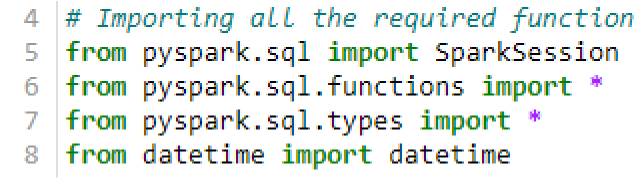
Scripts Execution

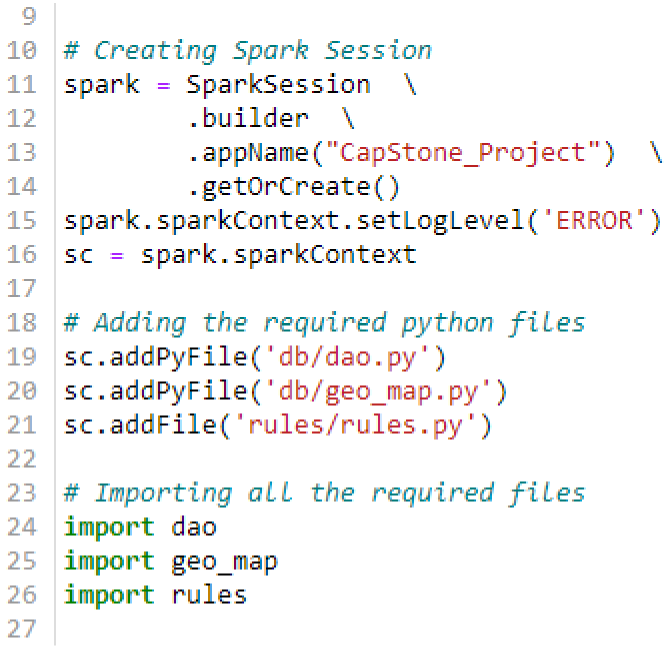
Explanation of the solution to the streaming layer problem

- All the necessary libraries and functions have been imported:



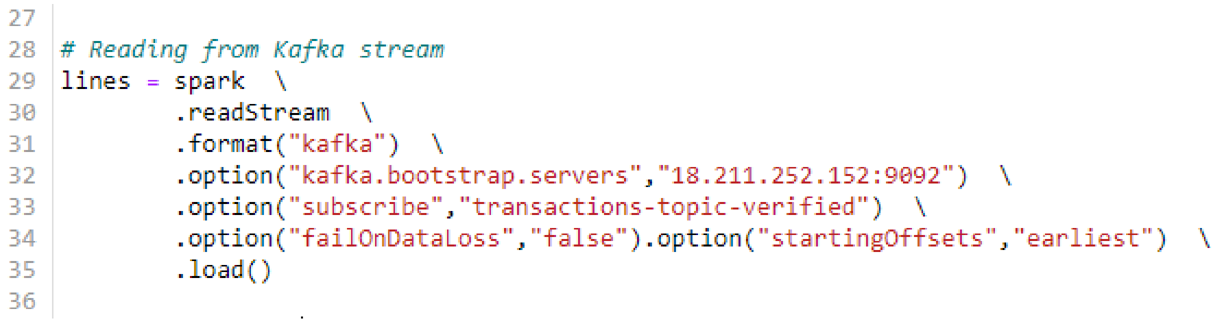
```python
# Importing all the required function
from pyspark.sql import SparkSession
from pyspark.sql.functions import *
from pyspark.sql.types import *
from datetime import datetime
```

- Spark session is created and all the required python files are imported:



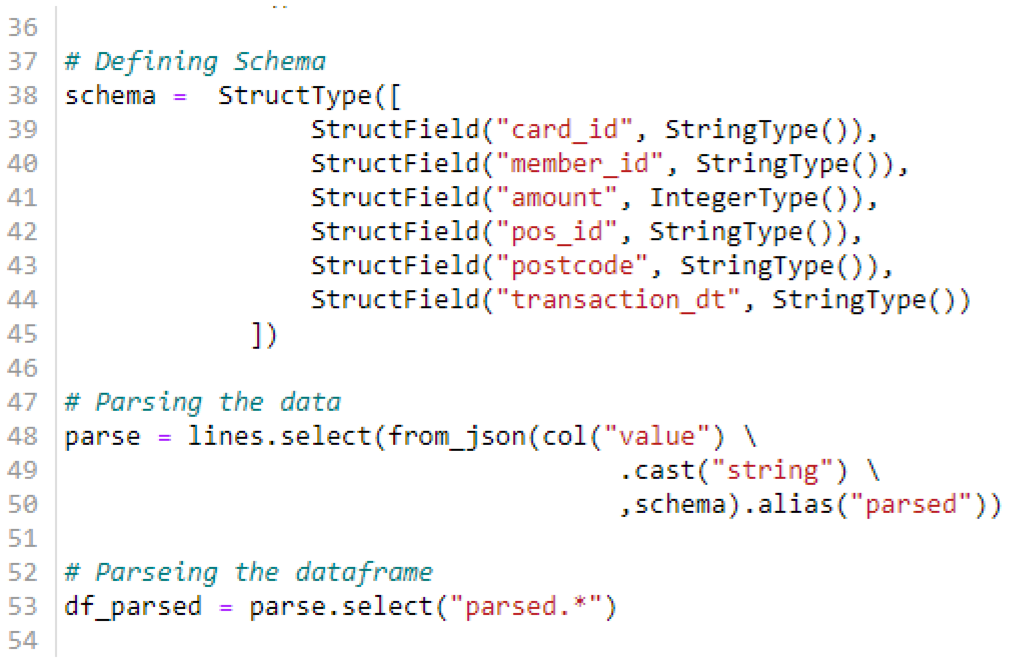
```python

# Creating Spark Session
spark = SparkSession  \
        .builder  \
        .appName("CapStone_Project")  \
        .getOrCreate()
spark.sparkContext.setLogLevel('ERROR')
sc = spark.sparkContext

# Adding the required python files
sc.addPyFile('db/dao.py')
sc.addPyFile('db/geo_map.py')
sc.addFile('rules/rules.py')

# Importing all the required files
import dao
import geo_map
import rules

```

- The session is now connected to the server “18.211.252.152:9092” and to kafka topic "transactions-topic-verified"



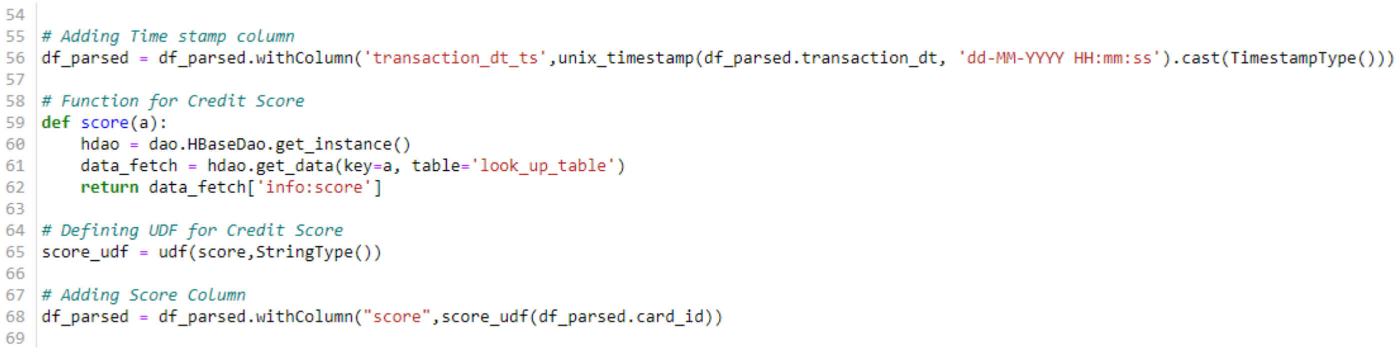
```
# Reading from Kafka stream
lines = spark  \
        .readStream  \
        .format("kafka")  \
        .option("kafka.bootstrap.servers","18.211.252.152:9092")  \
        .option("subscribe","transactions-topic-verified")  \
        .option("failOnDataLoss","false").option("startingOffsets","earliest")  \
        .load()
```

- The schema is defined and parsed in the format:



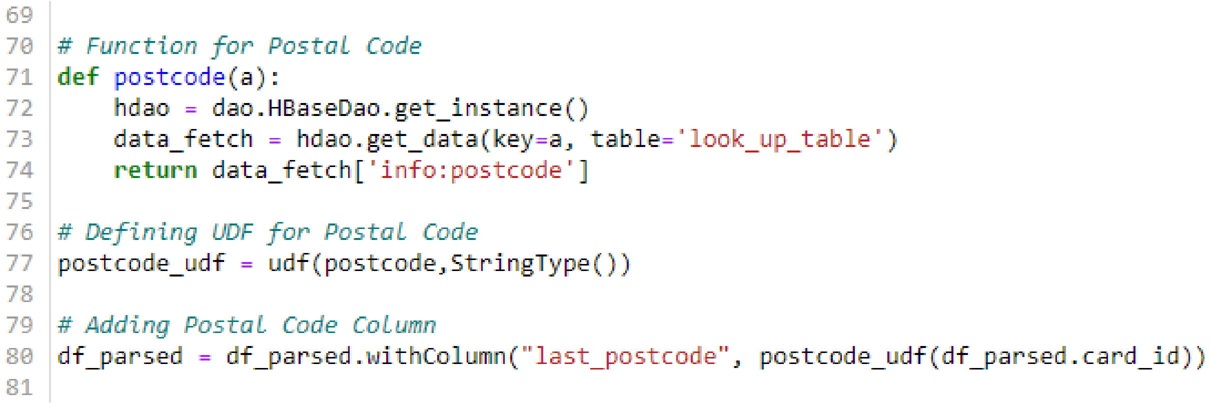
```
# Defining Schema
schema =  StructType([
                StructField("card_id", StringType()),
                StructField("member_id", StringType()),
                StructField("amount", IntegerType()),
                StructField("pos_id", StringType()),
                StructField("postcode", StringType()),
                StructField("transaction_dt", StringType())
            ])

# Parsing the data
parse = lines.select(from_json(col("value") \
                                    .cast("string") \
                                    ,schema).alias("parsed"))

# Parseing the dataframe
df_parsed = parse.select("parsed.*")
```

- The “look_up_table” and “card_transactions” table for card transaction details are used.
- A set of user defined functions are used in order to perform the required activates and to check whether the transactions are fraudulent or genuine.
- Function for fetching the Credit Scores from the look up tables using the “card_id”.



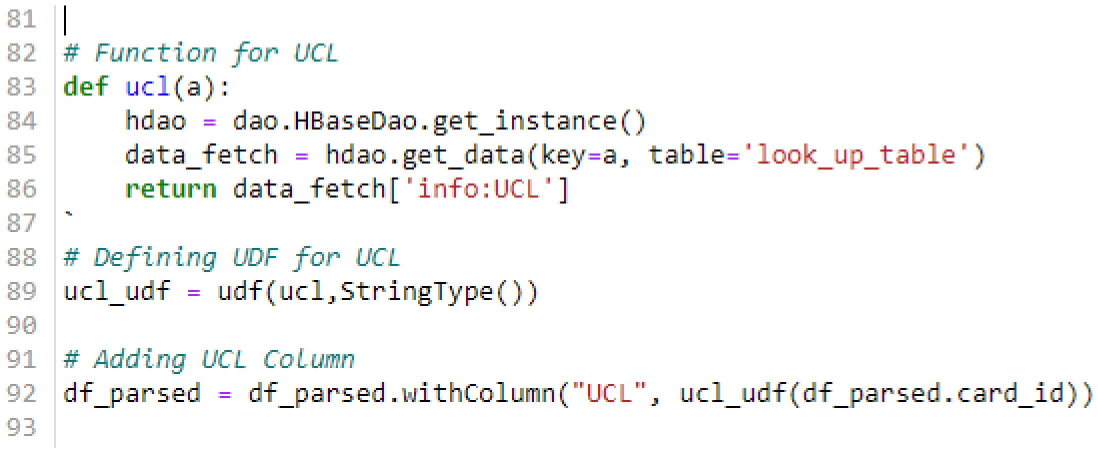
```
# Adding Time stamp column
df_parsed = df_parsed.withColumn('transaction_dt_ts',unix_timestamp(df_parsed.transaction_dt, 'dd-MM-YYYY HH:mm:ss').cast(TimestampType()))

# Function for Credit Score
def score(a):
    hdao = dao.HBaseDao.get_instance()
    data_fetch = hdao.get_data(key=a, table='look_up_table')
    return data_fetch['info:score']

# Defining UDF for Credit Score
score_udf = udf(score,StringType())

# Adding Score Column
df_parsed = df_parsed.withColumn("score",score_udf(df_parsed.card_id))
```

- A function for fetching postal code from the look up tables using the “card_id”



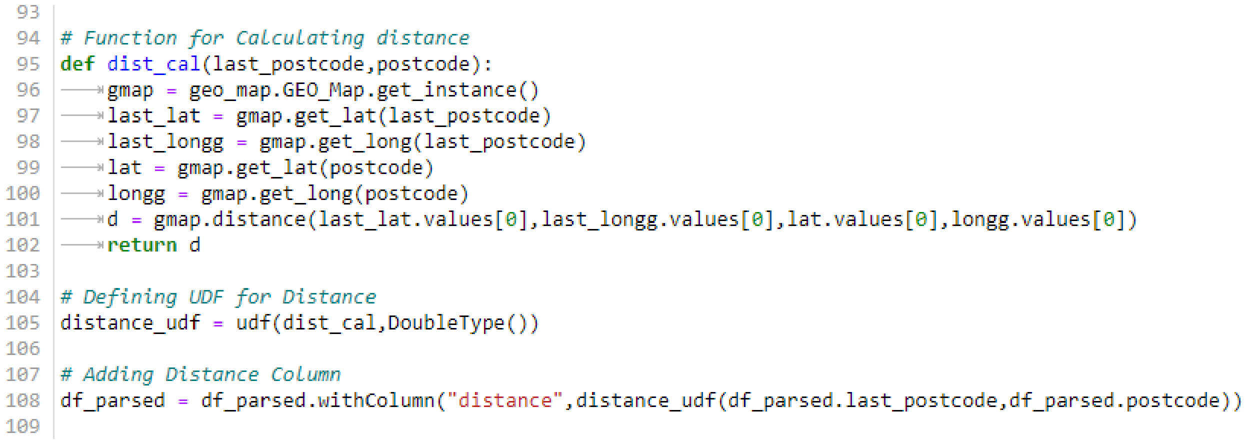
```
# Function for Postal Code
def postcode(a):
    hdao = dao.HBaseDao.get_instance()
    data_fetch = hdao.get_data(key=a, table='look_up_table')
    return data_fetch['info:postcode']

# Defining UDF for Postal Code
postcode_udf = udf(postcode,StringType())

# Adding Postal Code Column
df_parsed = df_parsed.withColumn("last_postcode", postcode_udf(df_parsed.card_id))

```

- Function to fetch Upper Control Limit from the look up tables using the “card_id”



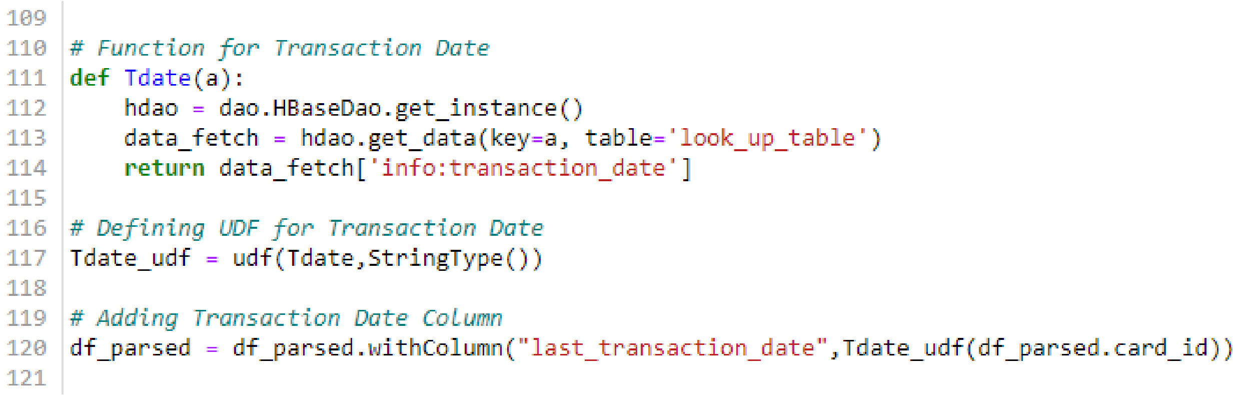
```

# Function for UCL
def ucl(a):
    hdao = dao.HBaseDao.get_instance()
    data_fetch = hdao.get_data(key=a, table='look_up_table')
    return data_fetch['info:UCL']
`
# Defining UDF for UCL
ucl_udf = udf(ucl,StringType())

# Adding UCL Column
df_parsed = df_parsed.withColumn("UCL", ucl_udf(df_parsed.card_id))

```

- Function to calculate the distance between previous and current transaction postal codes from the look up tables and kafka stream:



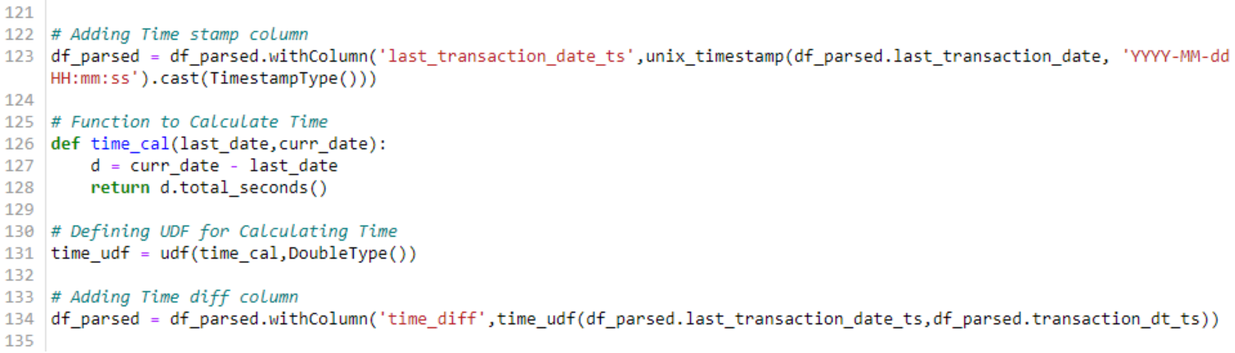
```

# Function for Calculating distance
def dist_cal(last_postcode,postcode):
    gmap = geo_map.GEO_Map.get_instance()
    last_lat = gmap.get_lat(last_postcode)
    last_longg = gmap.get_long(last_postcode)
    lat = gmap.get_lat(postcode)
    longg = gmap.get_long(postcode)
    d = gmap.distance(last_lat.values[0],last_longg.values[0],lat.values[0],longg.values[0])
    return d

# Defining UDF for Distance
distance_udf = udf(dist_cal,DoubleType())

# Adding Distance Column
df_parsed = df_parsed.withColumn("distance",distance_udf(df_parsed.last_postcode,df_parsed.postcode))

```

- Function to fetch the last transactions date from the look up tables using the “card_id”



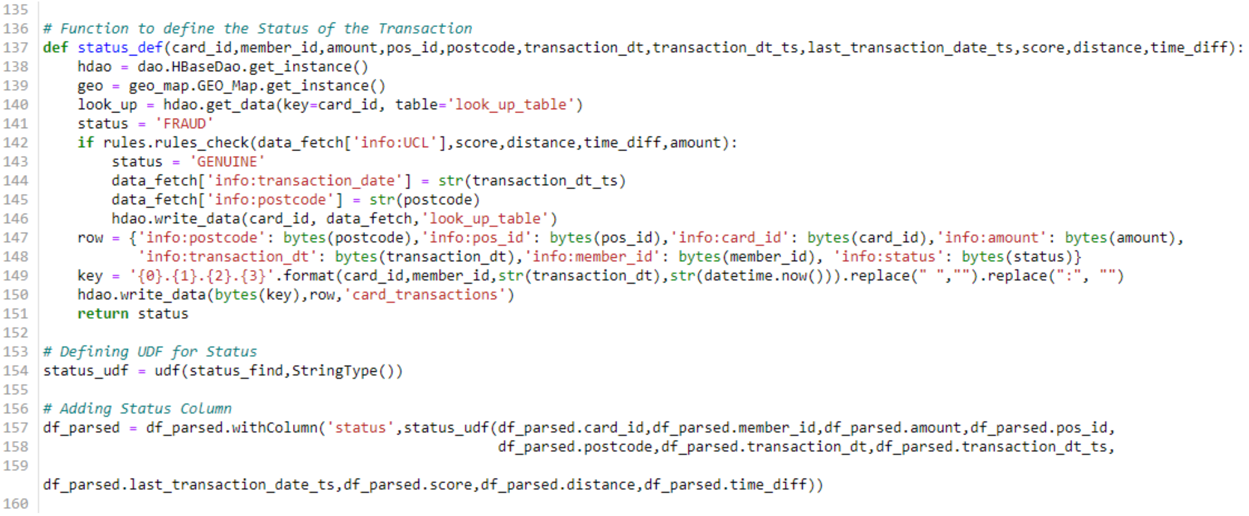
```python

# Function for Transaction Date
def Tdate(a):
    hdao = dao.HBaseDao.get_instance()
    data_fetch = hdao.get_data(key=a, table='look_up_table')
    return data_fetch['info:transaction_date']

# Defining UDF for Transaction Date
Tdate_udf = udf(Tdate,StringType())

# Adding Transaction Date Column
df_parsed = df_parsed.withColumn("last_transaction_date",Tdate_udf(df_parsed.card_id))

```

- Function to calculate the time difference (in sec) between the previous and current transactions from the look up tables and kafka stream:



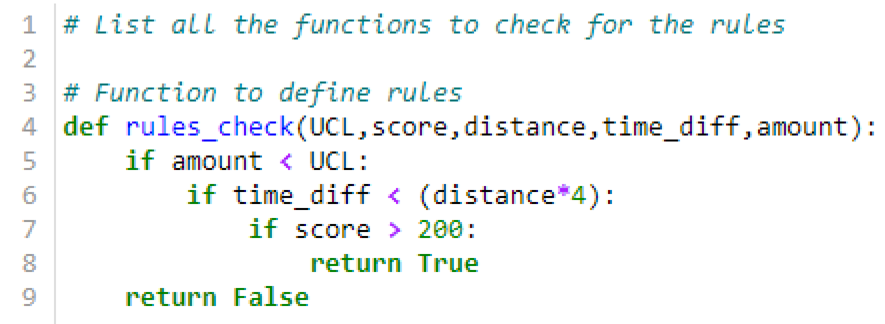
```python

# Adding Time stamp column
df_parsed = df_parsed.withColumn('last_transaction_date_ts',unix_timestamp(df_parsed.last_transaction_date, 'YYYY-MM-dd HH:mm:ss').cast(TimestampType()))

# Function to Calculate Time
def time_cal(last_date,curr_date):
    d = curr_date - last_date
    return d.total_seconds()

# Defining UDF for Calculating Time
time_udf = udf(time_cal,DoubleType())

# Adding Time diff column
df_parsed = df_parsed.withColumn('time_diff',time_udf(df_parsed.last_transaction_date_ts,df_parsed.transaction_dt_ts))

```

- The function to define the status of transaction is fraudulent or genuine:



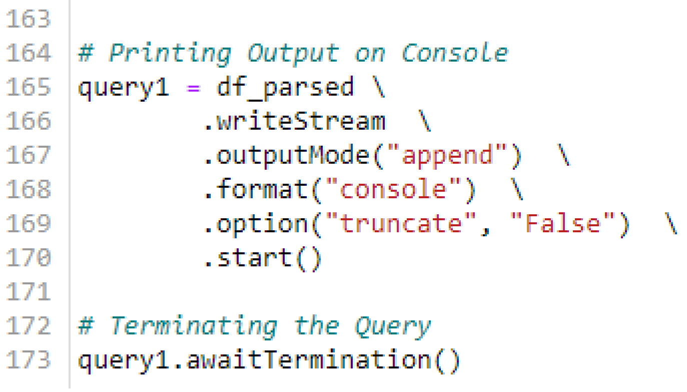
```python

# Function to define the Status of the Transaction
def status_def(card_id,member_id,amount,pos_id,postcode,transaction_dt,transaction_dt_ts,last_transaction_date_ts,score,distance,time_diff):
    hdao = dao.HBaseDao.get_instance()
    geo = geo_map.GEO_Map.get_instance()
    look_up = hdao.get_data(key=card_id, table='look_up_table')
    status = 'FRAUD'
    if rules.rules_check(data_fetch['info:UCL'],score,distance,time_diff,amount):
        status = 'GENUINE'
        data_fetch['info:transaction_date'] = str(transaction_dt_ts)
        data_fetch['info:postcode'] = str(postcode)
        hdao.write_data(card_id, data_fetch,'look_up_table')
    row = {'info:postcode': bytes(postcode),'info:pos_id': bytes(pos_id),'info:card_id': bytes(card_id),'info:amount': bytes(amount),
          'info:transaction_dt': bytes(transaction_dt),'info:member_id': bytes(member_id), 'info:status': bytes(status)}
    key = '{0}.{1}.{2}.{3}'.format(card_id,member_id,str(transaction_dt),str(datetime.now())).replace(" ","").replace(":", "")
    hdao.write_data(bytes(key),row,'card_transactions')
    return status

# Defining UDF for Status
status_udf = udf(status_find,StringType())

# Adding Status Column
df_parsed = df_parsed.withColumn('status',status_udf(df_parsed.card_id,df_parsed.member_id,df_parsed.amount,df_parsed.pos_id,
                                                     df_parsed.postcode,df_parsed.transaction_dt,df_parsed.transaction_dt_ts,

df_parsed.last_transaction_date_ts,df_parsed.score,df_parsed.distance,df_parsed.time_diff))

```

- Function to define the rules to check if the transaction is genuine or fraudulent.
    1. Transaction amount < UCL
    2. Time difference in sec < 4 times the distance
    3. Credit Score < 200



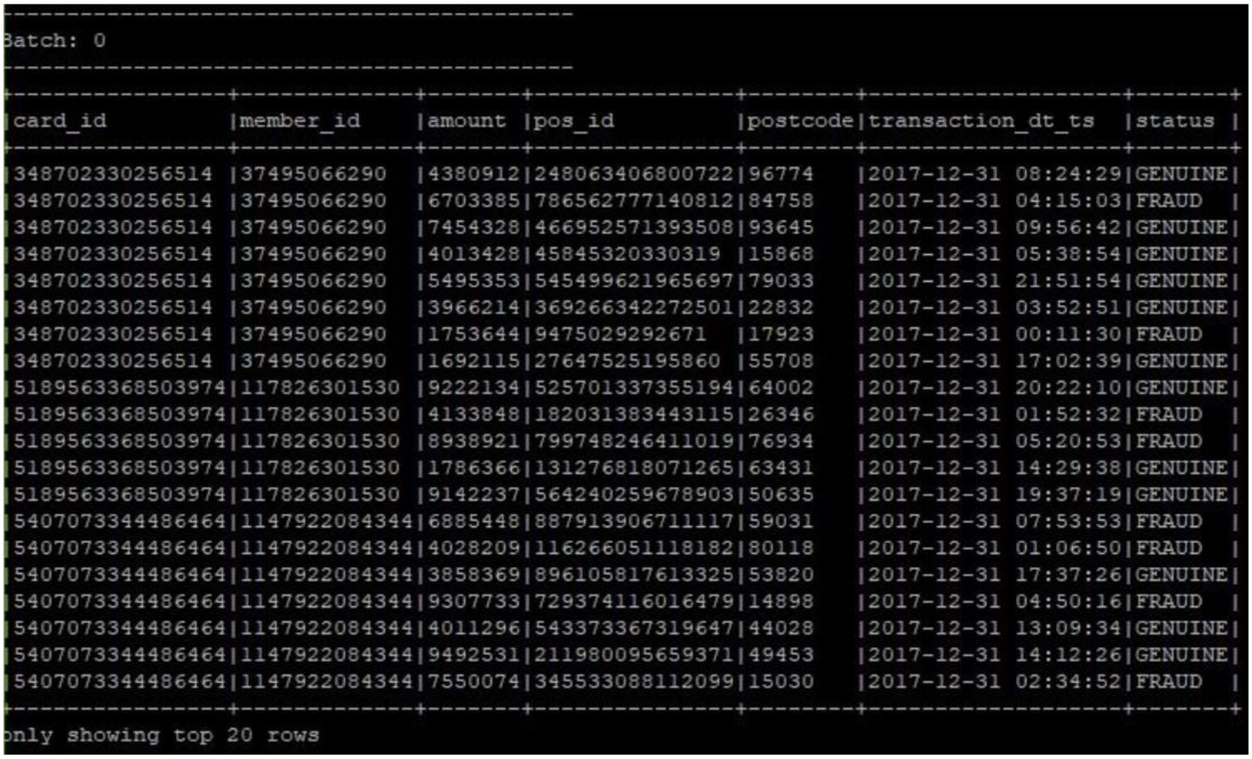
```
# List all the functions to check for the rules

# Function to define rules
def rules_check(UCL,score,distance,time_diff,amount):
    if amount < UCL:
        if time_diff < (distance*4):
            if score > 200:
                return True
    return False
```

- Displaying the required columns in the console and the query has to terminated properly.



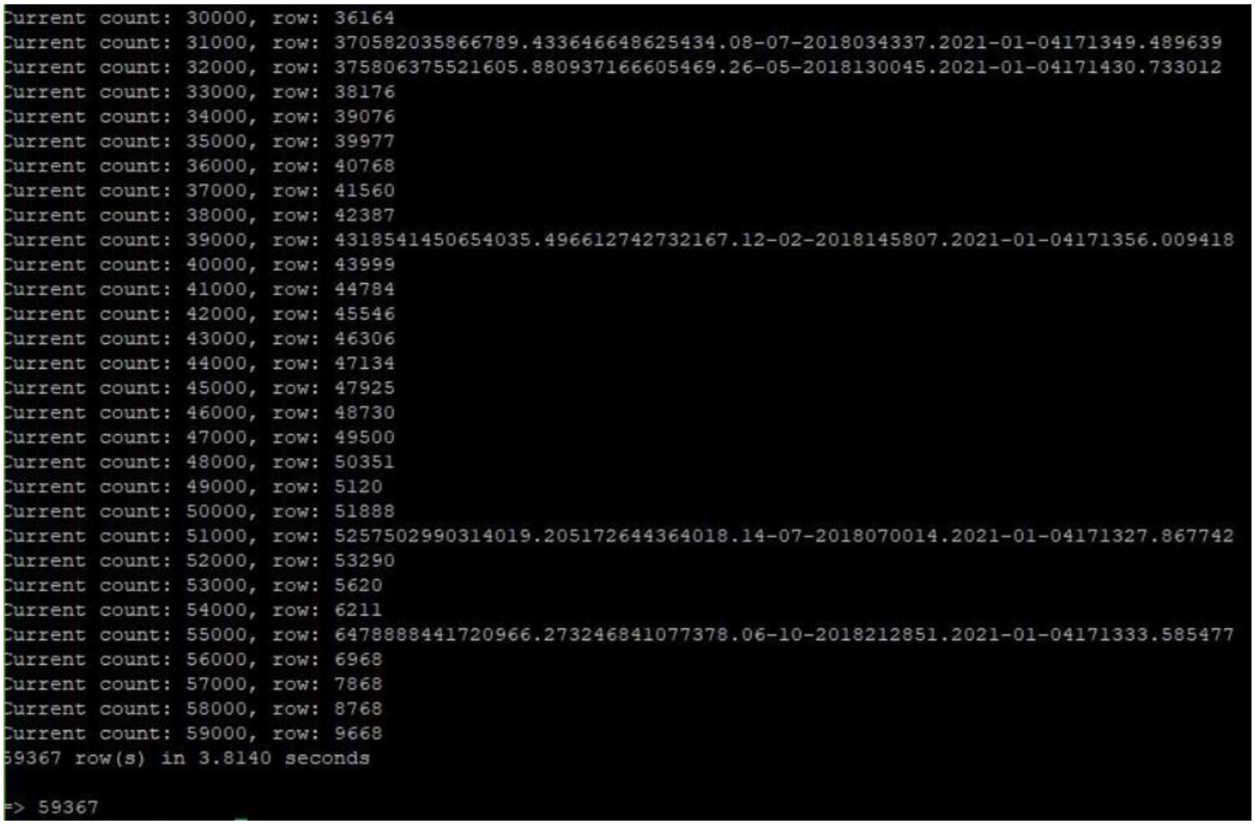
```

# Printing Output on Console
query1 = df_parsed \
        .writeStream  \
        .outputMode("append")  \
        .format("console")  \
        .option("truncate", "False")  \
        .start()

# Terminating the Query
query1.awaitTermination()
```

- Using Putty connect to the EC2 initialized and logging in as root user.
- Connect to the Hbase Shell and look for the card transactions and look up tables which will be used in driver.py script and exit back to root user.
- Create a directory named CapStone and place the driver.py, geomap.py & dao.py (in db), rules.py (in rules) and uszipsv.csv
- In dao.py, the given self.host had to be replace to 'localhost' to run.
- Ensure thrift server is up and running.
- To make sure happybase is imported Give command - python -c 'import happybase'
- In root user the following commands are given:
    - wget https://ds-spark-sql-kafka-jar.s3.amazonaws.com/spark-sql-kafka-0-10_2.11-2.3.0.jar to create jar file required to run the spark code.
    - export SPARK_KAFKA_VERSION=0.10
    - spark2-submit --jars spark-sql-kafka-0-10_2.11-2.3.0.jar --files uszipsv.csv driver.py to execute the driver program.
- The program is executed and the desired output is displayed in the console with coulumns card_id, member_id, amount, pos_id, postcode, transaction_dt_ts and status.



```
-------------------------------------------
Batch: 0
-------------------------------------------
+----------------+-------------+-------+---------------+--------+-------------------+-------+
|card_id         |member_id    |amount |pos_id         |postcode|transaction_dt_ts  |status |
+----------------+-------------+-------+---------------+--------+-------------------+-------+
|348702330256514 |37495066290  |4380912|248063406800722|96774   |2017-12-31 08:24:29|GENUINE|
|348702330256514 |37495066290  |6703385|786562777140812|84758   |2017-12-31 04:15:03|FRAUD  |
|348702330256514 |37495066290  |7454328|466952571393508|93645   |2017-12-31 09:56:42|GENUINE|
|348702330256514 |37495066290  |4013428|45845320330319 |15868   |2017-12-31 05:38:54|GENUINE|
|348702330256514 |37495066290  |5495353|545499621965697|79033   |2017-12-31 21:51:54|GENUINE|
|348702330256514 |37495066290  |3966214|369266342272501|22832   |2017-12-31 03:52:51|GENUINE|
|348702330256514 |37495066290  |1753644|9475029292671  |17923   |2017-12-31 00:11:30|FRAUD  |
|348702330256514 |37495066290  |1692115|27647525195860 |55708   |2017-12-31 17:02:39|GENUINE|
|5189563368503974|117826301530 |9222134|525701337355194|64002   |2017-12-31 20:22:10|GENUINE|
|5189563368503974|117826301530 |4133848|182031383443115|26346   |2017-12-31 01:52:32|FRAUD  |
|5189563368503974|117826301530 |8938921|799748246411019|76934   |2017-12-31 05:20:53|FRAUD  |
|5189563368503974|117826301530 |1786366|131276818071265|63431   |2017-12-31 14:29:38|GENUINE|
|5189563368503974|117826301530 |9142237|564240259678903|50635   |2017-12-31 19:37:19|GENUINE|
|5407073344486464|1147922084344|6885448|887913906711117|59031   |2017-12-31 07:53:53|FRAUD  |
|5407073344486464|1147922084344|4028209|116266051118182|80118   |2017-12-31 01:06:50|FRAUD  |
|5407073344486464|1147922084344|3858369|896105817613325|53820   |2017-12-31 17:37:26|GENUINE|
|5407073344486464|1147922084344|9307733|729374116016479|14898   |2017-12-31 04:50:16|FRAUD  |
|5407073344486464|1147922084344|4011296|543373367319647|44028   |2017-12-31 13:09:34|GENUINE|
|5407073344486464|1147922084344|9492531|211980095659371|49453   |2017-12-31 14:12:26|GENUINE|
|5407073344486464|1147922084344|7550074|345533088112099|15030   |2017-12-31 02:34:52|FRAUD  |
+----------------+-------------+-------+---------------+--------+-------------------+-------+
only showing top 20 rows
```

- In Hbase Shell, scanning card_transactions table, the count of rows after execution is over 59000.



```
Current count: 30000, row: 36164
Current count: 31000, row: 370582035866789.433646648625434.08-07-2018034337.2021-01-04171349.489639
Current count: 32000, row: 375806375521605.880937166605469.26-05-2018130045.2021-01-04171430.733012
Current count: 33000, row: 38176
Current count: 34000, row: 39076
Current count: 35000, row: 39977
Current count: 36000, row: 40768
Current count: 37000, row: 41560
Current count: 38000, row: 42387
Current count: 39000, row: 4318541450654035.496612742732167.12-02-2018145807.2021-01-04171356.009418
Current count: 40000, row: 43999
Current count: 41000, row: 44784
Current count: 42000, row: 45546
Current count: 43000, row: 46306
Current count: 44000, row: 47134
Current count: 45000, row: 47925
Current count: 46000, row: 48730
Current count: 47000, row: 49500
Current count: 48000, row: 50351
Current count: 49000, row: 5120
Current count: 50000, row: 51888
Current count: 51000, row: 5257502990314019.205172644364018.14-07-2018070014.2021-01-04171327.867742
Current count: 52000, row: 53290
Current count: 53000, row: 5620
Current count: 54000, row: 6211
Current count: 55000, row: 6478888441720966.273246841077378.06-10-2018212851.2021-01-04171333.585477
Current count: 56000, row: 6968
Current count: 57000, row: 7868
Current count: 58000, row: 8768
Current count: 59000, row: 9668
59367 row(s) in 3.8140 seconds

=> 59367
```