437
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 432
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 427
18/12/09 15:45:59 INFO storage.BlockManagerInfo: Removed broadcast_21_piece0 on 192.168.0.100:45515 in memory (size: 13.4 KB, free: 413.8
 MB)
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 434
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 435
18/12/09 15:45:59 INFO storage.BlockManagerInfo: Removed broadcast_19_piece0 on 192.168.0.100:45515 in memory (size: 24.9 KB, free: 413.8
 MB)
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 430
18/12/09 15:45:59 INFO spark.ContextCleaner: Cleaned accumulator 436
```



```
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../hcatalog does not exist! HCatalog jobs will fail.
Please set $HCAT_HOME to the root of your HCatalog installation.
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../accumulo does not exist! Accumulo imports will fail.
Please set $ACCUMULO_HOME to the root of your Accumulo installation.
18/12/09 16:21:09 INFO sqoop.Sqoop: Running Sqoop version: 1.4.6
18/12/09 16:21:09 WARN tool.BaseSqoopTool: Setting your password on the command-line is insecure. Consider using -P instead.
18/12/09 16:21:10 INFO manager.MySQLManager: Preparing to use a MySQL streaming resultset.
18/12/09 16:21:10 INFO tool.CodeGenTool: Beginning code generation
Sun Dec 09 16:21:12 IST 2018 WARN: Establishing SSL connection without server's identity verification is not recommended. According to My
SQL 5.5.45+, 5.6.26+ and 5.7.6+ requirements SSL connection must be established by default if explicit option isn't set. For compliance w
ith existing applications not using SSL the verifyServerCertificate property is set to 'false'. You need either to explicitly disable SSL
 by setting useSSL=false, or set useSSL=true and provide truststore for server certificate verification.
18/12/09 16:21:19 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `top_10_stations` AS t LIMIT 1
18/12/09 16:21:19 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `top_10_stations` AS t LIMIT 1
18/12/09 16:21:19 INFO orm.CompilationManager: HADOOP_MAPRED_HOME is /home/acadgild/install/hadoop/hadoop-2.6.5
Note: /tmp/sqoop-acadgild/compile/2e7e412a7c900121d658a47478733800/top_10_stations.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
18/12/09 16:21:32 INFO orm.CompilationManager: Writing jar file: /tmp/sqoop-acadgild/compile/2e7e412a7c900121d658a47478733800/top_10_stat
ions.jar
18/12/09 16:21:32 INFO mapreduce.ExportJobBase: Beginning export of top_10_stations
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
18/12/09 16:21:33 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/09 16:21:34 INFO Configuration.deprecation: mapred.jar is deprecated. Instead, use mapreduce.job.jar
18/12/09 16:21:41 INFO Configuration.deprecation: mapred.reduce.tasks.speculative.execution is deprecated. Instead, use mapreduce.reduce.
speculative
18/12/09 16:21:41 INFO Configuration.deprecation: mapred.map.tasks.speculative.execution is deprecated. Instead, use mapreduce.map.specul
ative
18/12/09 16:21:41 INFO Configuration.deprecation: mapred.map.tasks is deprecated. Instead, use mapreduce.job.maps
```

Problem 1:

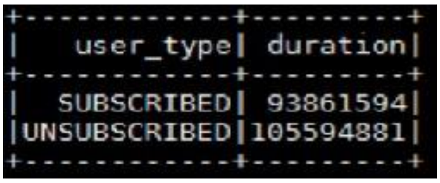
Determine top 10 station_id(s) where maximum number of songs were played, which were liked by unique users.



```
+----------+
|station_id|
+----------+
|     ST407|
|     ST414|
|     ST411|
|     ST402|
|     ST406|
|     ST405|
+----------+
```

Problem 2:

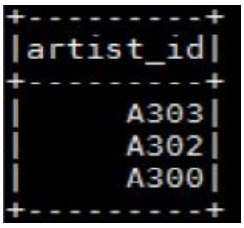
Determine total duration of songs played by each type of user, where type of user can be 'subscribed' or 'unsubscribed'. An unsubscribed user is the one whose record is either not present in Subscribed_users lookup table or has subscription_end_date earlier than the timestamp of the song played by him.



```
+------------+---------+
|   user_type| duration|
+------------+---------+
|  SUBSCRIBED| 93861594|
|UNSUBSCRIBED|105594881|
+------------+---------+
```

Problem 3:

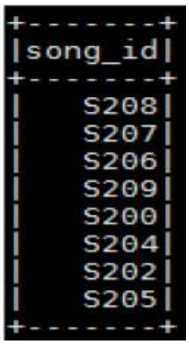
Determine top 10 connected artists. Connected artists are those whose songs are most listened by the unique users who follow them.



```
+---------+
|artist_id|
+---------+
|     A303|
|     A302|
|     A300|
+---------+
```

Problem 4:

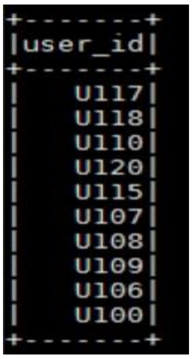
Determine top 10 songs who have generated the maximum revenue. Royalty applies to a song only if it was liked or was completed successfully or both



```
+-------+
|song_id|
+-------+
|   S208|
|   S207|
|   S206|
|   S209|
|   S200|
|   S204|
|   S202|
|   S205|
+-------+
```

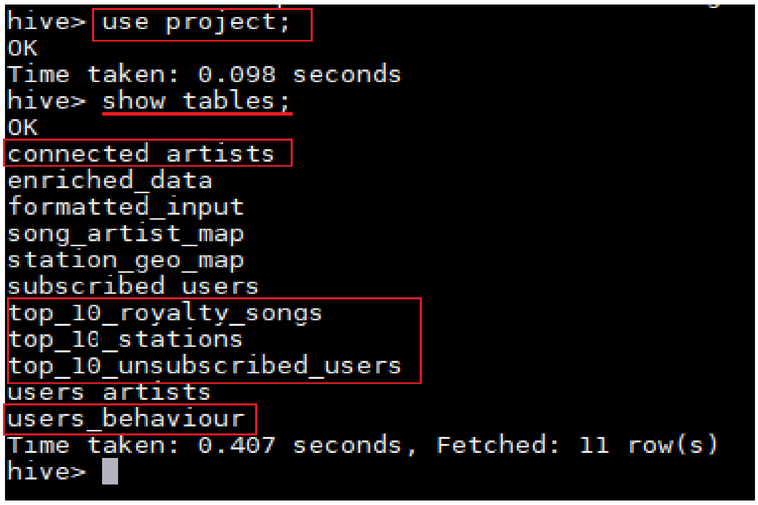
Problem 5:

Determine top 10 unsubscribed users who listened to the songs for the longest duration.



```
+-------+
|user_id|
+-------+
|   U117|
|   U118|
|   U110|
|   U120|
|   U115|
|   U107|
|   U108|
|   U109|
|   U106|
|   U100|
+-------+
```

We could see below that all tables have also been created in the Hive:

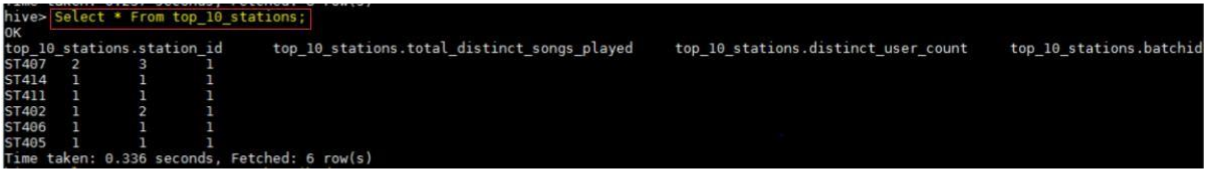


```
hive> use project;
OK
Time taken: 0.098 seconds
hive> show tables;
OK
connected_artists
enriched_data
formatted_input
song_artist_map
station_geo_map
subscribed_users
top_10_royalty_songs
top_10_stations
top_10_unsubscribed_users
users_artists
users_behaviour
Time taken: 0.407 seconds, Fetched: 11 row(s)
hive>
```

We have also verified that all the spark queries creating the tables for each query. So, Data Analysis using Spark is executed successfully.

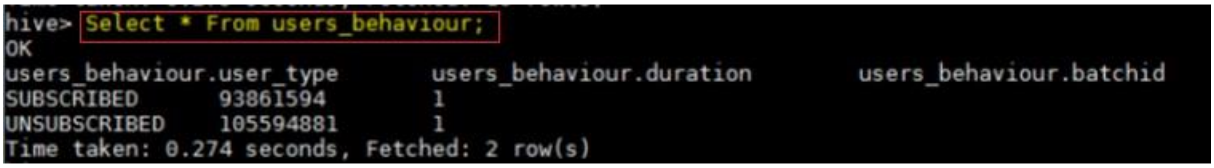
The data analysis result is shown in the Hive tables below in the screen shot:

Below is the output of **top_10_stations** table:



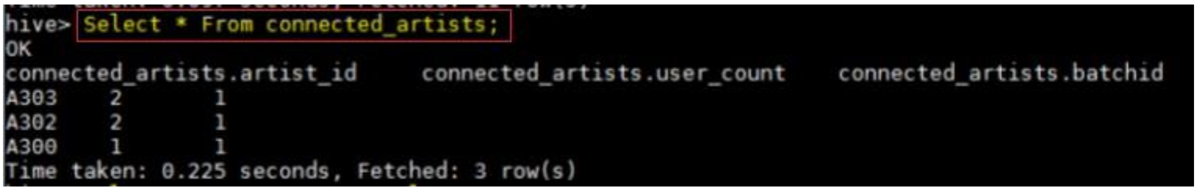
```
hive> Select * From top_10_stations;
OK
top_10_stations.station_id      top_10_stations.total_distinct_songs_played     top_10_stations.distinct_user_count     top_10_stations.batchid
ST407   2       3       1
ST414   1       1       1
ST411   1       1       1
ST402   1       2       1
ST406   1       1       1
ST405   1       1       1
Time taken: 0.336 seconds, Fetched: 6 row(s)
```

Below is the output of **users_behaviour** table:



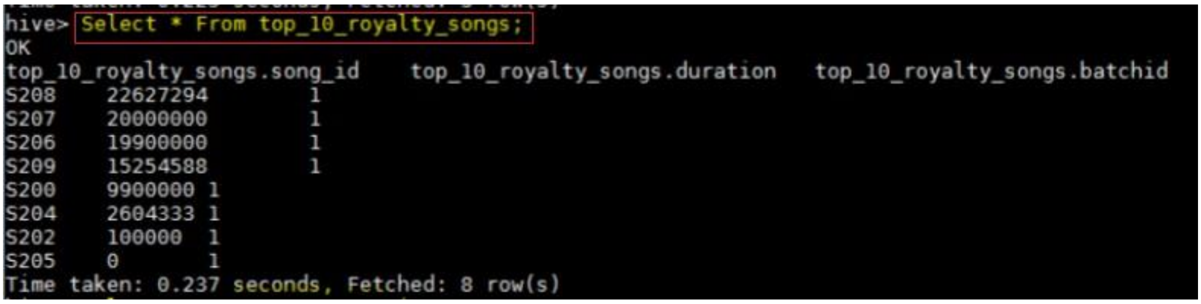
```
hive> Select * From users_behaviour;
OK
users_behaviour.user_type       users_behaviour.duration        users_behaviour.batchid
SUBSCRIBED      93861594        1
UNSUBSCRIBED    105594881       1
Time taken: 0.274 seconds, Fetched: 2 row(s)
```

Below is the output of **connected_artists** table:



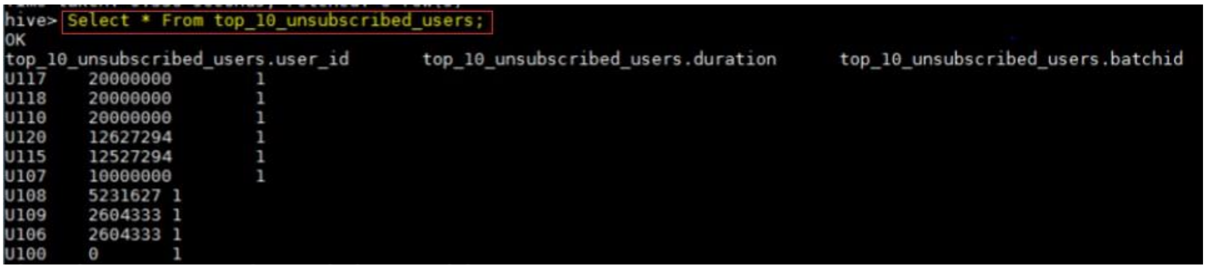
```
hive> Select * From connected_artists;
OK
connected_artists.artist_id      connected_artists.user_count     connected_artists.batchid
A303     2        1
A302     2        1
A300     1        1
Time taken: 0.225 seconds, Fetched: 3 row(s)
```

Below is the output of **top_10_royalty_songs** table:



```
hive> Select * From top_10_royalty_songs;
OK
top_10_royalty_songs.song_id    top_10_royalty_songs.duration   top_10_royalty_songs.batchid
S208     22627294        1
S207     20000000        1
S206     19900000        1
S209     15254588        1
S200     9900000 1
S204     2604333 1
S202     100000  1
S205     0       1
Time taken: 0.237 seconds, Fetched: 8 row(s)
```

Below is the output of **top_10_unsubscribed_users** table:



```
hive> Select * From top_10_unsubscribed_users;
OK
top_10_unsubscribed_users.user_id       top_10_unsubscribed_users.duration      top_10_unsubscribed_users.batchid
U117     20000000        1
U118     20000000        1
U110     20000000        1
U120     12627294        1
U115     12527294        1
U107     10000000        1
U108     5231627 1
U109     2604333 1
U106     2604333 1
U100     0       1
```

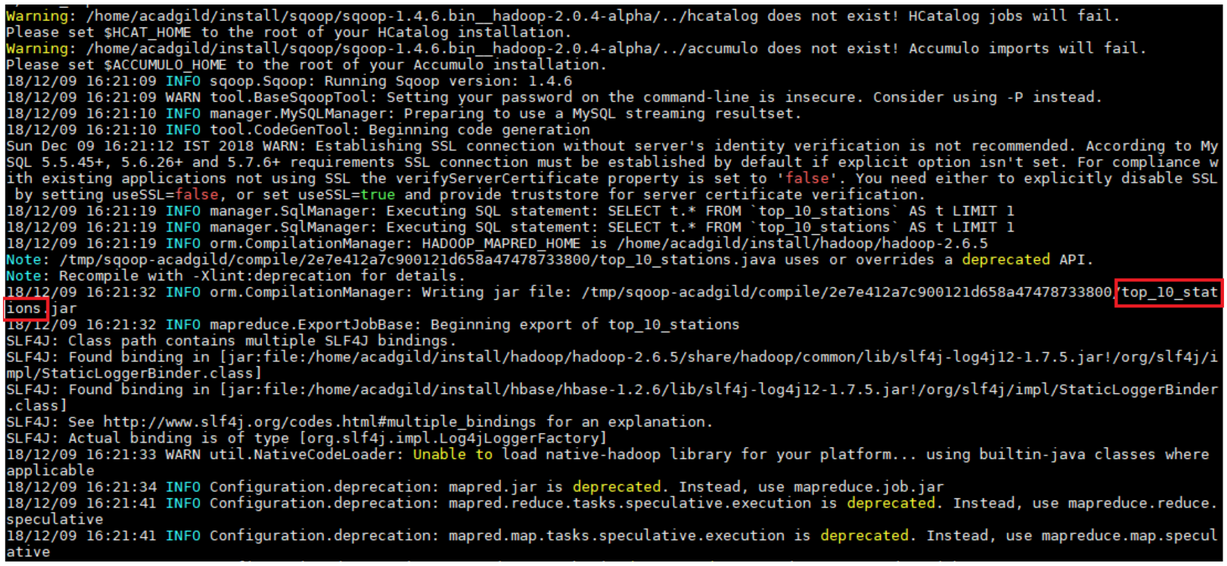
Now we need to export all the data to the MYSQL using sqoop, by executing ***data_export.sh*** script file. By using ***data_export.sh*** script file, we are going to export the data from the hive tables into mysql using Sqoop export.

```
#!/bin/bash

batchid=`cat /home/acadgild/examples/music/logs/current-batch.txt`
LOGFILE=/home/acadgild/examples/music/logs/log_batch_$batchid

echo "Creating mysql tables if not present..." >> $LOGFILE

echo "Running sqoop job for data export..." >> $LOGFILE

sqoop export \
--connect jdbc:mysql://localhost/project \
--username 'root' \
--password 'Root@123' \
--table 'top_10_stations' \
--export-dir
'/user/hive/warehouse/project.db/top_10_stations/batchid=$batchid' \
--input-fields-terminated-by ',' \
-m 1
```

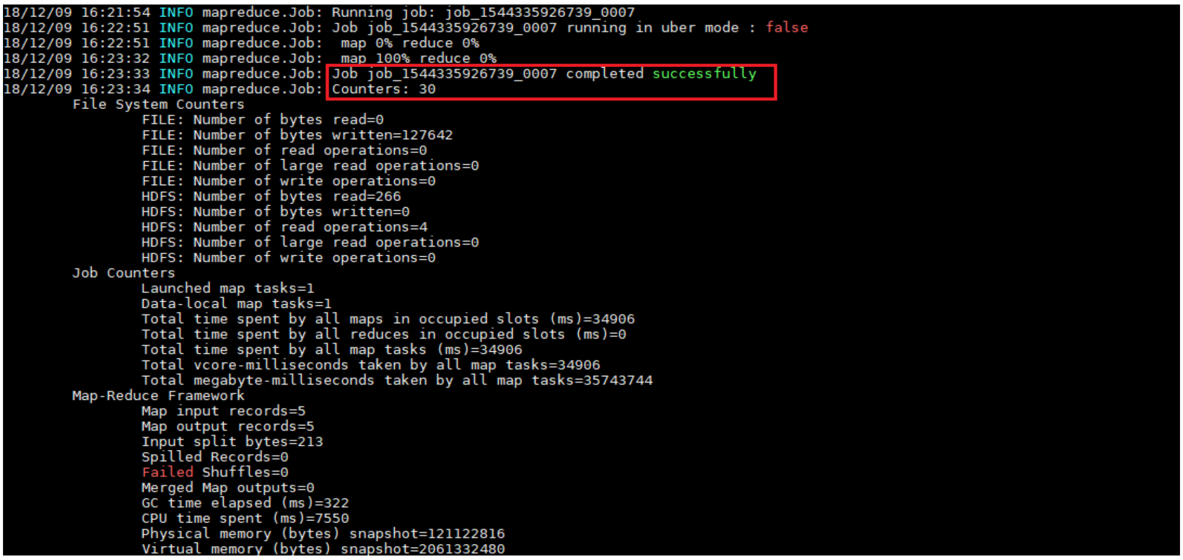
```
sqoop export \
--connect jdbc:mysql://localhost/project \
--username 'root' \
--password 'Root@123' \
--table 'song_duration' \
--export-dir
'/user/hive/warehouse/project.db/users_behaviour/batchid=$batchid' \
--input-fields-terminated-by ',' \
-m 1

sqoop export \
--connect jdbc:mysql://localhost/project \
--username 'root' \
--password 'Root@123' \
--table 'connected_artists' \
--export-dir
'/user/hive/warehouse/project.db/connected_artists/batchid=$batchid \
--input-fields-terminated-by ',' \
-m 1

sqoop export \
--connect jdbc:mysql://localhost/project \
--username 'root' \
--password 'Root@123' \
--table 'top_10_royalty_songs' \
--export-dir
'/user/hive/warehouse/project.db/top_10_royalty_songs/batchid=$batchid' \
--input-fields-terminated-by ',' \
-m 1

sqoop export \
--connect jdbc:mysql://localhost/project \
--username 'root' \
--password 'Root@123' \
--table 'top_10_unsubscribed_users' \
--export-dir
'/user/hive/warehouse/project.db/top_10_unsubscribed_users/batchid=$batch
id' \
--input-fields-terminated-by ',' \
-m 1
```

Below we could see that data exported successfully into the MYSQL Database for all the 5 queries:

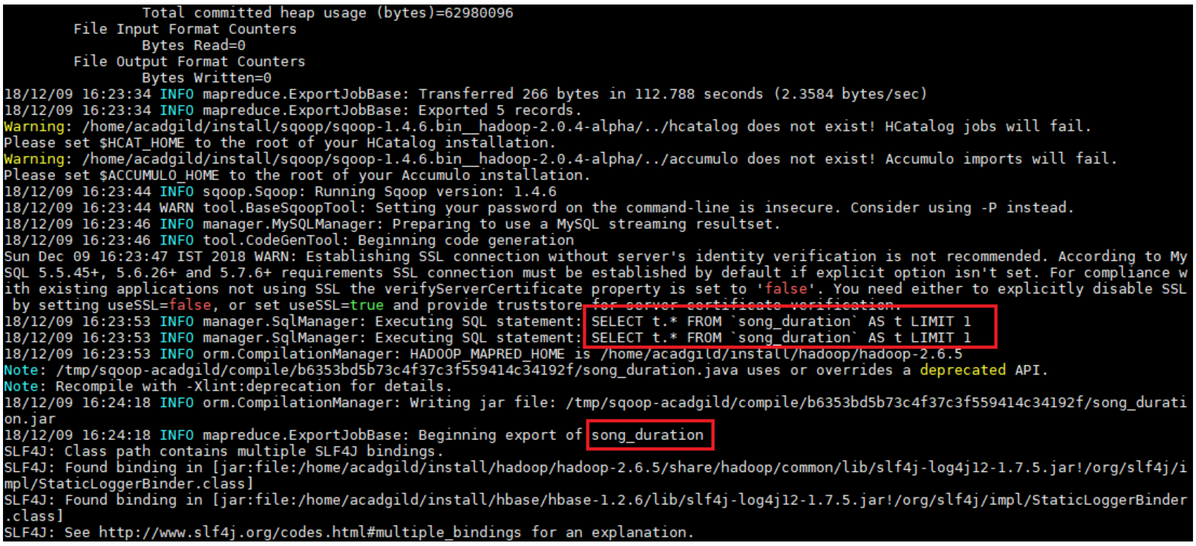
The sqoop export command exported the tables from the hive and it stored in the Mysql. The below screen shot show the successful Sqoop export from hive to mysql. The data stored in the Mysql is shown in below screenshots:



```
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../hcatalog does not exist! HCatalog jobs will fail.
Please set $HCAT_HOME to the root of your HCatalog installation.
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../accumulo does not exist! Accumulo imports will fail.
Please set $ACCUMULO_HOME to the root of your Accumulo installation.
18/12/09 16:21:09 INFO sqoop.Sqoop: Running Sqoop version: 1.4.6
18/12/09 16:21:09 WARN tool.BaseSqoopTool: Setting your password on the command-line is insecure. Consider using -P instead.
18/12/09 16:21:10 INFO manager.MySQLManager: Preparing to use a MySQL streaming resultset.
18/12/09 16:21:10 INFO tool.CodeGenTool: Beginning code generation
Sun Dec 09 16:21:12 IST 2018 WARN: Establishing SSL connection without server's identity verification is not recommended. According to My
SQL 5.5.45+, 5.6.26+ and 5.7.6+ requirements SSL connection must be established by default if explicit option isn't set. For compliance w
ith existing applications not using SSL the verifyServerCertificate property is set to 'false'. You need either to explicitly disable SSL
 by setting useSSL=false, or set useSSL=true and provide truststore for server certificate verification.
18/12/09 16:21:19 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `top_10_stations` AS t LIMIT 1
18/12/09 16:21:19 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `top_10_stations` AS t LIMIT 1
18/12/09 16:21:19 INFO orm.CompilationManager: HADOOP_MAPRED_HOME is /home/acadgild/install/hadoop/hadoop-2.6.5
Note: /tmp/sqoop-acadgild/compile/2e7e412a7c900121d658a47478733800/top_10_stations.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
18/12/09 16:21:32 INFO orm.CompilationManager: Writing jar file: /tmp/sqoop-acadgild/compile/2e7e412a7c900121d658a47478733800/top_10_stat
ions.jar
18/12/09 16:21:32 INFO mapreduce.ExportJobBase: Beginning export of top_10_stations
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Log4jLoggerFactory]
18/12/09 16:21:33 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where
applicable
18/12/09 16:21:34 INFO Configuration.deprecation: mapred.jar is deprecated. Instead, use mapreduce.job.jar
18/12/09 16:21:41 INFO Configuration.deprecation: mapred.reduce.tasks.speculative.execution is deprecated. Instead, use mapreduce.reduce.
speculative
18/12/09 16:21:41 INFO Configuration.deprecation: mapred.map.tasks.speculative.execution is deprecated. Instead, use mapreduce.map.specul
ative
```

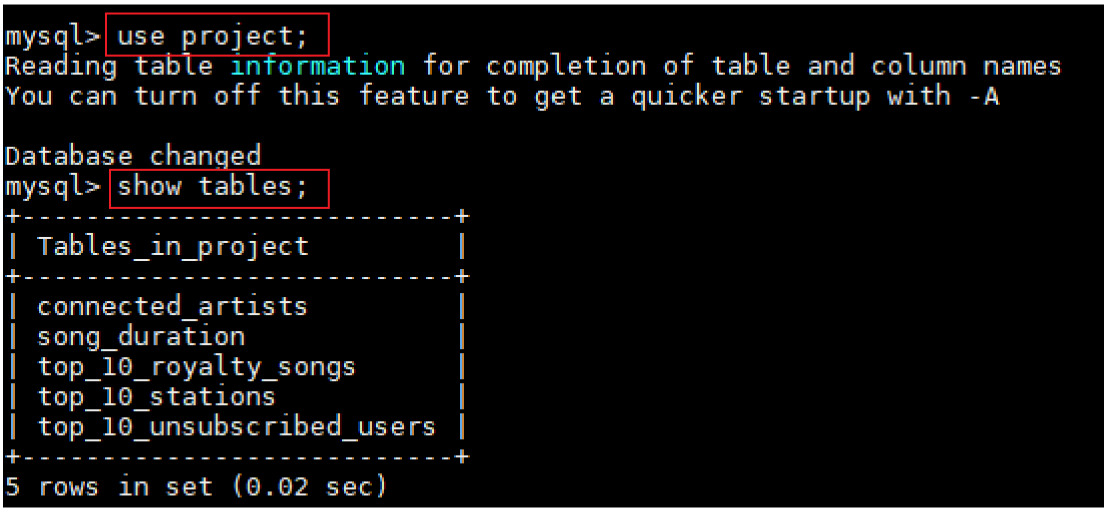


```
18/12/09 16:21:54 INFO mapreduce.Job: Running job: job_1544335926739_0007
18/12/09 16:22:51 INFO mapreduce.Job: Job job_1544335926739_0007 running in uber mode : false
18/12/09 16:22:51 INFO mapreduce.Job:  map 0% reduce 0%
18/12/09 16:23:32 INFO mapreduce.Job:  map 100% reduce 0%
18/12/09 16:23:33 INFO mapreduce.Job: Job job_1544335926739_0007 completed successfully
18/12/09 16:23:34 INFO mapreduce.Job: Counters: 30
        File System Counters
                FILE: Number of bytes read=0
                FILE: Number of bytes written=127642
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=266
                HDFS: Number of bytes written=0
                HDFS: Number of read operations=4
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=0
        Job Counters
                Launched map tasks=1
                Data-local map tasks=1
                Total time spent by all maps in occupied slots (ms)=34906
                Total time spent by all reduces in occupied slots (ms)=0
                Total time spent by all map tasks (ms)=34906
                Total vcore-milliseconds taken by all map tasks=34906
                Total megabyte-milliseconds taken by all map tasks=35743744
        Map-Reduce Framework
                Map input records=5
                Map output records=5
                Input split bytes=213
                Spilled Records=0
                Failed Shuffles=0
                Merged Map outputs=0
                GC time elapsed (ms)=322
                CPU time spent (ms)=7550
                Physical memory (bytes) snapshot=121122816
                Virtual memory (bytes) snapshot=2061332480
```



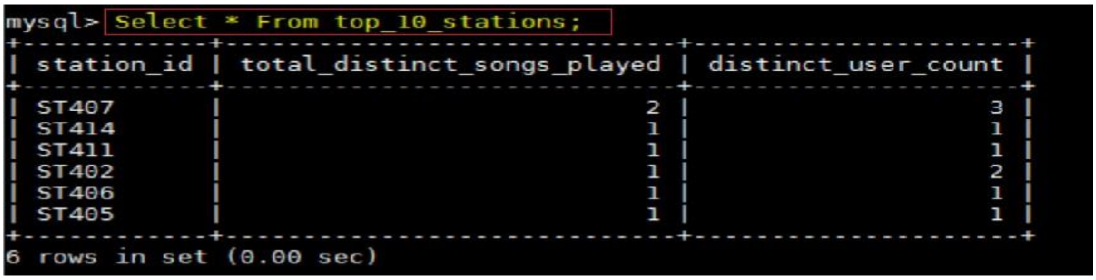
```
                Total committed heap usage (bytes)=62980096
        File Input Format Counters
                Bytes Read=0
        File Output Format Counters
                Bytes Written=0
18/12/09 16:23:34 INFO mapreduce.ExportJobBase: Transferred 266 bytes in 112.788 seconds (2.3584 bytes/sec)
18/12/09 16:23:34 INFO mapreduce.ExportJobBase: Exported 5 records.
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../hcatalog does not exist! HCatalog jobs will fail.
Please set $HCAT_HOME to the root of your HCatalog installation.
Warning: /home/acadgild/install/sqoop/sqoop-1.4.6.bin__hadoop-2.0.4-alpha/../accumulo does not exist! Accumulo imports will fail.
Please set $ACCUMULO_HOME to the root of your Accumulo installation.
18/12/09 16:23:44 INFO sqoop.Sqoop: Running Sqoop version: 1.4.6
18/12/09 16:23:44 WARN tool.BaseSqoopTool: Setting your password on the command-line is insecure. Consider using -P instead.
18/12/09 16:23:46 INFO manager.MySQLManager: Preparing to use a MySQL streaming resultset.
18/12/09 16:23:46 INFO tool.CodeGenTool: Beginning code generation
Sun Dec 09 16:23:47 IST 2018 WARN: Establishing SSL connection without server's identity verification is not recommended. According to My
SQL 5.5.45+, 5.6.26+ and 5.7.6+ requirements SSL connection must be established by default if explicit option isn't set. For compliance w
ith existing applications not using SSL the verifyServerCertificate property is set to 'false'. You need either to explicitly disable SSL
 by setting useSSL=false, or set useSSL=true and provide truststore for server certificate verification.
18/12/09 16:23:53 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `song_duration` AS t LIMIT 1
18/12/09 16:23:53 INFO manager.SqlManager: Executing SQL statement: SELECT t.* FROM `song_duration` AS t LIMIT 1
18/12/09 16:23:53 INFO orm.CompilationManager: HADOOP_MAPRED_HOME is /home/acadgild/install/hadoop/hadoop-2.6.5
Note: /tmp/sqoop-acadgild/compile/b6353bd5b73c4f37c3f559414c34192f/song_duration.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
18/12/09 16:24:18 INFO orm.CompilationManager: Writing jar file: /tmp/sqoop-acadgild/compile/b6353bd5b73c4f37c3f559414c34192f/song_durati
on.jar
18/12/09 16:24:18 INFO mapreduce.ExportJobBase: Beginning export of song_duration
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/acadgild/install/hadoop/hadoop-2.6.5/share/hadoop/common/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/i
mpl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/acadgild/install/hbase/hbase-1.2.6/lib/slf4j-log4j12-1.7.5.jar!/org/slf4j/impl/StaticLoggerBinder
.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
```

The **project** database had been exported from hive (HDFS) and the below screen shot shows all tables:



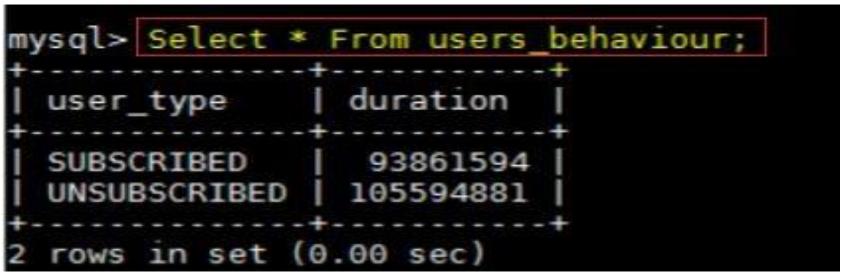
```
mysql> use project;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
mysql> show tables;
+--------------------------+
| Tables_in_project        |
+--------------------------+
| connected_artists        |
| song_duration            |
| top_10_royalty_songs     |
| top_10_stations          |
| top_10_unsubscribed_users |
+--------------------------+
5 rows in set (0.02 sec)
```

Output from **top_10_stations** table in mysql is shown below:



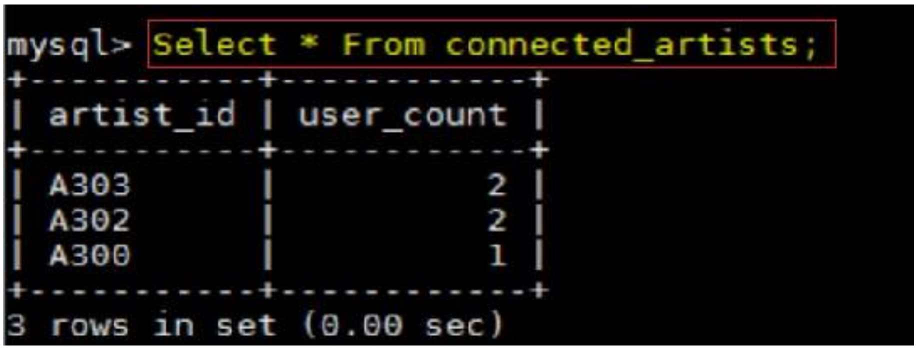
```
mysql> Select * From top_10_stations;
+------------+--------------------------+---------------------+
| station_id | total_distinct_songs_played | distinct_user_count |
+------------+--------------------------+---------------------+
| ST407      |                        2 |                   3 |
| ST414      |                        1 |                   1 |
| ST411      |                        1 |                   1 |
| ST402      |                        1 |                   2 |
| ST406      |                        1 |                   1 |
| ST405      |                        1 |                   1 |
+------------+--------------------------+---------------------+
6 rows in set (0.00 sec)
```

Output from **users_behaviour** table in mysql is shown below:



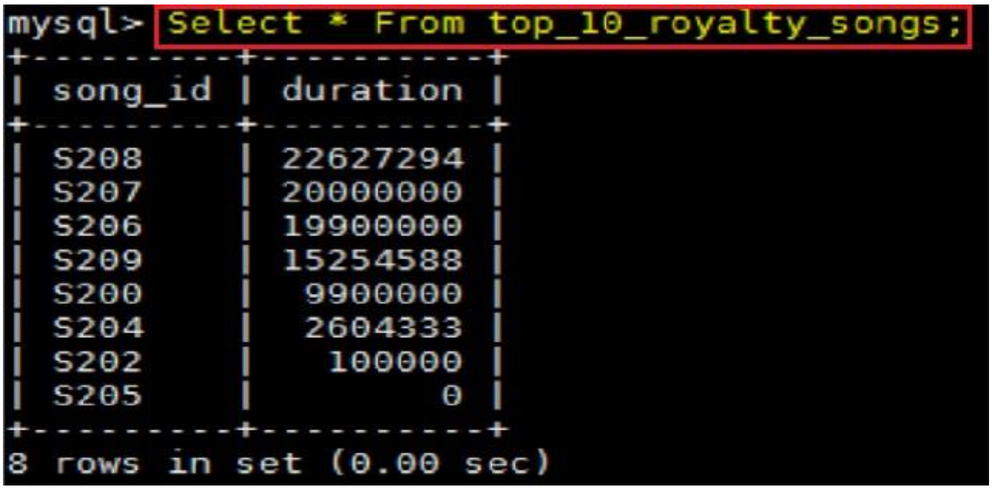
```
mysql> Select * From users_behaviour;
+--------------+-----------+
| user_type    | duration  |
+--------------+-----------+
| SUBSCRIBED   |  93861594 |
| UNSUBSCRIBED | 105594881 |
+--------------+-----------+
2 rows in set (0.00 sec)
```

Output from **connected_artists** table in mysql is shown below:



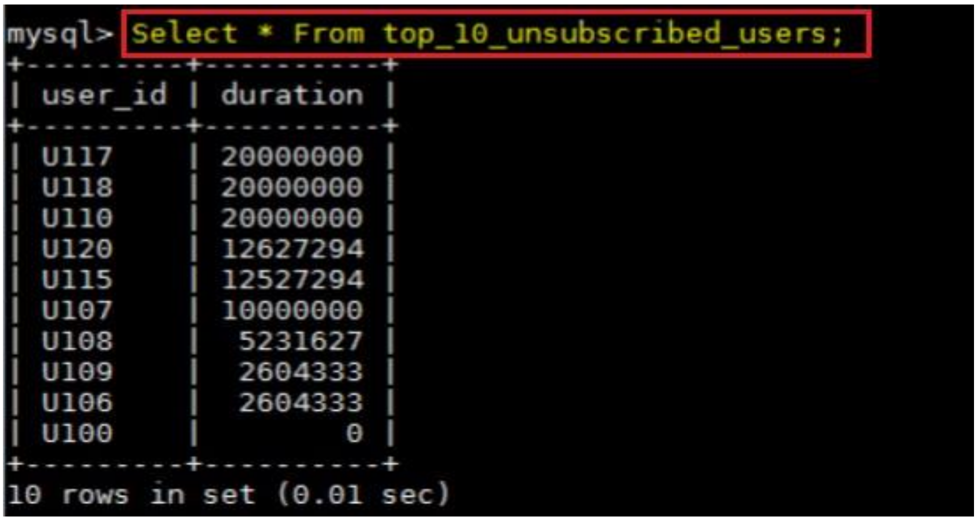
```
mysql> Select * From connected_artists;
+-----------+------------+
| artist_id | user_count |
+-----------+------------+
| A303      |          2 |
| A302      |          2 |
| A300      |          1 |
+-----------+------------+
3 rows in set (0.00 sec)
```

Output from **top_10_royalty_songs** table in mysql is shown below:



```
mysql> Select * From top_10_royalty_songs;
+---------+----------+
| song_id | duration |
+---------+----------+
| S208    | 22627294 |
| S207    | 20000000 |
| S206    | 19900000 |
| S209    | 15254588 |
| S200    |  9900000 |
| S204    |  2604333 |
| S202    |   100000 |
| S205    |        0 |
+---------+----------+
8 rows in set (0.00 sec)
```

Output from **top_10_unsubscribed_users** table in mysql is shown below:



```
mysql> Select * From top_10_unsubscribed_users;
+---------+----------+
| user_id | duration |
+---------+----------+
| U117    | 20000000 |
| U118    | 20000000 |
| U110    | 20000000 |
| U120    | 12627294 |
| U115    | 12527294 |
| U107    | 10000000 |
| U108    |  5231627 |
| U109    |  2604333 |
| U106    |  2604333 |
| U100    |        0 |
+---------+----------+
10 rows in set (0.01 sec)
```

Job Scheduling

Now after exporting data into MySQL, **batchid** will be incremented to additional 1 means one batch of data operations is successfully completed and new batch of data will be loaded for the analysis after every 3 hours.

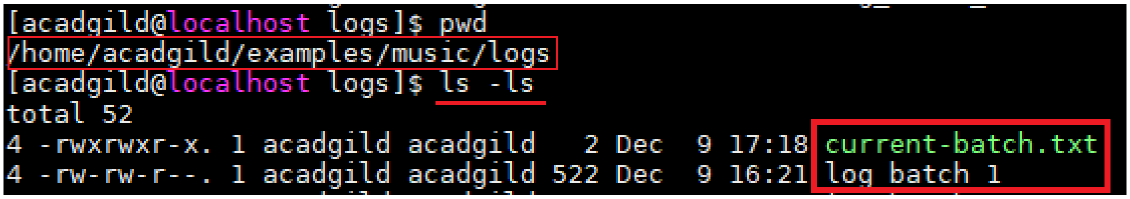
Part of Data_analysis.sh file:

sh /home/acadgild/examples/music/data_export.sh

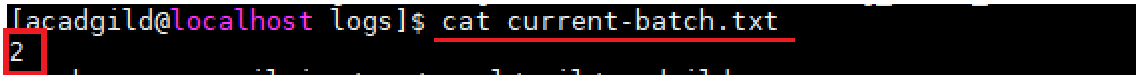
echo "Incrementing batchid..." >> $LOGFILE batchid=`expr $batchid + 1`

echo -n $batchid >/home/acadgild/examples/music/logs/current-batch.txt

We can check logs to track the behaviour of the operations we have done on the data and overcome failures (if any) we could see the **batchid** gets incremented by 1 in **current-batch.txt**



```
[acadgild@localhost logs]$ pwd
/home/acadgild/examples/music/logs
[acadgild@localhost logs]$ ls -ls
total 52
4 -rwxrwxr-x. 1 acadgild acadgild   2 Dec  9 17:18 current-batch.txt
4 -rw-rw-r--. 1 acadgild acadgild 522 Dec  9 16:21 log_batch_1
```



```
[acadgild@localhost logs]$ cat current-batch.txt
2
```

Conclusion

We have performed all data operations, executed all use cases and obtained results successfully for one of the leading music company.