PES UNIVERSITY
100 feet Ring Road, BSK 3rd Stage,
Bengaluru : 560085

Department of Computer Science and Engineering
B. Tech. CSE - 6th Semester
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DATABASE TECHNOLOGIES (DBT)

Project Report

STREAM AND BATCH PROCESSING OF DATA

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1. Introduction

This project aims to explore the capabilities of Apache Spark and Kafka in processing of streaming data. It involves executing multiple workloads such as Spark SQL queries to perform actions, transformations, or aggregations on input data. The input data considered here is **Twitter feeds** which is stored in **MySQL Database**. The data in the MYSQL database is streamed continuously at random intervals and random number of queries by kafka. Also, Kafka produces 4 topics, in which each topic is result of a certain SQL query. The 4 topics considered in this project are **tweets, hashtags, top_tweets, top_hashtags**.

The subscribers(streaming consumer and batch consumer) subscribe to a particular topic on random basis and same queries are being run on same data in streaming mode and batch mode. The accuracy and performance is compared. The computation examples include counting tweets within the window and applying aggregate functions on numeric data within each **tumbling window**. The project's window size will be significant and suitable to the chosen domain problem, such as 15-30 minutes of tweets as one window.

2. Installation of Software [include version #s and URLs]

Streaming Tools Used

- **Apache Kafka (3.2.3) :** A distributed streaming platform that allows for the building of real-time data pipelines and streaming applications. We used this for streaming of data and as a publisher.

LINK : https://downloads.apache.org/kafka/3.2.3/kafka-3.2.3-src.tgz

- **Apache Spark Streaming (3.4.0) :** A real-time processing engine built on top of the Apache Spark platform, allowing for

processing of data streams in real-time. Also, gives way for batch processing.

LINK : https://spark.apache.org/downloads.html

Pyspark (3.4.0): A streaming engine just like apache kafka, but exclusively meant for python and its associated functionalities.
TO INSTALL : pip install pyspark==”3.4.0”

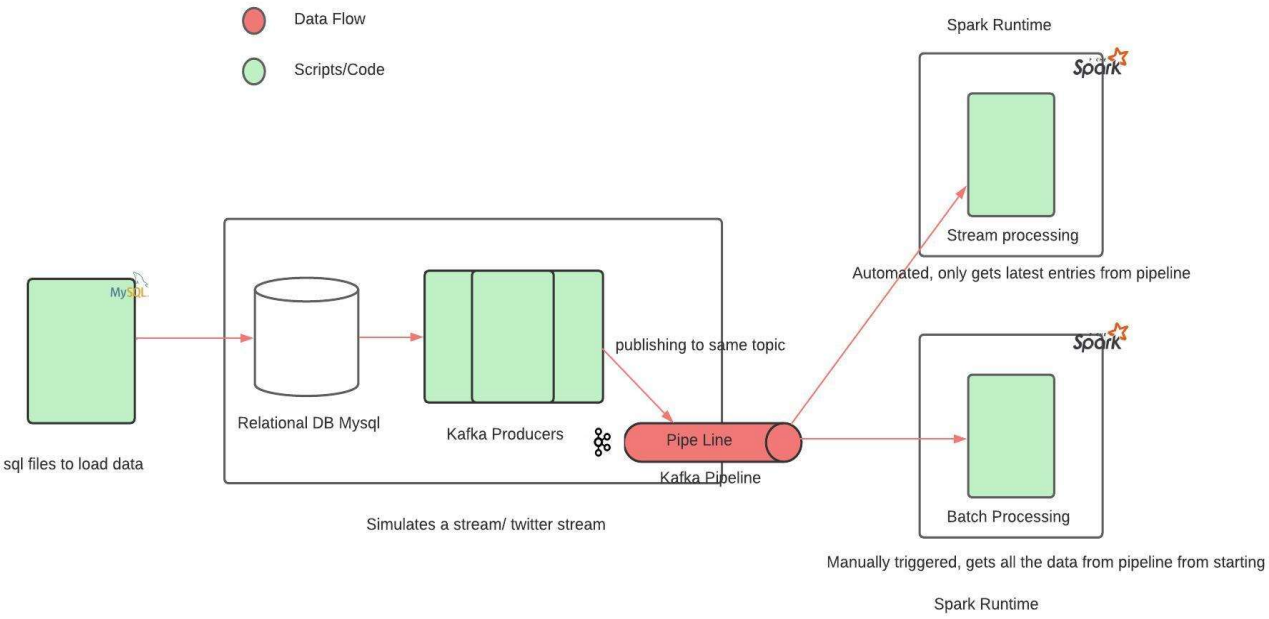
DBMS Used

MySQL-8.0.32
Link of our remote hosted database :
https://www.db4free.net/phpMyAdmin/index.php?route=/

3. Problem Description

The main challenge addressed in this project is to process the massive volume of data generated by Twitter and perform various actions, transformations, and aggregations on it. To address this challenge, the project involves creating **multiple topics using Kafka**, such as tweets, hashtags, top_tweets, and top_hashtags, and continuously publishing data from the MySQL database to these topics. Also, we can be assured that kafka does the **real-time streaming of data** from the database, as mentioned in the architecture below. This simulation is near to the Twitter – API like performance. Overall, this project aims to demonstrate how Apache Spark and Kafka can be used to efficiently process and analyse real-time streaming data, with a focus on Twitter feeds and gain valuable insights. We also see the batch processing of the queries, which is also a major use of Spark. We can also understand that Spark does the subscribing part of the entire model. At last, we see the comparison of a topic between the stream and batch processing and application of the type of windows, etc…This is our problem statement and intention of the same.

4. Architecture Diagram



5. Input Data

Source:

Twitter dataset collected across multiple sources in the form of .CSV files from Kaggle, etc…

Description:

This dataset contains the actual format of a general tweet message which includes the following metadata :
"id, conversation_id, created_at, date, time, timezone, user_id, username, name, place, tweet language, mentions, urls, photos, replies_count, retweets_count, likes_count, hashtags, cashtags, link, retweet, quote_url, videothumbnail, near, geo, source, user_rt_id, user_rt, retweet_id, reply_to, retweet_date, translate, trans_src and trans_dest

But, we choose only the relevant data, that we need for our project. The following is the database and table , that is obtained form this dataset.

```
CREATE TABLE tweets (
    tweet_id BIGINT PRIMARY KEY,
    tweet TEXT,
    date_time VARCHAR(40),
    language VARCHAR(10)
    );


CREATE TABLE hashtags (
    hashtag_id BIGINT PRIMARY KEY,
    hashtag VARCHAR(300) collate utf8mb4_bin
    );

CREATE TABLE tweet_hashtags (
    tweet_id BIGINT,
    hashtag_id BIGINT,
    count BIGINT,
    PRIMARY KEY(tweet_id, hashtag_id),
    FOREIGN KEY(tweet_id) REFERENCES tweets(tweet_id) ON DELETE
CASCADE,
    FOREIGN KEY(hashtag_id) REFERENCES hashtags(hashtag_id) ON
DELETE CASCADE
    );
```

a. The Kafka Topics (STREAMING + PRODUCER)

```
from pyspark.sql import SparkSession
from pyspark.sql.functions import *
from pyspark.sql.types import StructType, StructField,
IntegerType, StringType, TimestampType
from pandas import *
import random
import time
topic = ""
```

```
print("WELCOME TO SPARK STREAMING CONSUMER")
print("Enter the topic you want to choose : \n 1.
top_tweets \n 2. top_hashtags \n 3. tweets \n 4. hashtags
\n 5. random topic\n")
choice = random.randint(1, 4)
print("The chosen topic is : ", choice)
if choice == 1:
    topic = "top_tweets"
elif choice == 2:
    topic = "top_hashtags"
elif choice == 3:
    topic = "tweets"
elif choice == 4:
    topic = "hashtags"

# create a SparkSession object
spark = SparkSession.builder \
    .appName("MySparkApp") \
    .master("local[*]") \
    .getOrCreate()

# Define the schema for the incoming data
schema = StructType([
    StructField("id", IntegerType()),
    StructField("text", StringType()),
    StructField("date_time", TimestampType()),
    StructField("language", StringType()),
    StructField("hashtags", StringType())
])

# Create the streaming dataframe
df = spark \
    .readStream \
    .format("kafka") \
    .option("kafka.bootstrap.servers", "localhost:9092") \
    .option("subscribe", topic) \
```

```
    .option("startingOffsets", "latest") \
    .load() \
    .selectExpr("CAST(value AS STRING)") \
    .select(from_json(col("value"), schema).alias("data"))
\
    .select("data.*")

# Define the window and group by clauses
windowedCounts = df \
    .withWatermark("date_time", "30 minutes") \
    .groupBy(
        window(col("date_time"), "30 minutes"),
        col("hashtags")
    ) \
    .agg(count("id").alias("tweet_count"))

# Sort the data in ascending order by the window start time
and hashtags
sortedCounts = windowedCounts \
    .sort(
        col("window.start").asc(),
        col("hashtags").asc()
    )

# Write the output to the console
console_query = sortedCounts \
    .writeStream \
    .outputMode("complete") \
    .format("console") \
    .option("truncate", "false") \
    .start()

# Write the output to a CSV file
csv_query = sortedCounts \
    .writeStream \
    .outputMode("complete") \
```

```
    .foreachBatch(lambda df, epochId:
df.toPandas().to_csv("output.csv", index=False,
header=True)) \
    .start()

# Wait for the queries to terminate
console_query.awaitTermination()
csv_query.awaitTermination()

time.sleep(100)

# Stop the queries
console_query.stop()
csv_query.stop()
```

6. Streaming Mode Experiment

Windows

The code defines a sliding window of 15 minutes and groups the data within that window based on topics provided. The 15 minutes tell us the fact that , a query/data is maximum delayed upto 15 min, beyond which, it is discarded.

Workloads

The code reads data from a Kafka topic (randomly selected), processes the data in a streaming fashion, calculates the count of tweets per hashtag within a 30-minute window, sorts the result by window start time and hashtag, and writes the output to both the console and a CSV file. Here Pyspark is used to subscribe to the topic provided by kafka.

Code like SQL scripts

The SQL like queries are provided in the kafka topics, here we see the stream processing of the data below.

```
from pyspark.sql import SparkSession
from pyspark.sql.functions import *
from pyspark.sql.types import StructType, StructField,
IntegerType, StringType, TimestampType
from pandas import *
import random
import time
topic = ""
print("WELCOME TO SPARK STREAMING CONSUMER")
print("Enter the topic you want to choose : \n 1.
top_tweets \n 2. top_hashtags \n 3. tweets \n 4. hashtags
\n 5. random topic\n")
choice = random.randint(1, 4)
print("The chosen topic is : ", choice)
if choice == 1:
    topic = "top_tweets"
elif choice == 2:
    topic = "top_hashtags"
elif choice == 3:
    topic = "tweets"
elif choice == 4:
    topic = "hashtags"

# create a SparkSession object
spark = SparkSession.builder \
    .appName("MySparkApp") \
    .master("local[*]") \
    .getOrCreate()

# Define the schema for the incoming data
schema = StructType([
    StructField("id", IntegerType()),
```

```
    StructField("text", StringType()),
    StructField("date_time", TimestampType()),
    StructField("language", StringType()),
    StructField("hashtags", StringType())
])

# Create the streaming dataframe
df = spark \
    .readStream \
    .format("kafka") \
    .option("kafka.bootstrap.servers", "localhost:9092") \
    .option("subscribe", topic) \
    .option("startingOffsets", "latest") \
    .load() \
    .selectExpr("CAST(value AS STRING)") \
    .select(from_json(col("value"), schema).alias("data"))
\
    .select("data.*")

# Define the window and group by clauses
windowedCounts = df \
    .withWatermark("date_time", "15 minutes") \
    .groupBy(
        window(col("date_time"), "15 minutes"),
        col("hashtags")
    ) \
    .agg(count("id").alias("tweet_count"))

# Sort the data in ascending order by the window start time
and hashtags
sortedCounts = windowedCounts \
    .sort(
        col("window.start").asc(),
        col("hashtags").asc()
    )
```

```
# Write the output to the console
console_query = sortedCounts \
    .writeStream \
    .outputMode("complete") \
    .format("console") \
    .option("truncate", "false") \
    .start()

# Write the output to a CSV file
csv_query = sortedCounts \
    .writeStream \
    .outputMode("complete") \
    .foreachBatch(lambda df, epochId:
df.toPandas().to_csv("output.csv", index=False,
header=True)) \
    .start()

# Wait for the queries to terminate
console_query.awaitTermination()
csv_query.awaitTermination()

time.sleep(100)

# Stop the queries
console_query.stop()
csv_query.stop()
```

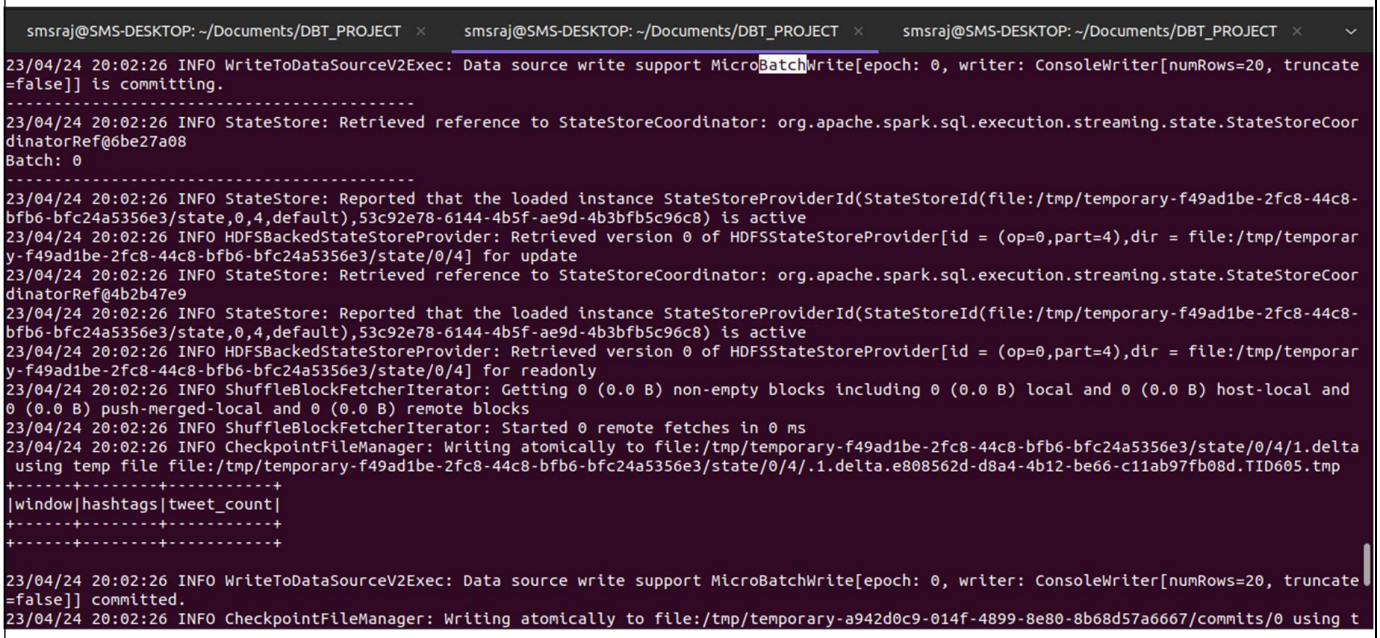
Inputs and corresponding results

These are explained in the screenshots mentioned below

```
smsraj@SMS-DESKTOP:~/Documents/DBT_PROJECT$ spark-submit --packages org.apache.spark:spark-sql-kafka-0-10_2.12:3.2.3 spark_streaming_consumer.
py
:: loading settings :: url = jar:file:/opt/spark/jars/ivy-2.5.1.jar!/org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/smsraj/.ivy2/cache
The jars for the packages stored in: /home/smsraj/.ivy2/jars
org.apache.spark#spark-sql-kafka-0-10_2.12 added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-e52bd622-e4e9-4a48-88c5-7bc2c339e5c5;1.0
        confs: [default]
        found org.apache.spark#spark-sql-kafka-0-10_2.12;3.2.3 in central
        found org.apache.spark#spark-token-provider-kafka-0-10_2.12;3.2.3 in central
        found org.apache.kafka#kafka-clients;2.8.1 in central
        found org.lz4#lz4-java;1.7.1 in central
        found org.xerial.snappy#snappy-java;1.1.8.4 in central
        found org.slf4j#slf4j-api;1.7.30 in central
        found org.apache.hadoop#hadoop-client-runtime;3.3.1 in central
        found org.spark-project.spark#unused;1.0.0 in central
        found org.apache.hadoop#hadoop-client-api;3.3.1 in central
        found org.apache.htrace#htrace-core4;4.1.0-incubating in central
        found commons-logging#commons-logging;1.1.3 in central
        found com.google.code.findbugs#jsr305;3.0.0 in central
        found org.apache.commons#commons-pool2;2.6.2 in central
:: resolution report :: resolve 2491ms :: artifacts dl 120ms
        :: modules in use:
        com.google.code.findbugs#jsr305;3.0.0 from central in [default]
        commons-logging#commons-logging;1.1.3 from central in [default]
        org.apache.commons#commons-pool2;2.6.2 from central in [default]
        org.apache.hadoop#hadoop-client-api;3.3.1 from central in [default]
        org.apache.hadoop#hadoop-client-runtime;3.3.1 from central in [default]
        org.apache.htrace#htrace-core4;4.1.0-incubating from central in [default]
        org.apache.kafka#kafka-clients;2.8.1 from central in [default]
```

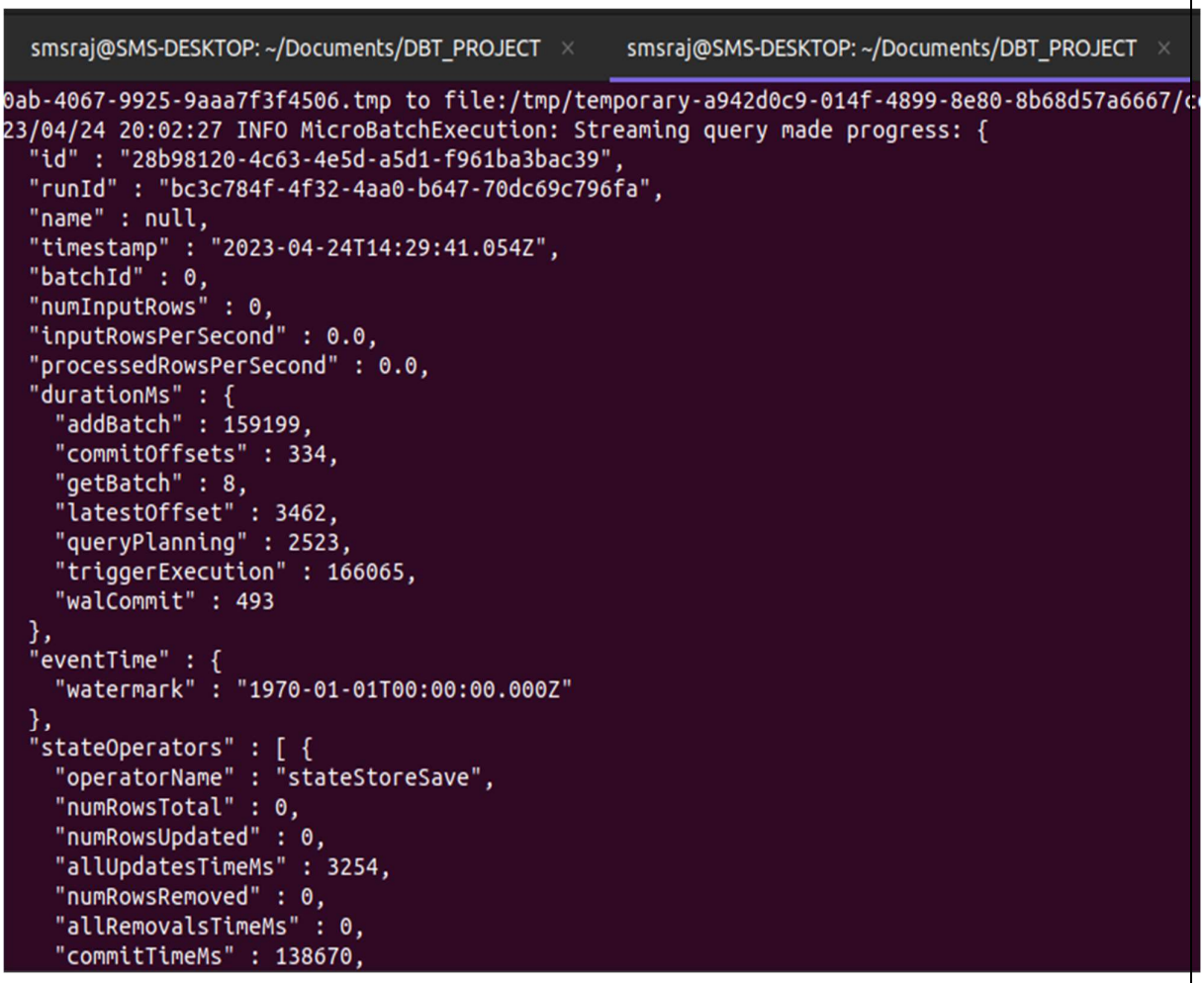
```
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT  smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT  smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
        org.slf4j#slf4j-api;1.7.30 from central in [default]
        org.spark-project.spark#unused;1.0.0 from central in [default]
        org.xerial.snappy#snappy-java;1.1.8.4 from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   13  |   0   |   0   |   0   ||   13  |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-e52bd622-e4e9-4a48-88c5-7bc2c339e5c5
        confs: [default]
        0 artifacts copied, 13 already retrieved (0kB/28ms)
23/04/24 19:59:19 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
WELCOME TO SPARK STREAMING CONSUMER
Enter the topic you want to choose :
 1. top_tweets
 2. top_hashtags
 3. tweets
 4. hashtags
 5. random topic

The chosen topic is :  1
23/04/24 19:59:22 INFO SparkContext: Running Spark version 3.4.0
23/04/24 19:59:22 INFO ResourceUtils: ==============================================================
23/04/24 19:59:22 INFO ResourceUtils: No custom resources configured for spark.driver.
23/04/24 19:59:22 INFO ResourceUtils: ==============================================================
23/04/24 19:59:22 INFO SparkContext: Submitted application: MySparkApp
23/04/24 19:59:23 INFO ResourceProfile: Default ResourceProfile created, executor resources: Map(cores -> name: cores, amount: 1, script: , ve
ndor: , memory -> name: memory, amount: 1024, script: , vendor: , offHeap -> name: offHeap, amount: 0, script: , vendor: ), task resources: Ma
p(cpus -> name: cpus, amount: 1.0)
```

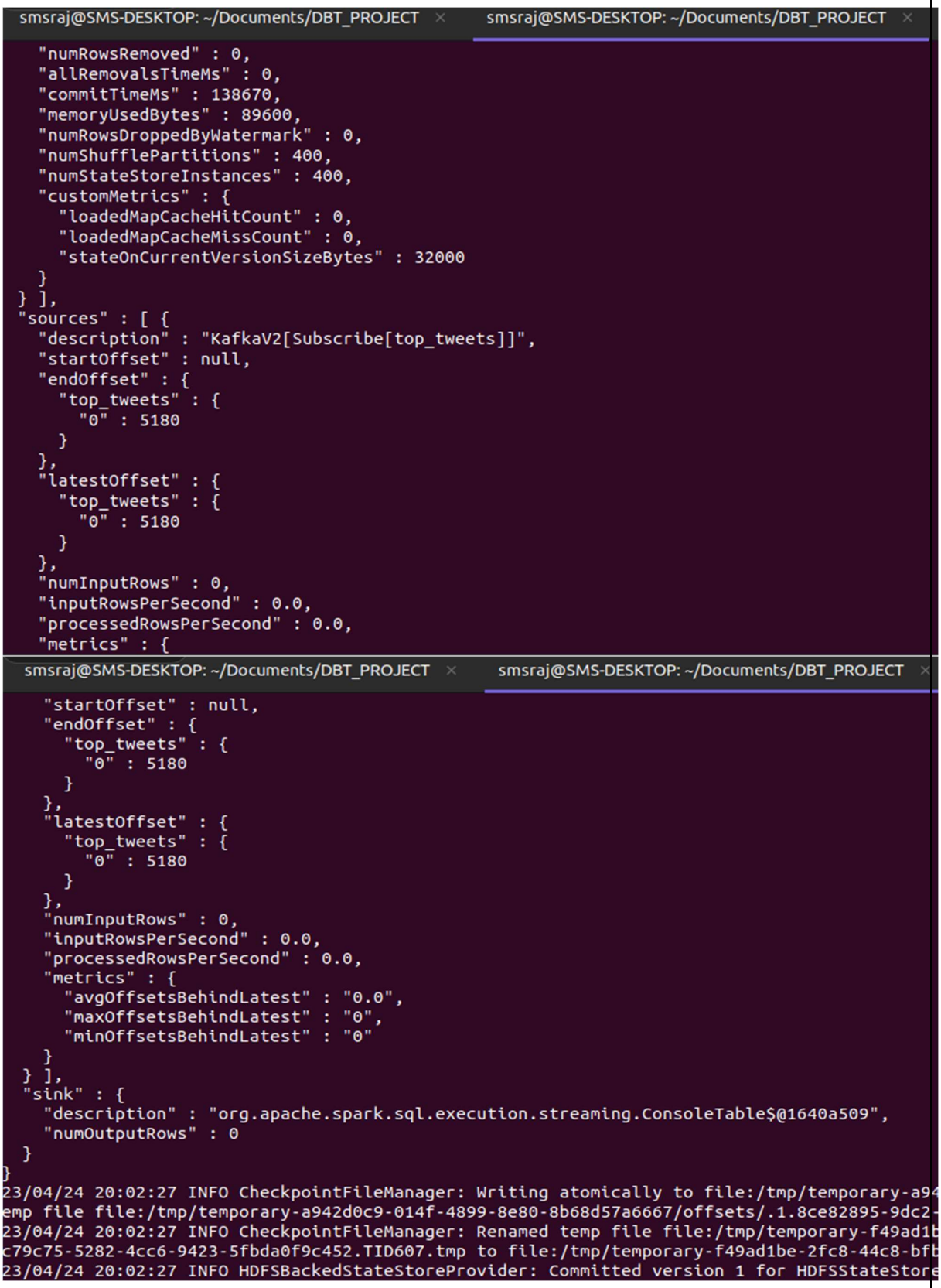
```
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT  smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT  smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
23/04/24 20:00:55 INFO WriteToDataSourceV2Exec: Start processing data source write support: MicroBatchWrite[epoch: 0, writer: ConsoleWriter[nu
mRows=20, truncate=false]]. The input RDD has 1 partitions.
23/04/24 20:00:55 INFO SparkContext: Starting job: start at NativeMethodAccessorImpl.java:0
23/04/24 20:00:55 INFO DAGScheduler: Registering RDD 32 (start at NativeMethodAccessorImpl.java:0) as input to shuffle 2
23/04/24 20:00:55 INFO DAGScheduler: Got job 2 (start at NativeMethodAccessorImpl.java:0) with 1 output partitions
23/04/24 20:00:55 INFO DAGScheduler: Final stage: ResultStage 6 (start at NativeMethodAccessorImpl.java:0)
23/04/24 20:00:55 INFO DAGScheduler: Parents of final stage: List(ShuffleMapStage 5)
23/04/24 20:00:55 INFO DAGScheduler: Missing parents: List(ShuffleMapStage 5)
23/04/24 20:00:55 INFO DAGScheduler: Submitting ShuffleMapStage 5 (MapPartitionsRDD[32] at start at NativeMethodAccessorImpl.java:0), which ha
s no missing parents
23/04/24 20:00:55 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/0/_metada
ta/schema using temp file file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/0/_metadata/.schema.9e7471b6-7fdf-48c0-966e-93127ad
d47d5.TID200.tmp
23/04/24 20:00:56 INFO MemoryStore: Block broadcast_6 stored as values in memory (estimated size 75.6 KiB, free 433.2 MiB)
23/04/24 20:00:56 INFO MemoryStore: Block broadcast_6_piece0 stored as bytes in memory (estimated size 33.1 KiB, free 433.1 MiB)
23/04/24 20:00:56 INFO BlockManagerInfo: Added broadcast_6_piece0 in memory on localhost:38855 (size: 33.1 KiB, free: 434.2 MiB)
23/04/24 20:00:56 INFO SparkContext: Created broadcast 6 from broadcast at DAGScheduler.scala:1535
23/04/24 20:00:56 INFO DAGScheduler: Submitting 200 missing tasks from ShuffleMapStage 5 (MapPartitionsRDD[32] at start at NativeMethodAccesso
rImpl.java:0) (first 15 tasks are for partitions Vector(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14))
23/04/24 20:00:56 INFO TaskSchedulerImpl: Adding task set 5.0 with 200 tasks resource profile 0
23/04/24 20:00:56 INFO CheckpointFileManager: Renamed temp file file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/0/_metadata/.
schema.9e7471b6-7fdf-48c0-966e-93127add47d5.TID200.tmp to file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/0/_metadata/schema
23/04/24 20:00:56 INFO StateStore: Retrieved reference to StateStoreCoordinator: org.apache.spark.sql.execution.streaming.state.StateStoreCoor
dinatorRef@3fe27957
23/04/24 20:00:56 INFO StateStore: Reported that the loaded instance StateStoreProviderId(StateStoreId(file:/tmp/temporary-f49ad1be-2fc8-44c8-
bfb6-bfc24a5356e3/state,0,0,default),53c92e78-6144-4b5f-ae9d-4b3bfb5c96c8) is active
23/04/24 20:00:56 INFO HDFSBackedStateStoreProvider: Retrieved version 0 of HDFSStateStoreProvider[id = (op=0,part=0),dir = file:/tmp/temporar
y-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/0] for update
23/04/24 20:00:56 INFO BlockManagerInfo: Removed broadcast_4_piece0 on localhost:38855 in memory (size: 32.8 KiB, free: 434.2 MiB)
23/04/24 20:00:56 INFO StateStore: Retrieved reference to StateStoreCoordinator: org.apache.spark.sql.execution.streaming.state.StateStoreCoor
```


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
23/04/24 20:02:26 INFO WriteToDataSourceV2Exec: Data source write support MicroBatchWrite[epoch: 0, writer: ConsoleWriter[numRows=20, truncate=false]] is committing.

23/04/24 20:02:26 INFO StateStore: Retrieved reference to StateStoreCoordinator: org.apache.spark.sql.execution.streaming.state.StateStoreCoordinatorRef@6be27a08
Batch: 0

23/04/24 20:02:26 INFO StateStore: Reported that the loaded instance StateStoreProviderId(StateStoreId(file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state,0,4,default),53c92e78-6144-4b5f-ae9d-4b3bfb5c96c8) is active
23/04/24 20:02:26 INFO HDFSBackedStateStoreProvider: Retrieved version 0 of HDFSStateStoreProvider[id = (op=0,part=4),dir = file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/4] for update
23/04/24 20:02:26 INFO StateStore: Retrieved reference to StateStoreCoordinator: org.apache.spark.sql.execution.streaming.state.StateStoreCoordinatorRef@4b2b47e9
23/04/24 20:02:26 INFO StateStore: Reported that the loaded instance StateStoreProviderId(StateStoreId(file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state,0,4,default),53c92e78-6144-4b5f-ae9d-4b3bfb5c96c8) is active
23/04/24 20:02:26 INFO HDFSBackedStateStoreProvider: Retrieved version 0 of HDFSStateStoreProvider[id = (op=0,part=4),dir = file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/4] for readonly
23/04/24 20:02:26 INFO ShuffleBlockFetcherIterator: Getting 0 (0.0 B) non-empty blocks including 0 (0.0 B) local and 0 (0.0 B) host-local and 0 (0.0 B) push-merged-local and 0 (0.0 B) remote blocks
23/04/24 20:02:26 INFO ShuffleBlockFetcherIterator: Started 0 remote fetches in 0 ms
23/04/24 20:02:26 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/4/1.delta using temp file file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb6-bfc24a5356e3/state/0/4/.1.delta.e808562d-d8a4-4b12-be66-c11ab97fb08d.TID605.tmp
+------+--------+-----------+
|window|hashtags|tweet_count|
+------+--------+-----------+
+------+--------+-----------+
23/04/24 20:02:26 INFO WriteToDataSourceV2Exec: Data source write support MicroBatchWrite[epoch: 0, writer: ConsoleWriter[numRows=20, truncate=false]] committed.
23/04/24 20:02:26 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-a942d0c9-014f-4899-8e80-8b68d57a6667/commits/0 using t


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
0ab-4067-9925-9aaa7f3f4506.tmp to file:/tmp/temporary-a942d0c9-014f-4899-8e80-8b68d57a6667/c
23/04/24 20:02:27 INFO MicroBatchExecution: Streaming query made progress: {
"id" : "28b98120-4c63-4e5d-a5d1-f961ba3bac39",
"runId" : "bc3c784f-4f32-4aa0-b647-70dc69c796fa",
"name" : null,
"timestamp" : "2023-04-24T14:29:41.054Z",
"batchId" : 0,
"numInputRows" : 0,
"inputRowsPerSecond" : 0.0,
"processedRowsPerSecond" : 0.0,
"durationMs" : {
"addBatch" : 159199,
"commitOffsets" : 334,
"getBatch" : 8,
"latestOffset" : 3462,
"queryPlanning" : 2523,
"triggerExecution" : 166065,
"walCommit" : 493
},
"eventTime" : {
"watermark" : "1970-01-01T00:00:00.000Z"
},
"stateOperators" : [{
"operatorName" : "stateStoreSave",
"numRowsTotal" : 0,
"numRowsUpdated" : 0,
"allUpdatesTimeMs" : 3254,
"numRowsRemoved" : 0,
"allRemovalsTimeMs" : 0,
"commitTimeMs" : 138670,


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
"numRowsRemoved" : 0,
"allRemovalsTimeMs" : 0,
"commitTimeMs" : 138670,
"memoryUsedBytes" : 89600,
"numRowsDroppedByWatermark" : 0,
"numShufflePartitions" : 400,
"numStateStoreInstances" : 400,
"customMetrics" : {
"loadedMapCacheHitCount" : 0,
"loadedMapCacheMissCount" : 0,
"stateOnCurrentVersionSizeBytes" : 32000
}
}],
"sources" : [{
"description" : "KafkaV2[Subscribe[top_tweets]]",
"startOffset" : null,
"endOffset" : {
"top_tweets" : {
"0" : 5180
}
},
"latestOffset" : {
"top_tweets" : {
"0" : 5180
}
},
"numInputRows" : 0,
"inputRowsPerSecond" : 0.0,
"processedRowsPerSecond" : 0.0,
"metrics" : {
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
"startOffset" : null,
"endOffset" : {
"top_tweets" : {
"0" : 5180
}
},
"latestOffset" : {
"top_tweets" : {
"0" : 5180
}
},
"numInputRows" : 0,
"inputRowsPerSecond" : 0.0,
"processedRowsPerSecond" : 0.0,
"metrics" : {
"avgOffsetsBehindLatest" : "0.0",
"maxOffsetsBehindLatest" : "0",
"minOffsetsBehindLatest" : "0"
}
}],
"sink" : {
"description" : "org.apache.spark.sql.execution.streaming.ConsoleTable$@1640a509",
"numOutputRows" : 0
}
}
23/04/24 20:02:27 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-a94
emp file file:/tmp/temporary-a942d0c9-014f-4899-8e80-8b68d57a6667/offsets/.1.8ce82895-9dc2-
23/04/24 20:02:27 INFO CheckpointFileManager: Renamed temp file file:/tmp/temporary-f49ad1b
c79c75-5282-4cc6-9423-5fbda0f9c452.TID607.tmp to file:/tmp/temporary-f49ad1be-2fc8-44c8-bfb
23/04/24 20:02:27 INFO HDFSBackedStateStoreProvider: Committed version 1 for HDFSStateStore

7. Batch Mode Experiment

a. Description

This program reads data from a Kafka topic named "tweets" in a streaming fashion using Spark Structured Streaming. The data is parsed using a predefined schema and processed to count the number of tweets based on their language within a sliding window of 5 minutes. The processed results are then output to the console using the complete mode of output.

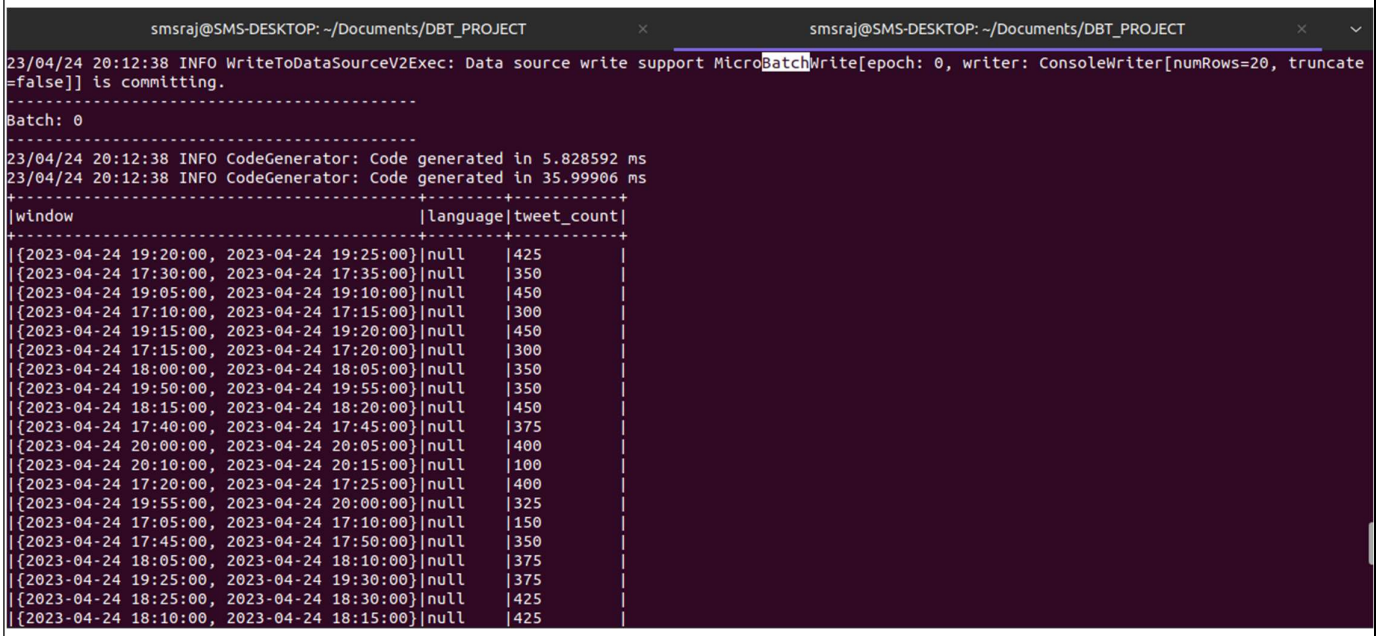
b. Data size

The size of the data is 20 rows per batch. It depends on the size of the data produced and stored in the Kafka topic.

c. Results

```
WELCOME TO SPARK BATCH CONSUMER
Enter the topic you want to choose :
 1. top_tweets
 2. top_hashtags
 3. tweets
 4. hashtags
 5. random topic

The chosen topic is :  1
23/04/24 20:10:56 INFO SparkContext: Running Spark version 3.4.0
23/04/24 20:10:56 INFO ResourceUtils: ==============================================================
23/04/24 20:10:56 INFO ResourceUtils: No custom resources configured for spark.driver.
23/04/24 20:10:56 INFO ResourceUtils: ==============================================================
23/04/24 20:10:56 INFO SparkContext: Submitted application: TwitterCount
23/04/24 20:10:56 INFO ResourceProfile: Default ResourceProfile created, executor resources: Map(cores -> name: cores, amount: 1, script: , ve
ndor: , memory -> name: memory, amount: 1024, script: , vendor: , offHeap -> name: offHeap, amount: 0, script: , vendor: ), task resources: Ma
p(cpus -> name: cpus, amount: 1.0)
23/04/24 20:10:56 INFO ResourceProfile: Limiting resource is cpu
23/04/24 20:10:56 INFO ResourceProfileManager: Added ResourceProfile id: 0
23/04/24 20:10:57 INFO SecurityManager: Changing view acls to: smsraj
23/04/24 20:10:57 INFO SecurityManager: Changing modify acls to: smsraj
```

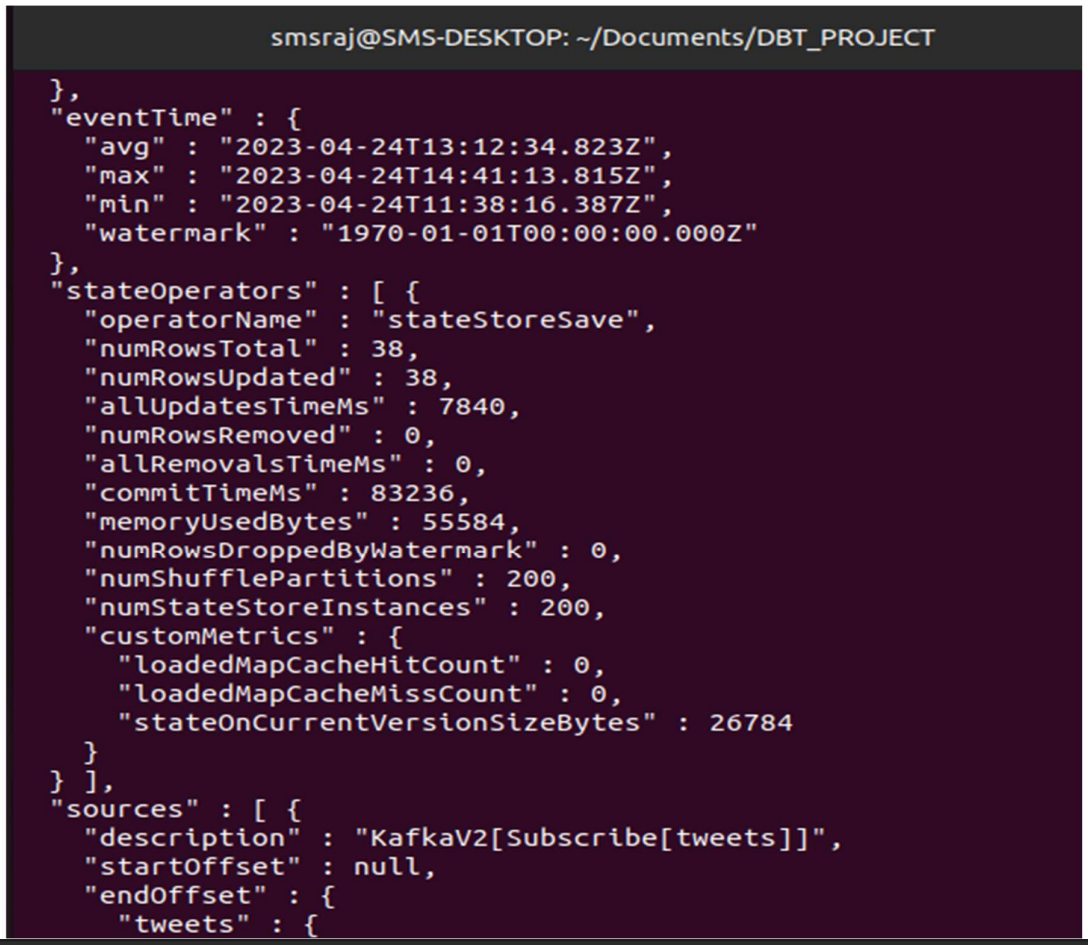
```
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT          smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT

23/04/24 20:11:13 INFO MicroBatchExecution: Starting [id = eb8b7a76-d542-49cf-96d3-d79cb50eadc2, runId = cebb8346-6b85-4a1d-b334-7f58be64a4
. Use file:/tmp/temporary-250cdd5c-7d44-47ae-84da-3fdba0b11d41 to store the query checkpoint.
23/04/24 20:11:13 INFO MicroBatchExecution: Reading table [org.apache.spark.sql.kafka010.KafkaSourceProvider$KafkaTable@43b07bb2] from Data
rceV2 named 'kafka' [org.apache.spark.sql.kafka010.KafkaSourceProvider@7589a8bd]
23/04/24 20:11:13 INFO OffsetSeqLog: BatchIds found from listing:
23/04/24 20:11:13 INFO OffsetSeqLog: BatchIds found from listing:
23/04/24 20:11:13 INFO MicroBatchExecution: Starting new streaming query.
23/04/24 20:11:13 INFO MicroBatchExecution: Stream started from {}
23/04/24 20:11:15 INFO AdminClientConfig: AdminClientConfig values:
        bootstrap.servers = [localhost:9092]
        client.dns.lookup = use_all_dns_ips
        client.id =
        connections.max.idle.ms = 300000
        default.api.timeout.ms = 60000
        metadata.max.age.ms = 300000
        metric.reporters = []
        metrics.num.samples = 2
        metrics.recording.level = INFO
        metrics.sample.window.ms = 30000
        receive.buffer.bytes = 65536
        reconnect.backoff.max.ms = 1000
        reconnect.backoff.ms = 50
        request.timeout.ms = 30000
        retries = 2147483647
        retry.backoff.ms = 100
        sasl.client.callback.handler.class = null
        sasl.jaas.config = null
        sasl.kerberos.kinit.cmd = /usr/bin/kinit
        sasl.kerberos.min.time.before.relogin = 60000
        sasl.kerberos.service.name = null
```

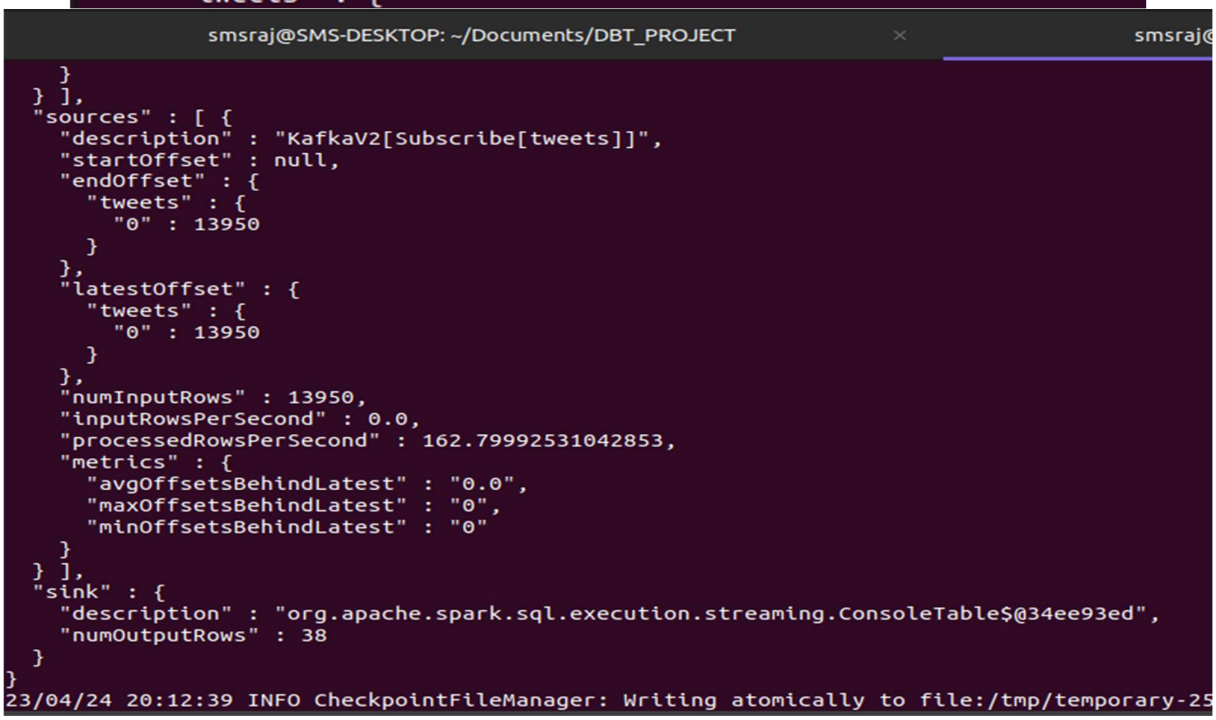

smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
23/04/24 20:12:38 INFO WriteToDataSourceV2Exec: Data source write support MicroBatchWrite[epoch: 0, writer: ConsoleWriter[numRows=20, truncate
=false]] is committing.

Batch: 0

23/04/24 20:12:38 INFO CodeGenerator: Code generated in 5.828592 ms
23/04/24 20:12:38 INFO CodeGenerator: Code generated in 35.99906 ms
+--+--------+-----------+
|window |language|tweet_count|
+--+--------+-----------+
{2023-04-24 19:20:00, 2023-04-24 19:25:00}	null	425
{2023-04-24 17:30:00, 2023-04-24 17:35:00}	null	350
{2023-04-24 19:05:00, 2023-04-24 19:10:00}	null	450
{2023-04-24 17:10:00, 2023-04-24 17:15:00}	null	300
{2023-04-24 19:15:00, 2023-04-24 19:20:00}	null	450
{2023-04-24 17:15:00, 2023-04-24 17:20:00}	null	300
{2023-04-24 18:00:00, 2023-04-24 18:05:00}	null	350
{2023-04-24 19:50:00, 2023-04-24 19:55:00}	null	350
{2023-04-24 18:15:00, 2023-04-24 18:20:00}	null	450
{2023-04-24 17:40:00, 2023-04-24 17:45:00}	null	375
{2023-04-24 20:00:00, 2023-04-24 20:05:00}	null	400
{2023-04-24 20:10:00, 2023-04-24 20:15:00}	null	100
{2023-04-24 17:20:00, 2023-04-24 17:25:00}	null	400
{2023-04-24 19:55:00, 2023-04-24 20:00:00}	null	325
{2023-04-24 17:05:00, 2023-04-24 17:10:00}	null	150
{2023-04-24 17:45:00, 2023-04-24 17:50:00}	null	350
{2023-04-24 18:05:00, 2023-04-24 18:10:00}	null	375
{2023-04-24 19:25:00, 2023-04-24 19:30:00}	null	375
{2023-04-24 18:25:00, 2023-04-24 18:30:00}	null	425
{2023-04-24 18:10:00, 2023-04-24 18:15:00}	null	425


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
+--+--------+-----------+
only showing top 20 rows
23/04/24 20:12:38 INFO WriteToDataSourceV2Exec: Data source write support MicroBatchWrite[epoch: 0, writer: ConsoleWriter[numRows=20, trunc
=false]] committed.
23/04/24 20:12:38 INFO WatermarkTracker: Updating event-time watermark from 0 to 1682346973815 ms
23/04/24 20:12:38 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-250cdd5c-7d44-47ae-84da-3fdba0b11d41/commits/0 usir
emp file file:/tmp/temporary-250cdd5c-7d44-47ae-84da-3fdba0b11d41/commits/.0.0ae082cc-324e-4693-a0ed-60e2aa3e8b22.tmp
23/04/24 20:12:39 INFO CheckpointFileManager: Renamed temp file file:/tmp/temporary-250cdd5c-7d44-47ae-84da-3fdba0b11d41/commits/.0.0ae082c
24e-4693-a0ed-60e2aa3e8b22.tmp to file:/tmp/temporary-250cdd5c-7d44-47ae-84da-3fdba0b11d41/commits/0
23/04/24 20:12:39 INFO MicroBatchExecution: Streaming query made progress: {
"id" : "eb8b7a76-d542-49cf-96d3-d79cb50eadc2",
"runId" : "cebb8346-6b85-4a1d-b334-7f58be64a4b9",
"name" : null,
"timestamp" : "2023-04-24T14:41:13.705Z",
"batchId" : 0,
"numInputRows" : 13950,
"inputRowsPerSecond" : 0.0,
"processedRowsPerSecond" : 162.79992531042853,
"durationMs" : {
"addBatch" : 76023,
"commitOffsets" : 515,
"getBatch" : 175,
"latestOffset" : 5508,
"queryPlanning" : 2801,
"triggerExecution" : 85684,
"walCommit" : 527
},
"eventTime" : {
"avg" : "2023-04-24T13:12:34.823Z",


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
},
"eventTime" : {
"avg" : "2023-04-24T13:12:34.823Z",
"max" : "2023-04-24T14:41:13.815Z",
"min" : "2023-04-24T11:38:16.387Z",
"watermark" : "1970-01-01T00:00:00.000Z"
},
"stateOperators" : [{
"operatorName" : "stateStoreSave",
"numRowsTotal" : 38,
"numRowsUpdated" : 38,
"allUpdatesTimeMs" : 7840,
"numRowsRemoved" : 0,
"allRemovalsTimeMs" : 0,
"commitTimeMs" : 83236,
"memoryUsedBytes" : 55584,
"numRowsDroppedByWatermark" : 0,
"numShufflePartitions" : 200,
"numStateStoreInstances" : 200,
"customMetrics" : {
"loadedMapCacheHitCount" : 0,
"loadedMapCacheMissCount" : 0,
"stateOnCurrentVersionSizeBytes" : 26784
}
}],
"sources" : [{
"description" : "KafkaV2[Subscribe[tweets]]",
"startOffset" : null,
"endOffset" : {
"tweets" : {


smsraj@SMS-DESKTOP: ~/Documents/DBT_PROJECT
smsraj@
}
}],
"sources" : [{
"description" : "KafkaV2[Subscribe[tweets]]",
"startOffset" : null,
"endOffset" : {
"tweets" : {
"0" : 13950
}
},
"latestOffset" : {
"tweets" : {
"0" : 13950
}
},
"numInputRows" : 13950,
"inputRowsPerSecond" : 0.0,
"processedRowsPerSecond" : 162.79992531042853,
"metrics" : {
"avgOffsetsBehindLatest" : "0.0",
"maxOffsetsBehindLatest" : "0",
"minOffsetsBehindLatest" : "0"
}
}],
"sink" : {
"description" : "org.apache.spark.sql.execution.streaming.ConsoleTable$@34ee93ed",
"numOutputRows" : 38
}
}
23/04/24 20:12:39 INFO CheckpointFileManager: Writing atomically to file:/tmp/temporary-25

8. Comparison of Streaming and Batch modes

a. Results and Discussion

For this case we used both the streaming and batch process to subscribe to only Topic-1 i.e. top_tweets. We take all the statistics of computation, aggregation, count by window,etc…

When observed, we see that processed #row in seconds is near to 0 in case of streaming as, the processing taking place in a very near time, which is the actual real time, whereas in case of batch processing it is in few 100s in number which indicates that we are processing the data, only after some time. This is the case with number of rows input to the process models.

Also, memory and amount of commit time is less in stream processing , compared to batch processing, which account for the huge data processed in batch, viz. not applicable to stream processing.

These are some of the statistics available when we compare the results of both the process. There are many more parameters, on which we can evaluate on.

9. Conclusion

In conclusion, streaming and batch processing are both important concepts in data processing. Streaming is suitable for handling data in real-time or near real-time, where data is processed as it arrives, whereas batch processing is more suitable for processing large volumes of data at once.

In this particular code example, batch processing was used to process a large volume of tweets received from a Kafka topic over a specific time period (window duration), grouped by language and timestamp window,

and counted to show the total number of tweets. The results were printed to the console in the "complete" output mode.

Ultimately, the choice between streaming and batch processing depends on the nature of the data being processed and the specific requirements of the use case. Both have their own advantages and disadvantages, and it's up to the data engineer or scientist to choose the appropriate processing mode for their specific needs. The results metrics as discussed above will show the difference between as mentioned above.

10. References

a. URLs

[1] https://medium.com/analytics-vidhya/apache-spark-structured-streaming-with-pyspark-b4a054a7947d

[2] https://linuxhint.com/install-apache-kafka-ubuntu-22-04/

[3] https://stackoverflow.com/questions/65809459/syntaxerror-on-self-async-when-running-python-kafka-producer

[4] https://towardsdatascience.com/how-to-build-a-simple-kafka-producer-and-consumer-with-python-a967769c4742

[5] https://www.btelligent.com/en/blog/how-to-csv-to-kafka-with-python/