First Round Done – Need some find tuning

Date : 17th Mar 2024.

https://docs.confluent.io/current/ksql/docs/tutorials/examples.html#ksql-examples

1. Prerequisite

JDk : 1.11
Confluent : 7.3.3
Kafka : 3.11
Registry & KSQL DB

Since ksqlDB runs natively on Apache Kafka®, you'll need to have a Kafka cluster that ksqlDB is configured to use. Use the steps to the right to install the latest release of ksqlDB.

Use 0.23.1 only

```
#curl http://ksqldb-packages.s3.amazonaws.com/archive/0.29/confluent-ksqldb-0.29.0.tar.gz --output confluent-ksqldb-0.23.1.tar.gz
```

```
# Download the archive and its signature

#curl http://ksqldb-packages.s3.amazonaws.com/archive/0.29/confluent-ksqldb-0.29.0.tar.gz --output confluent-ksqldb-0.29.0.tar.gz
```

https://ksqldb.io/quickstart-standalone-tarball.html#quickstart-content

Confugure Kafka confluent and kafka cluster

2. Install KSQL DB – 60 Minutes(D)

Prerequisite: Kafka Node installation.

And kafka registry, required for Avro integration.

Update kafka server.properties with the following entries.

#vi /opt/kafka/config/server.properties

transaction.state.log.replication.factor=1
transaction.state.log.min.isr=1
offsets.topic.replication.factor=1

Restart the kafka broker.

Get standalone ksqlDB

Since ksqlDB runs natively on Apache Kafka®, you'll need to have a Kafka cluster that ksqlDB is configured to use. Use the steps to the right to install the latest release of ksqlDB.

```
# Extract the tarball to the directory of your choice
```

#tar -xf confluent-ksqldb-0.29.0.tar -C /opt/

Rename the folder to ksqldb for brevity

```
#mv confluent-ksq* ksqldb
```

Configure ksqlDB server

Ensure your ksqlDB server has network connectivity to Kafka.

Edit the highlighted line in `/opt/ksqldb/etc/ksqldb/ksql-server.properties` to match your Kafka hostname and port.

```
#------ Kafka -------

# The set of Kafka brokers to bootstrap Kafka cluster information from:
bootstrap.servers=kafka0:9092

# Enable snappy compression for the Kafka producers
compression.type=snappy
```

To enable Schema Registry Add the following line at the end of the configuration file.

#------ Schema Registry -------

Uncomment and complete the following to enable KSQL's integration to the Confluent Schema Registry:

ksql.schema.registry.url=http://kafka0:8081

Start ksqlDB's server

ksqlDB is packaged with a startup script for development use. We'll use that here.
When you're ready to run it as a service, you'll want to manage ksqlDB with something like `systemd`.

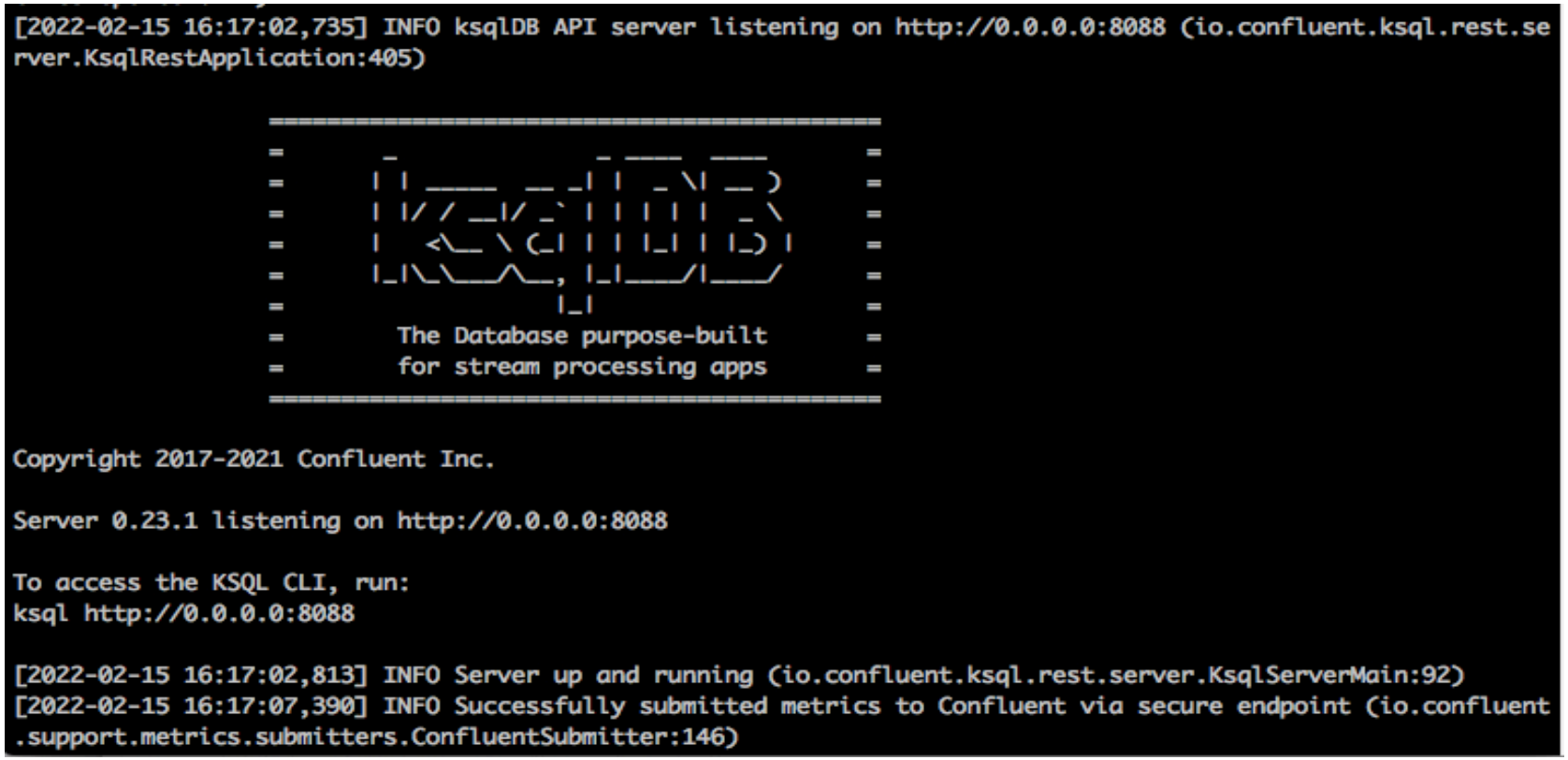
#/opt/ksqldb/bin/ksql-server-start /opt/ksqldb/etc/ksqldb/ksql-server.properties

If any issue in start up because of jar.

Download and store in the following folder.

#cd /opt/ksqldb/share/java/ksqldb
#wget https://repo1.maven.org/maven2/io/netty/netty-all/4.1.30.Final/netty-all-4.1.30.Final.jar

If you are able to successfully start the KSQL DB server, you should get the following output.

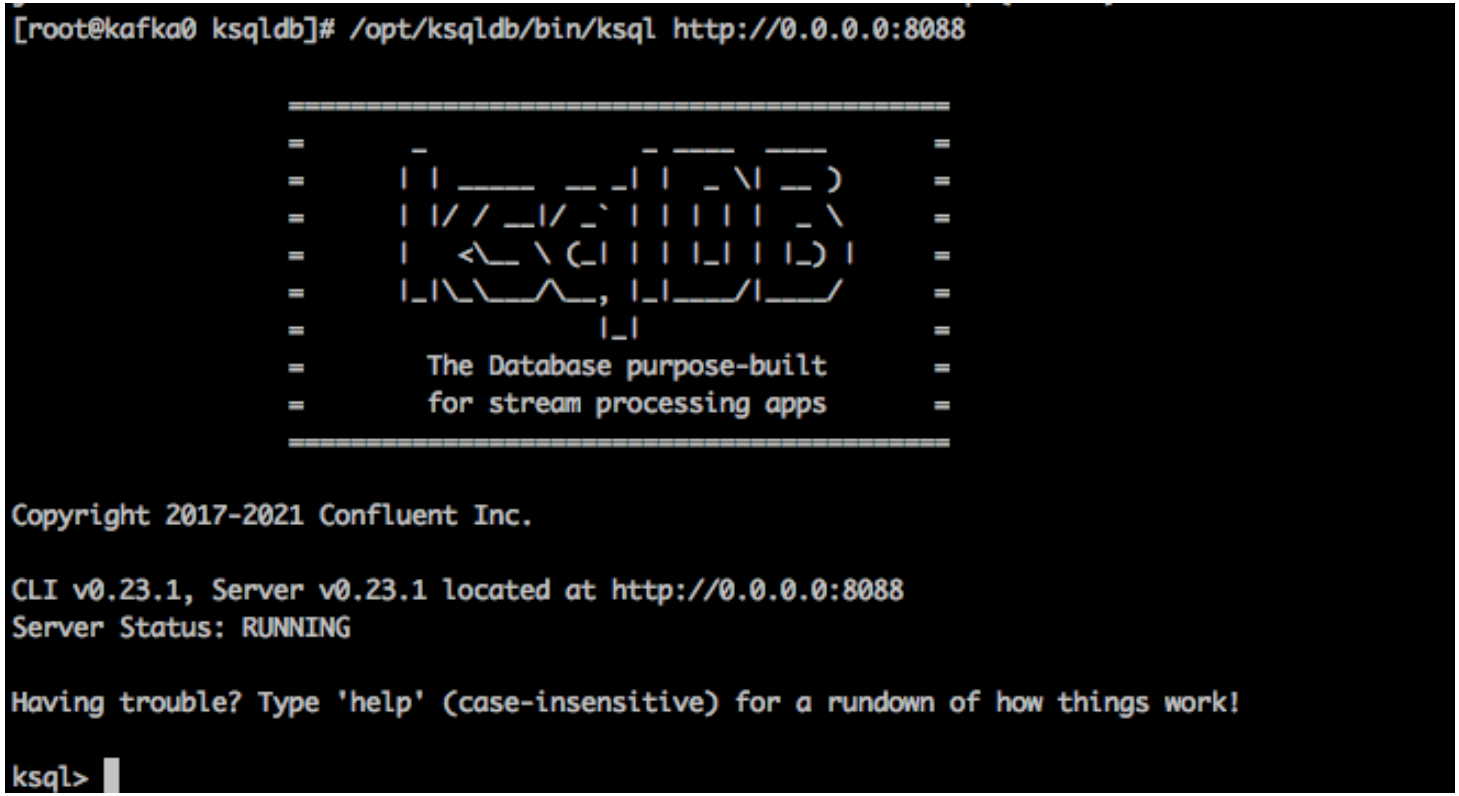


Start ksqlDB's interactive CLI

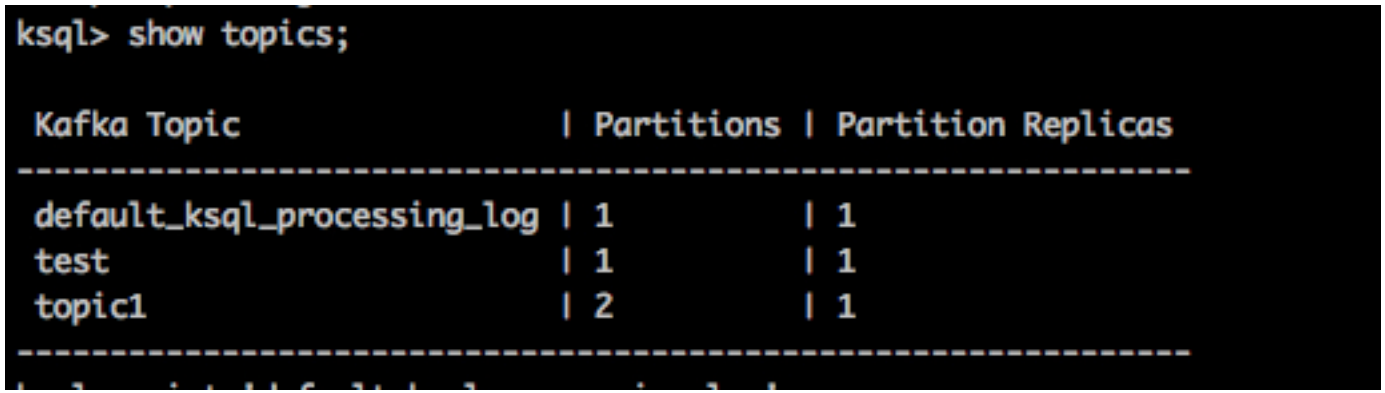
ksqlDB runs as a server which clients connect to in order to issue queries.

Run this command to connect to the ksqlDB server and enter an interactive command-line interface (CLI) session.

```
#/opt/ksqldb/bin/ksql http://0.0.0.0:8088
```



#show topics;



The topics listed above depends on the number of topic in your kafka system.

----------Lab Ends Here ----------

4. Workflow using KSQL - CLI – 90 Minutes(D)

Following features will be demonstrated.

- Create Topics and Produce Data
- Create and produce data to the Kafka topics pageviews and users.
- Inspect Kafka Topics by Using SHOW and PRINT Statements
- Create a Stream and Table
- Write Queries

This tutorial demonstrates a simple workflow using KSQL to write streaming queries against messages in Kafka.

To get started, you must start a Kafka cluster, including ZooKeeper and a Kafka broker.

Start Schema Registry

KSQL will then query messages from this Kafka cluster.

KSQL is installed in the Confluent Platform by default.

Confluent Kafka needs to be installed for data generation.

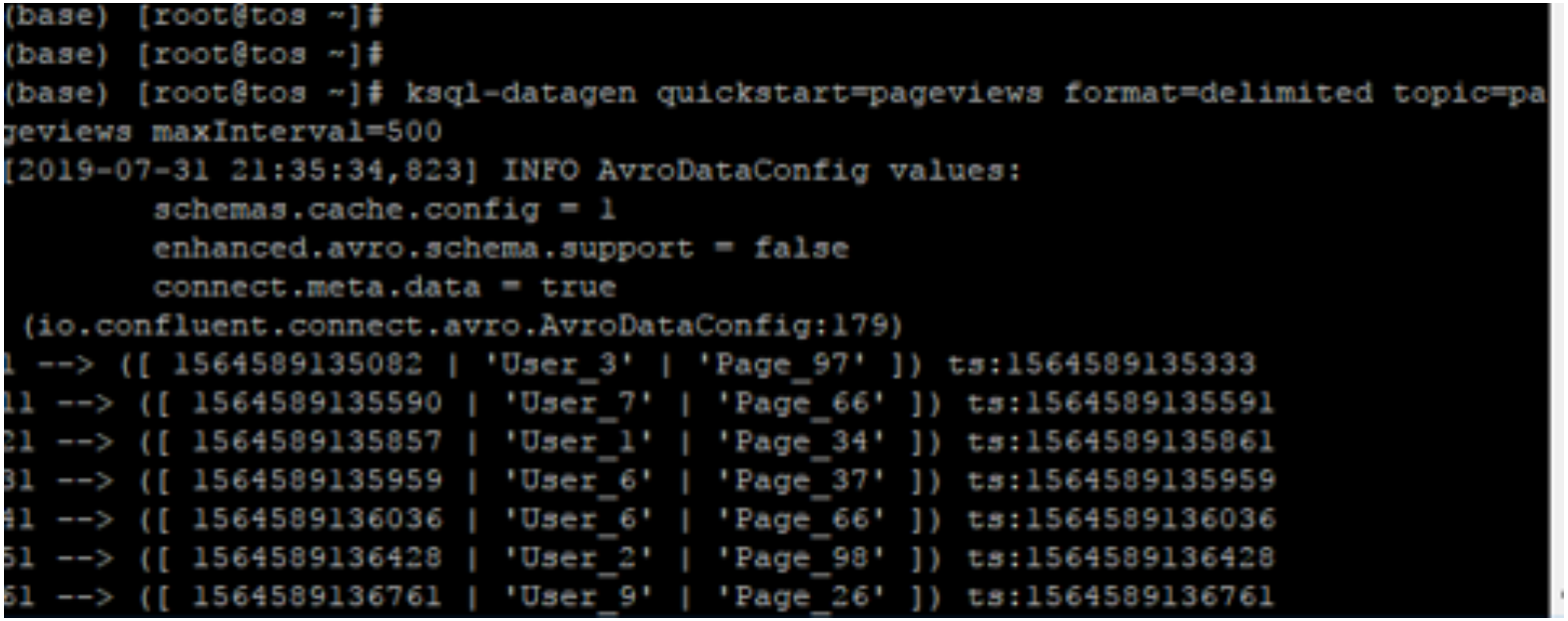
Create Topics and Produce Data

Create and produce data to the Kafka topics `pageviews` and `users`. These steps use the KSQL datagen that is included with Confluent Platform.

1. Create the `pageviews` topic and produce data using the data generator. The following example continuously generates data with a value in DELIMITED format.

Open a new terminal and execute the following commands:

```
kafka-topics --bootstrap-server kafka0:9092 --create --topic pageviews

ksql-datagen bootstrap-server=kafka0:9092 quickstart=pageviews format=json topic=pageviews
maxInterval=2500
```



Keep the terminal open.

2. Open a new terminal
3. Produce Kafka data to the users topic using the data generator. The following example continuously generates data with a value in JSON format.

```
kafka-topics --bootstrap-server kafka0:9092 --create --topic users
```

```
$ ksql-datagen bootstrap-server=kafka0:9092 quickstart=users format=json topic=users
maxInterval=2500
```

Keep open the terminal.

```
(base) [root@tos ~]#
(base) [root@tos ~]# ksql-datagen quickstart=pageviews format=delimited topic=pa
geviews maxInterval=500
[2019-07-31 21:35:34,823] INFO AvroDataConfig values:
        schemas.cache.config = 1
        enhanced.avro.schema.support = false
        connect.meta.data = true
 (io.confluent.connect.avro.AvroDataConfig:179)
1 --> ([ 1564589135082 | 'User_3' | 'Page_97' ]) ts:1564589135333
11 --> ([ 1564589135590 | 'User_7' | 'Page_66' ]) ts:1564589135591
21 --> ([ 1564589135857 | 'User_1' | 'Page_34' ]) ts:1564589135861
31 --> ([ 1564589135959 | 'User_6' | 'Page_37' ]) ts:1564589135959
41 --> ([ 1564589136036 | 'User_6' | 'Page_66' ]) ts:1564589136036
51 --> ([ 1564589136428 | 'User_2' | 'Page_98' ]) ts:1564589136428
61 --> ([ 1564589136761 | 'User_9' | 'Page_26' ]) ts:1564589136761
```

Launch the KSQL CLI

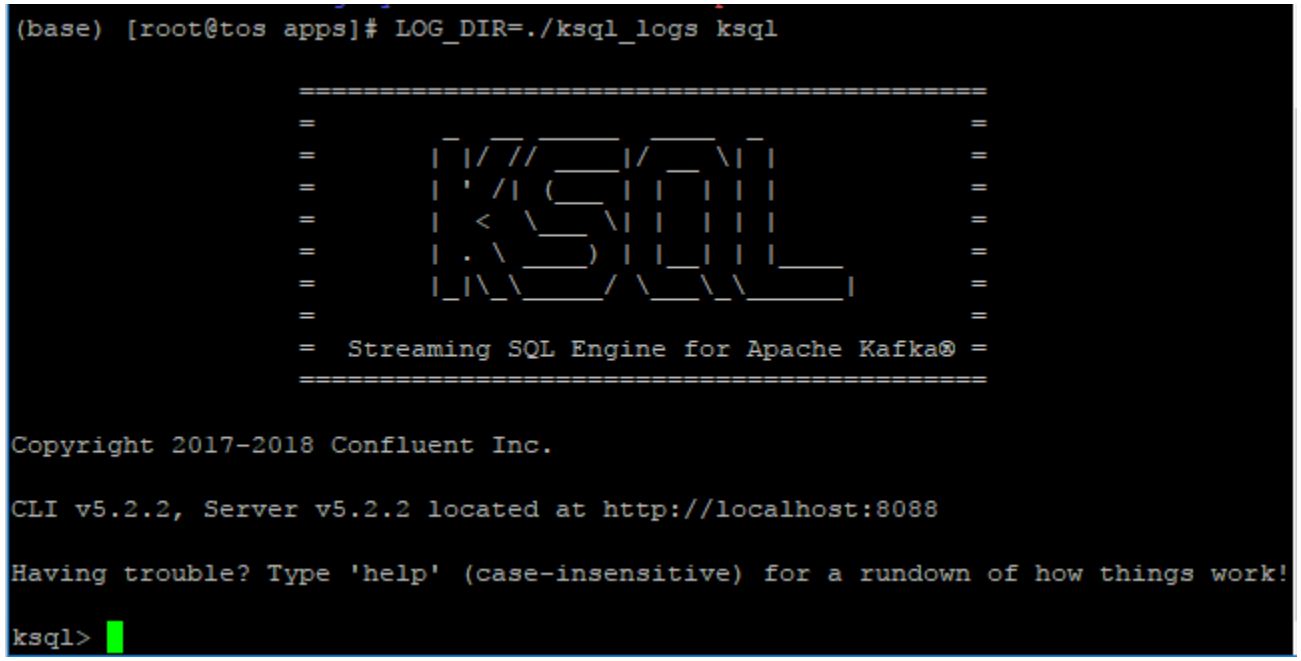
To launch the CLI, run the following command. It will route the CLI logs to the `./ksql_logs` directory, relative to your current directory. By default, the CLI will look for a KSQL Server running at `http://localhost:8088`.

```
$ LOG_DIR=./ksql_logs ksql
```

Important

By default KSQL attempts to store its logs in a directory called `logs` that is relative to the location of the `ksql` executable. For example, if `ksql` is installed at `/usr/local/bin/ksql`, then it would attempt to store its logs in `/usr/local/logs`. If you are running `ksql` from the default Confluent Platform location, `<path-to-confluent>/bin`, you must override this default behavior by using the `LOG_DIR` variable.

After KSQL is started, your terminal should resemble this.



Inspect Kafka Topics By Using SHOW and PRINT Statements

KSQL enables inspecting Kafka topics and messages in real time.

- Use the SHOW TOPICS statement to list the available topics in the Kafka cluster.
- Use the PRINT statement to see a topic's messages as they arrive.

In the KSQL CLI, run the following statement:

```
SHOW TOPICS;
```

Your output should resemble as shown below, it depends on the context. You should be able to see the earlier two topics, you have created earlier i.e pageviews and users:

```
 Kafka Topic        | Registered | Partitions | Partition Replicas | Consumers | ConsumerGrou
ps
-----------------------------------------------------------------------------------------------
 _confluent-metrics | false      | 12         | 1                  | 0         | 0
 _schemas           | false      | 1          | 1                  | 0         | 0
 pageviews          | false      | 1          | 1                  | 0         | 0
 users              | false      | 1          | 1                  | 0         | 0
-----------------------------------------------------------------------------------------------
```

Inspect the `users` topic by using the PRINT statement:

```
PRINT 'users';
```

Your output should resemble:

```
Format:JSON
```

```
{"ROWTIME":1540254230041,"ROWKEY":"User_1","registertime":1516754966866,"userid":"User_1","regionid":"Region_9","gender":"MALE"}
{"ROWTIME":1540254230081,"ROWKEY":"User_3","registertime":1491558386780,"userid":"User_3","regionid":"Region_2","gender":"MALE"}
{"ROWTIME":1540254230091,"ROWKEY":"User_7","registertime":1514374073235,"userid":"User_7","regionid":"Region_2","gender":"OTHER"}
^C{"ROWTIME":1540254232442,"ROWKEY":"User_4","registertime":1510034151376,"userid":"User_4","regionid":"Region_8","gender":"FEMALE"}
Topic printing ceased
```

Press CTRL+C to stop printing messages.

Inspect the `pageviews` topic by using the PRINT statement:

```
PRINT 'pageviews';
```

Your output should resemble:

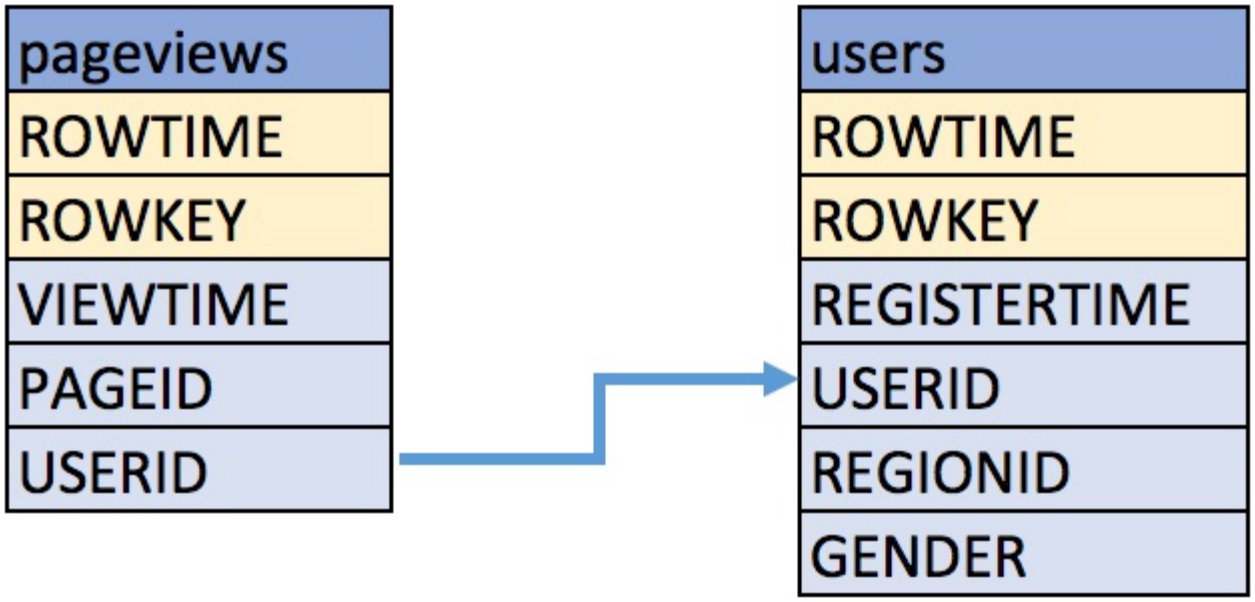
```
Format:STRING
10/23/18 12:24:03 AM UTC , 9461 , 1540254243183,User_9,Page_20
10/23/18 12:24:03 AM UTC , 9471 , 1540254243617,User_7,Page_47
10/23/18 12:24:03 AM UTC , 9481 , 1540254243888,User_4,Page_27
^C10/23/18 12:24:05 AM UTC , 9521 , 1540254245161,User_9,Page_62
Topic printing ceased
```

```
ksql>
```

Press CTRL+C to stop printing messages.

Create a Stream and Table

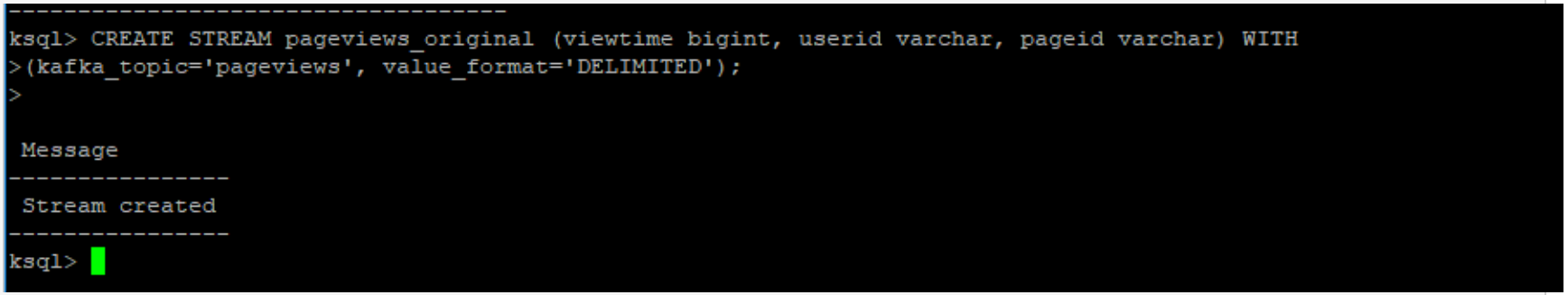
These examples query messages from Kafka topics called pageviews and users using the following schemas:



1. Create a stream, named `pageviews_original`, from the `pageviews` Kafka topic, specifying the `value_format` of `DELIMITED`.

```
CREATE STREAM pageviews_original (viewtime bigint, userid varchar, pageid varchar) WITH (kafka_topic='pageviews', value_format='JSON');
```

Your output should resemble:



Tip

You can run `DESCRIBE pageviews_original;` to see the schema for the stream. Notice that KSQL created two additional columns, named `ROWTIME`, which corresponds with the Kafka message timestamp, and `ROWKEY`, which corresponds with the Kafka message key. – Removed in the latest version.

```
DESCRIBE  pageviews_original;
```

```
ksql> DESCRIBE pageviews_original;

Name                 : PAGEVIEWS_ORIGINAL
 Field    | Type
-------------------------------------
 ROWTIME  | BIGINT           (system)
 ROWKEY   | VARCHAR(STRING)  (system)
 VIEWTIME | BIGINT
 USERID   | VARCHAR(STRING)
 PAGEID   | VARCHAR(STRING)
-------------------------------------
For runtime statistics and query details run: DESCRIBE EXTENDED <Stream,Table>;
ksql>
```

2. Create a table, named `users_original`, from the `users` Kafka topic, specifying the `value_format` of `JSON`.

```
CREATE TABLE users_original (registertime BIGINT, gender VARCHAR, regionid VARCHAR, userid VARCHAR PRIMARY KEY) WITH
(kafka_topic='users', value_format='JSON');
```

Your output should resemble:

```
 Message
---------------
 Table created
---------------
```

Tip

You can run `DESCRIBE users_original;` to see the schema for the Table.

3. Optional: Show all streams and tables.

```
ksql> SHOW STREAMS;
```

```
 Stream Name              | Kafka Topic              | Format
-----------------------------------------------------------------
 PAGEVIEWS_ORIGINAL       | pageviews                | DELIMITED

ksql> SHOW TABLES;

 Table Name       | Kafka Topic       | Format    | Windowed
-------------------------------------------------------------
 USERS_ORIGINAL   | users             | JSON      | false
```

Write Queries

```
SET 'auto.offset.reset'='earliest';
```

These examples write queries using KSQL.

Note: By default KSQL reads the topics for streams and tables from the latest offset.

1. Use `SELECT` to create a query that returns data from a STREAM. This query includes the `LIMIT` keyword to limit the number of rows returned in the query result. Note that exact data output may vary because of the randomness of the data generation.

```
SELECT pageid FROM pageviews_original EMIT changes LIMIT 3;
```

Your output should resemble:

```
Page_24
Page_73
Page_78
LIMIT reached
Query terminated
```

2. Create a persistent query by using the `CREATE STREAM` keywords to precede the `SELECT` statement. The results from this query are written to the `PAGEVIEWS_ENRICHED` Kafka topic. The following query enriches the `pageviews_original` STREAM by doing a `LEFT JOIN` with the `users_original` TABLE on the user ID.

```
CREATE STREAM pageviews_enriched AS
SELECT users_original.userid AS userid, pageid, regionid, gender
FROM pageviews_original
JOIN users_original
  ON pageviews_original.userid = users_original.userid
Emit changes;
```

Your output should resemble:

```
 Message
----------------------------
 Stream created and running
----------------------------
```

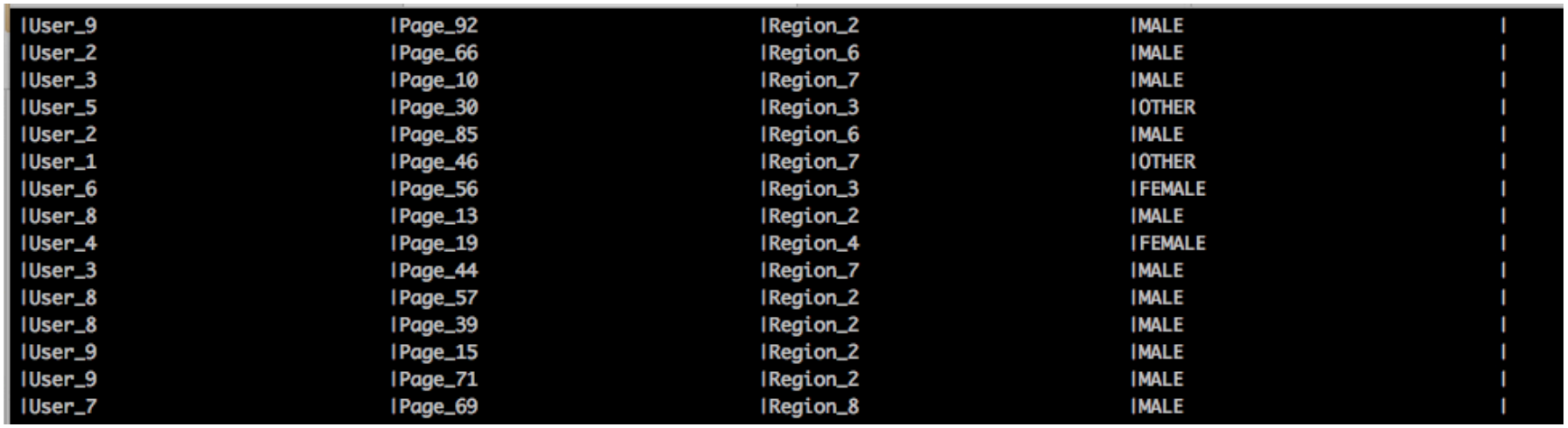
Tip

You can run `DESCRIBE pageviews_enriched;` to describe the stream.

3. Use `SELECT` to view query results as they come in. To stop viewing the query results, press `<ctrl-c>`. This stops printing to the console but it does not terminate the actual query. The query continues to run in the underlying KSQL application.

```
SELECT * FROM pageviews_enriched Emit Changes;
```

Your output should resemble:



```
|User_9 |Page_92 |Region_2 |MALE   |
|User_2 |Page_66 |Region_6 |MALE   |
|User_3 |Page_10 |Region_7 |MALE   |
|User_5 |Page_30 |Region_3 |OTHER  |
|User_2 |Page_85 |Region_6 |MALE   |
|User_1 |Page_46 |Region_7 |OTHER  |
|User_6 |Page_56 |Region_3 |FEMALE |
|User_8 |Page_13 |Region_2 |MALE   |
|User_4 |Page_19 |Region_4 |FEMALE |
|User_3 |Page_44 |Region_7 |MALE   |
|User_8 |Page_57 |Region_2 |MALE   |
|User_8 |Page_39 |Region_2 |MALE   |
|User_9 |Page_15 |Region_2 |MALE   |
|User_9 |Page_71 |Region_2 |MALE   |
|User_7 |Page_69 |Region_8 |MALE   |
```

4. Create a new persistent query where a condition limits the streams content, using `WHERE`. Results from this query are written to a Kafka topic called `PAGEVIEWS_FEMALE`.

```
CREATE STREAM pageviews_female AS
SELECT * FROM pageviews_enriched
WHERE gender = 'FEMALE';
```

Your output should resemble:

```
 Message
----------------------------
 Stream created and running
----------------------------
```

Tip

You can run `DESCRIBE pageviews_female;` to describe the stream.

5. Create a new persistent query where another condition is met, using `LIKE`. Results from this query are written to the `pageviews_enriched_r8_r9` Kafka topic.

```
CREATE STREAM pageviews_female_like_89
  WITH (kafka_topic='pageviews_enriched_r8_r9') AS
SELECT * FROM pageviews_female
WHERE regionid LIKE '%_8' OR regionid LIKE '%_9';
```

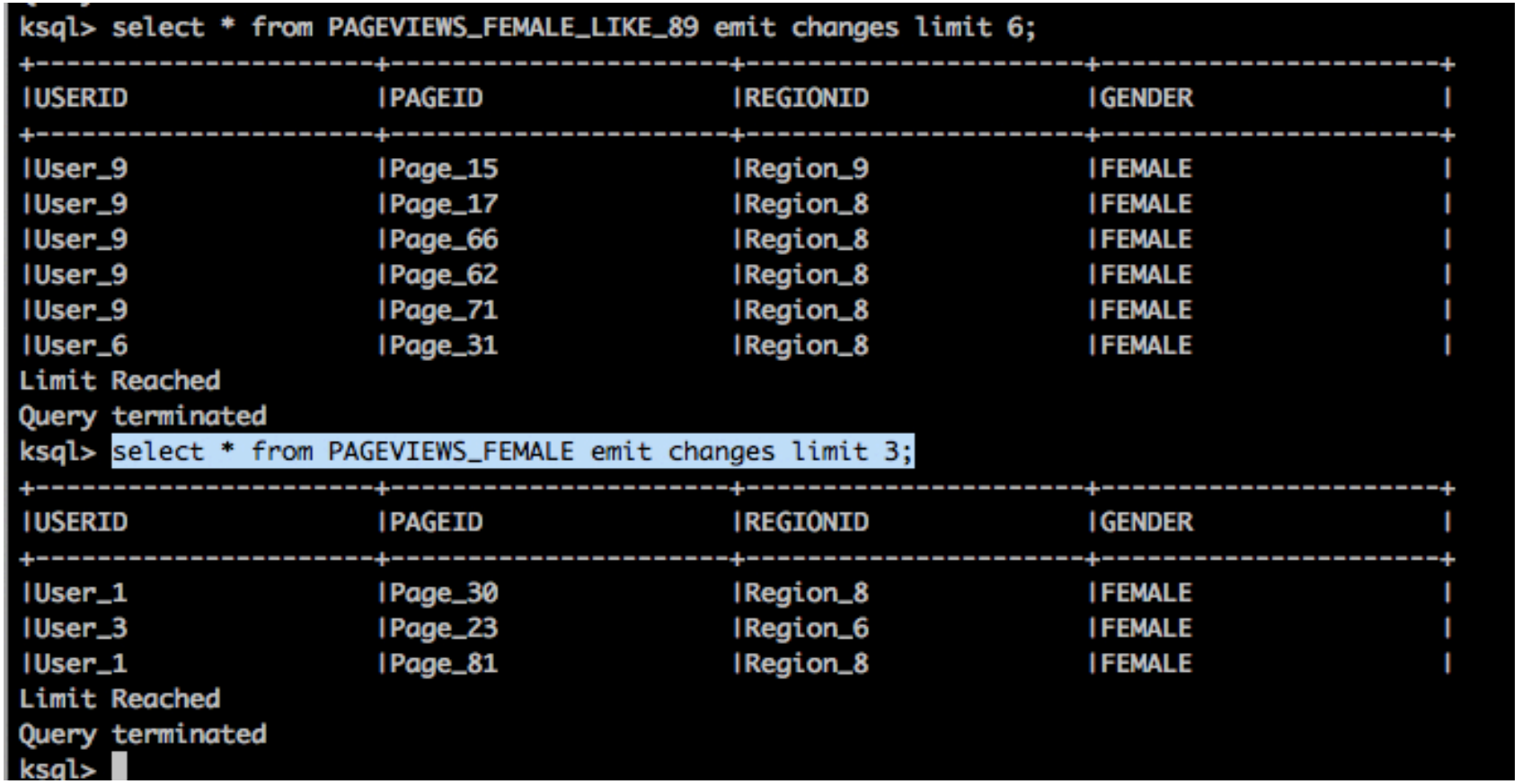
Your output should resemble:

```
 Message
----------------------------
 Stream created and running
```

```
--------------------------
```

6. Verify the above 2 streams:

select * from PAGEVIEWS_FEMALE_LIKE_89 emit changes limit 6;
select * from PAGEVIEWS_FEMALE emit changes limit 3;



7. Create a new persistent query that counts the pageviews for each region combination in a tumbling window of 30 seconds when the count is greater than one. Results from this query are written to the `PAGEVIEWS_REGIONS` Kafka topic in the Avro format. KSQL will register the Avro schema with the configured Schema Registry when it writes the first message to the `PAGEVIEWS_REGIONS` topic.

```
CREATE TABLE pageviews_regions
  WITH (
KAFKA_TOPIC = 'pageviews_regions',VALUE_FORMAT='AVRO'
) AS
SELECT   regionid , COUNT(*) AS numusers
FROM pageviews_enriched
  WINDOW TUMBLING (size 30 second)
GROUP BY  regionid
HAVING COUNT(*) > 1 emit changes;
```

Your output should resemble:

```
 Message
----------------------------
 Table created and running
----------------------------
```

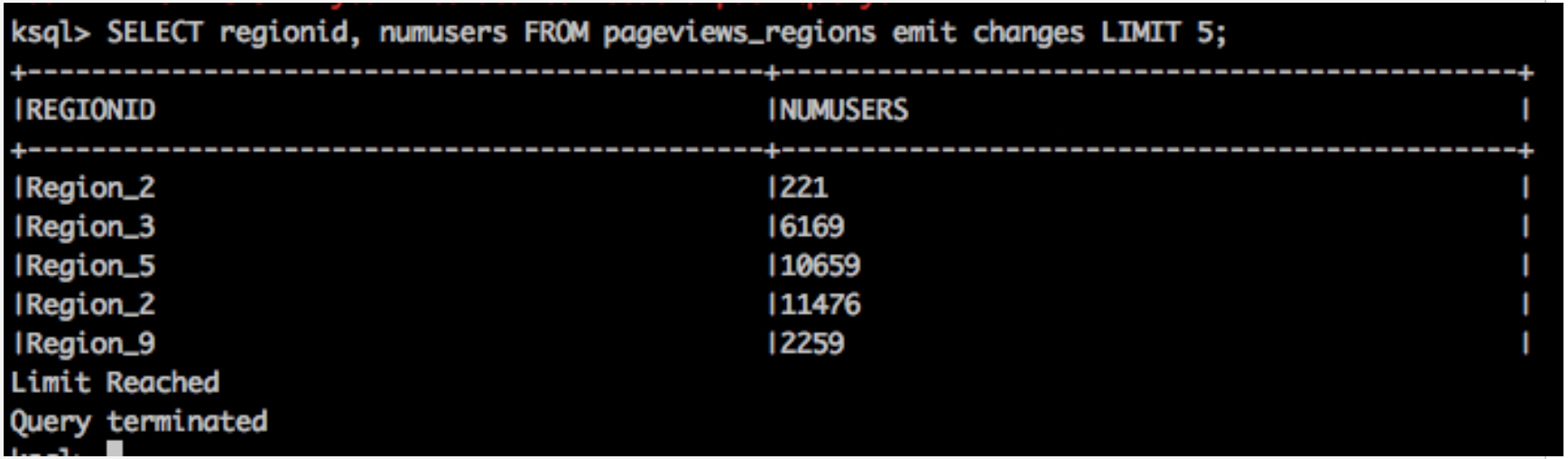
Tip

You can run `DESCRIBE pageviews_regions;` to describe the table.

8. Optional: View results from the above queries using `SELECT`.

```
SELECT regionid, numusers FROM pageviews_regions emit changes LIMIT 5;
```

Your output should resemble:



9. Optional: Show all persistent queries.

```
SHOW QUERIES;
```

Your output should resemble:

```
Query ID                | Kafka Topic          | Query String
```

```
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-----
CSAS_PAGEVIEWS_FEMALE_1       | PAGEVIEWS_FEMALE       | CREATE STREA
M pageviews_female AS      SELECT * FROM pageviews_enriched      WHERE gender =
'FEMALE';
CTAS_PAGEVIEWS_REGIONS_3      | PAGEVIEWS_REGIONS      | CREATE TABLE
pageviews_regions       WITH (VALUE_FORMAT='avro') AS      SELECT gender, region
id , COUNT(*) AS numusers      FROM pageviews_enriched       WINDOW TUMBLING
(size 30 second)      GROUP BY gender, regionid      HAVING COUNT(*) > 1;
CSAS_PAGEVIEWS_FEMALE_LIKE_89_2 | PAGEVIEWS_FEMALE_LIKE_89 | CRE
ATE STREAM pageviews_female_like_89       WITH (kafka_topic='pageviews_enriche
d_r8_r9') AS      SELECT * FROM pageviews_female      WHERE regionid LIKE '%_8' O
R regionid LIKE '%_9';
CSAS_PAGEVIEWS_ENRICHED_0      | PAGEVIEWS_ENRICHED      | CREATE STR
EAM pageviews_enriched AS      SELECT users_original.userid AS userid, pageid, regio
nid, gender      FROM pageviews_original      LEFT JOIN users_original       ON pagevie
ws_original.userid = users_original.userid;
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-----
For detailed information on a Query run: EXPLAIN <Query ID>;
```

10. Optional: Examine query run-time metrics and details. Observe that information including the target Kafka topic is available, as well as throughput figures for the messages being processed.

```
DESCRIBE PAGEVIEWS_REGIONS EXTENDED;
```

Your output should resemble:

```
Name                 : PAGEVIEWS_REGIONS
Type                 : TABLE
Key field            : KSQL_INTERNAL_COL_0|+|KSQL_INTERNAL_COL_1
Key format           : STRING
Timestamp field      : Not set - using <ROWTIME>
Value format         : AVRO
Kafka topic          : PAGEVIEWS_REGIONS (partitions: 4, replication: 1)

Field    | Type
-----------------------------------
ROWTIME  | BIGINT          (system)
ROWKEY   | VARCHAR(STRING)  (system)
GENDER   | VARCHAR(STRING)
REGIONID | VARCHAR(STRING)
NUMUSERS | BIGINT
-----------------------------------

Queries that write into this TABLE
```

```
---------------------------------
CTAS_PAGEVIEWS_REGIONS_3 : CREATE TABLE pageviews_regions       WITH (val
ue_format='avro') AS      SELECT gender, regionid , COUNT(*) AS numusers      FROM
pageviews_enriched       WINDOW TUMBLING (size 30 second)      GROUP BY gender,
regionid      HAVING COUNT(*) > 1;

For query topology and execution plan please run: EXPLAIN <QueryId>

Local runtime statistics
------------------------
messages-per-sec:      3.06   total-messages:      1827     last-message: 7/19/18 4:17:55 PM
UTC
failed-messages:       0 failed-messages-per-sec:       0      last-failed:       n/a
(Statistics of the local KSQL server interaction with the Kafka topic PAGEVIEWS_REGI
ONS)
ksql>
```

You can close the data generation windows/terminals.

---------- Lab Ends Here ----------

https://ksqldb.io/quickstart.html?_ga=2.53841192.1438767497.1642131382-2002989446.1641377120&_gac=1.255954681.1642171371.CjwKCAiA24SPBhB0EiwAjBgkhg1qFCOJ-Ohq2cWlGrT9c3232dWfPKKpOG6zXpZrNXjqUelgasqp5BoCTE0QAvD_BwE

Any issues related to minimum config clean the zookeeper/kafka-logs and restart the services.

5. KStream and KTable using KSQL - CC

You need to complete the lab – "Workflow using KSQL - CLI" before proceeding ahead.

In this step, KSQL queries are run on the pageviews and users topics that were created in the earlier step. The KSQL commands are run using the KSQL tab in Control Center.

Create Streams and Tables

In this step, KSQL is used to create a stream for the `pageviews` topic, and a table for the `users` topic.

1. From your cluster, click Development → **KSQL** .

From the **KSQL EDITOR** page, click the **Streams** tab and **Add Stream**.

Select the `pageviews` topic.

Choose your stream options:

- In the **Encoding** field, select `AVRO`.
- In the **Field(s) you'd like to include in your STREAM** field, ensure fields are set as follows:
  - `viewtime` with type `BIGINT`
  - `userid` with type `VARCHAR`

- `pageid` with type `VARCHAR`
- Click **Save STREAM**.
-

Click the **Tables** tab -> **Add a Table** and select the `users` topic.
Choose your table options:

- In the **Encoding** field, select `AVRO`.
- In the **Key** field, select `userid`.
- In the **Field(s) you'd like to include in your TABLE** field, ensure fields are set as follows:
  - `registertime` with type `BIGINT`
  - `userid` with type `VARCHAR`
  - `regionid` with type `VARCHAR`
  - `gender` with type `VARCHAR`
- Click **Save TABLE**.

Write Queries

These examples write queries using the **KSQL** tab in Control Center.

1. From your cluster, click **KSQL** and choose the **KSQL EDITOR** page.
2. Click **query properties** to add a custom query property. Set the `auto.offset.reset` parameter to `earliest`.

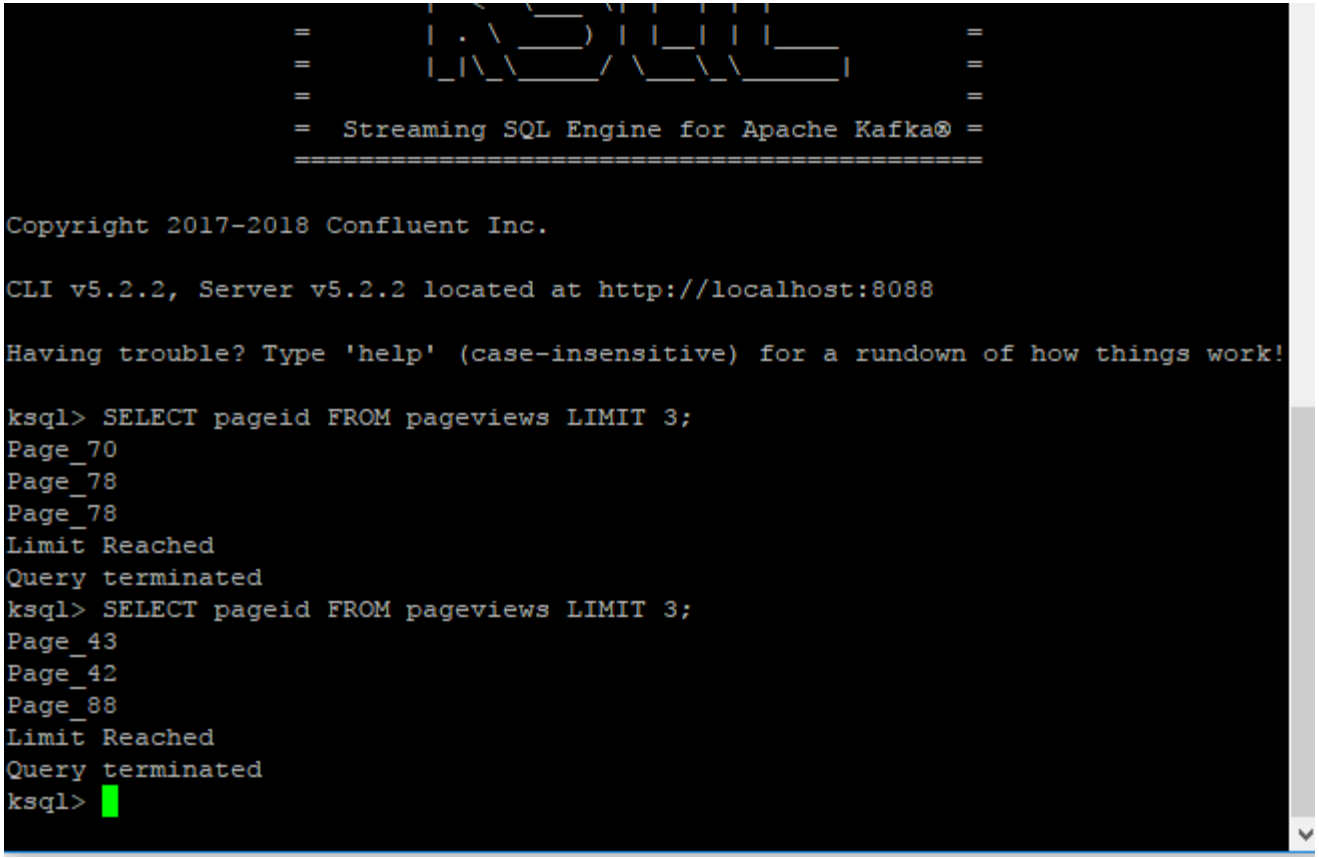
This instructs KSQL queries to read all available topic data from the beginning. This configuration is used for each subsequent query. For more information, see the KSQL Configuration Parameter Reference.

Run the following queries.

1. Create a non-persistent query that returns data from a stream with the results limited to a maximum of three rows.

```
SELECT pageid FROM pageviews LIMIT 3;
```

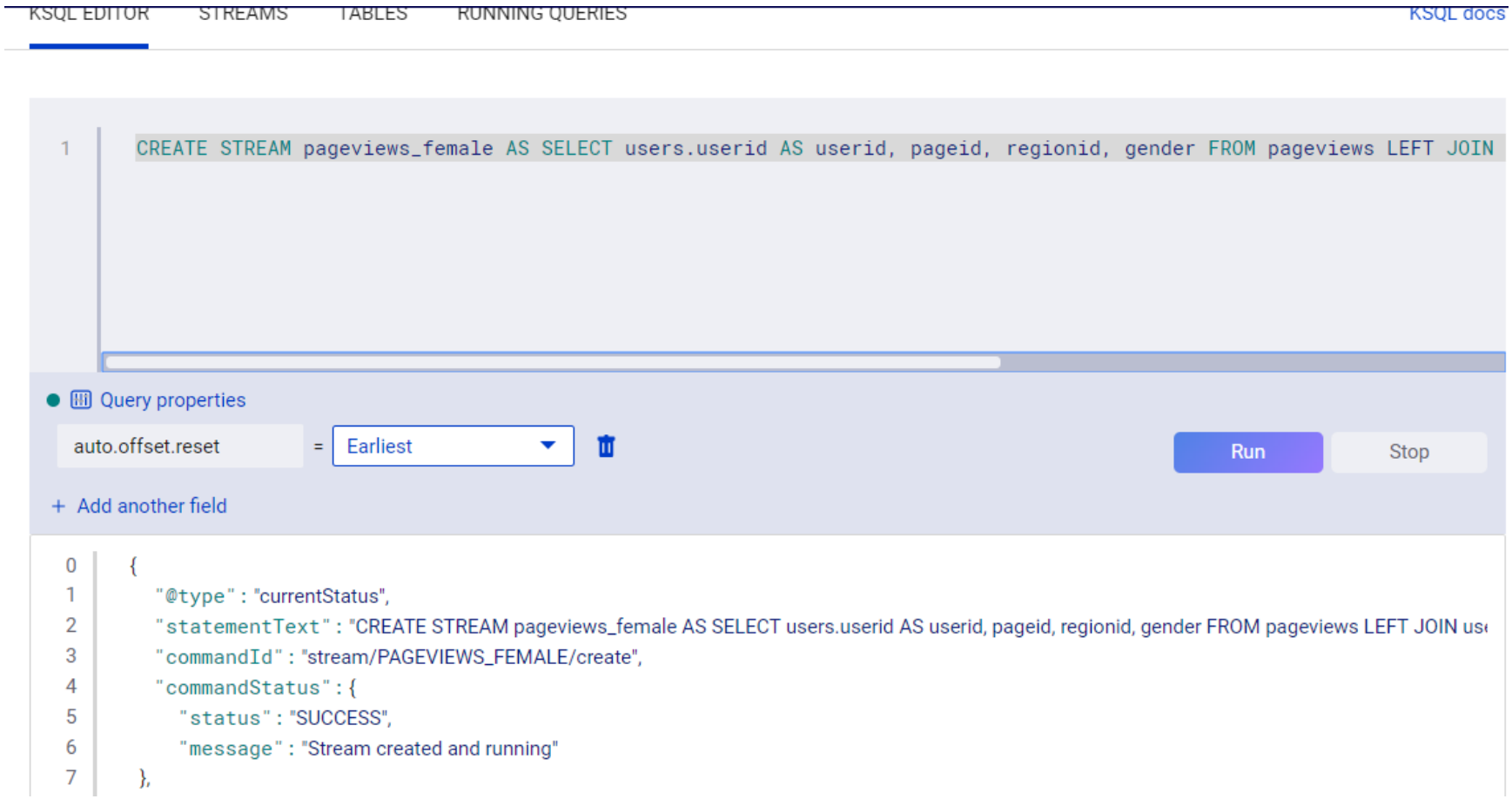
Your output should resemble:



Create a persistent query that filters for female users. The results from this query are written to the Kafka `PAGEVIEWS_FEMALE` topic. This query enriches the `pageviews` STREAM by doing a `LEFT JOIN` with the `users` TABLE on the user ID, where a condition (`gender = 'FEMALE'`) is met.

```
CREATE STREAM pageviews_female AS SELECT users.userid AS userid, pageid, regionid, gender FROM pageviews LEFT JOIN users ON pageviews.userid = users.userid WHERE ge
nder = 'FEMALE';
```

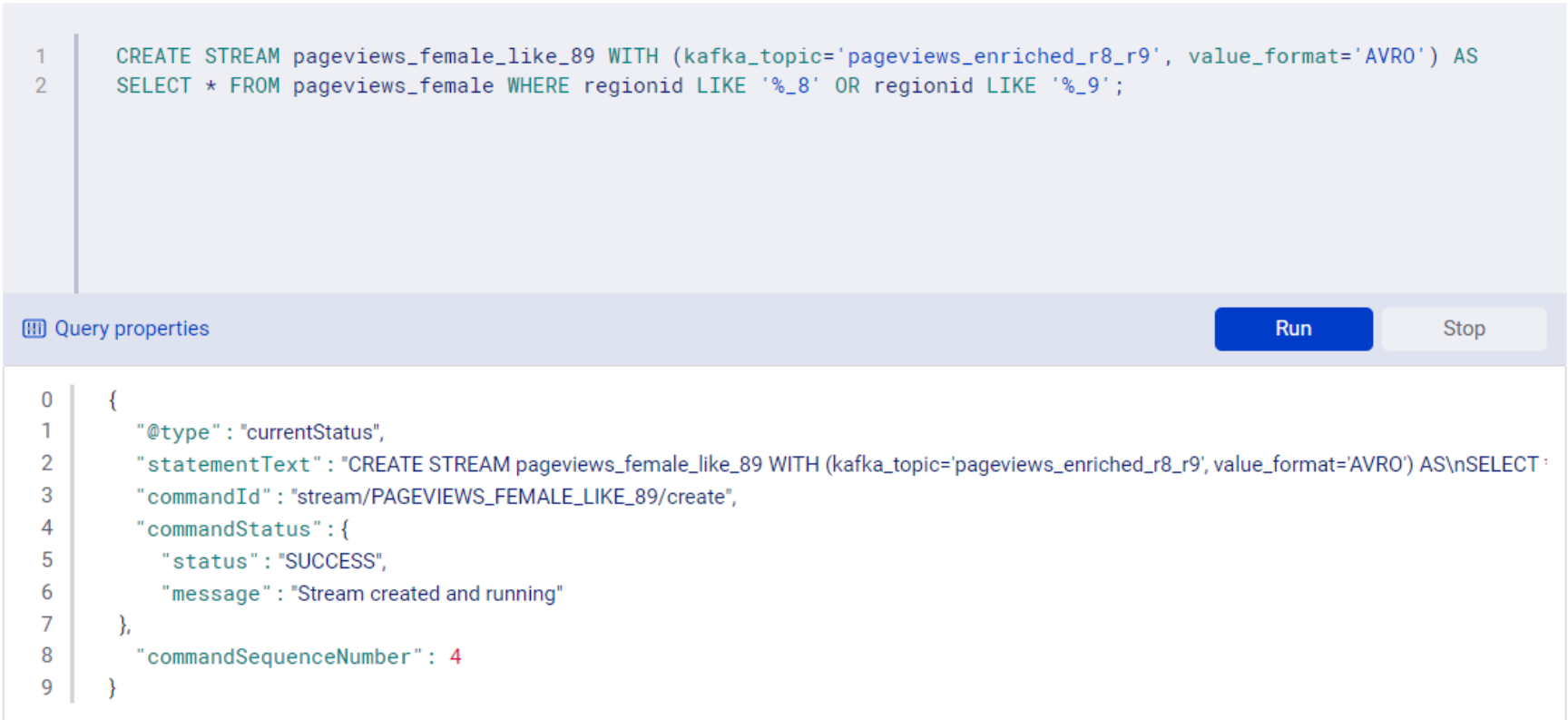
Your output should resemble:



Create a persistent query where a condition (`regionid`) is met, using `LIKE`. Results from this query are written to a Kafka topic named `pageviews_enriched_r8_r9`.

```
CREATE STREAM pageviews_female_like_89 WITH (kafka_topic='pageviews_enriched_r8_r9', value_format='AVRO') AS SELECT * FROM pageviews_female WHERE regionid LIKE '%_8' OR regionid LIKE '%_9';
```

Your output should resemble:



Create a persistent query that counts the pageviews for each region and gender combination in a tumbling window of 30 seconds when the count is greater than 1. Because the procedure is grouping and counting, the result is now a table, rather than a stream. Results from this query are written to a Kafka topic called `PAGEVIEWS_REGIONS`.

```
CREATE TABLE pageviews_regions AS SELECT gender, regionid , COUNT(*) AS numuser
s FROM pageviews_female WINDOW TUMBLING (size 30 second) GROUP BY gender, reg
ionid HAVING COUNT(*) > 1;
```

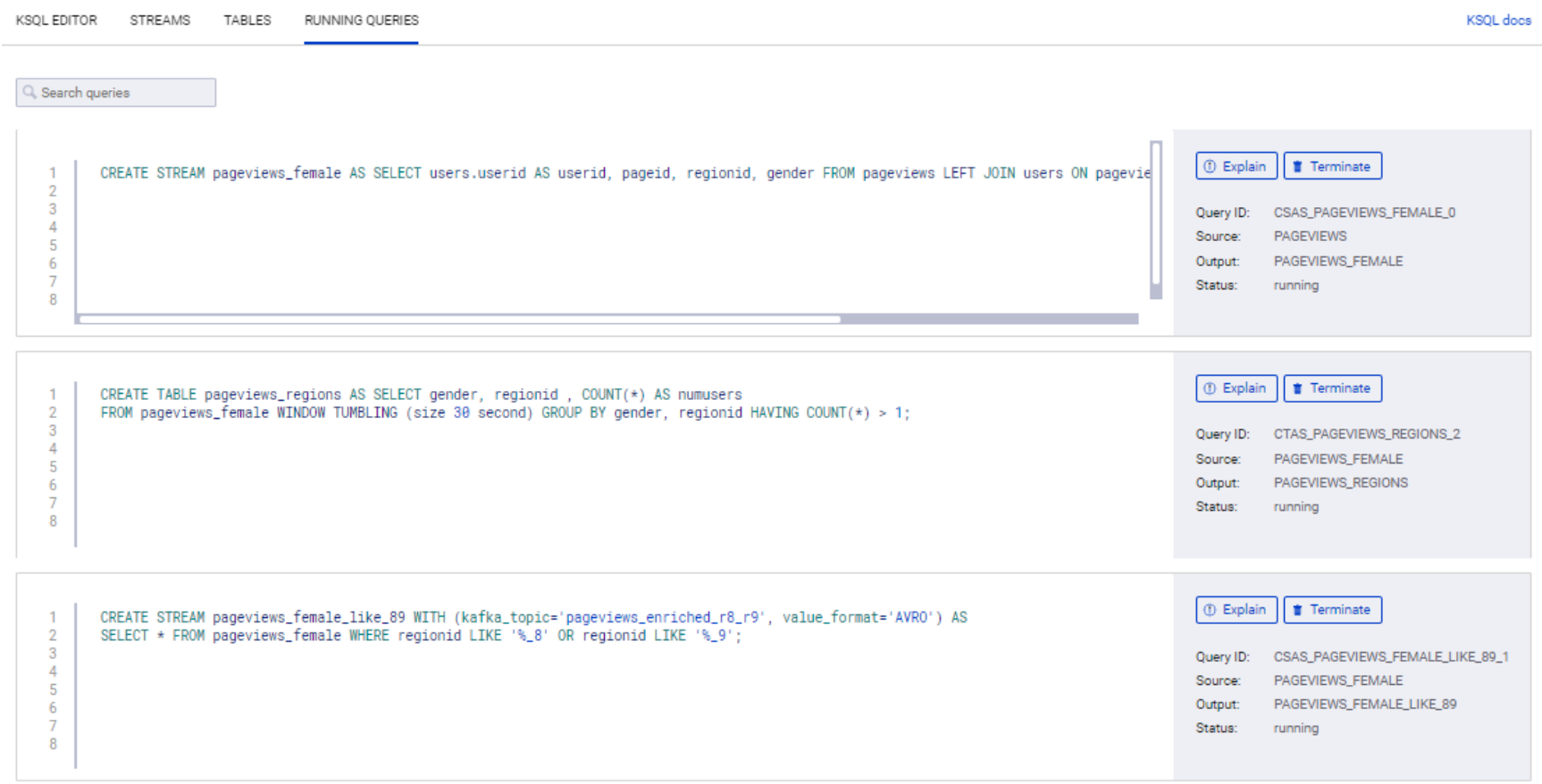
Your output should resemble:

```
CREATE TABLE pageviews_regions AS SELECT gender, regionid , COUNT(*) AS numusers
FROM pageviews_female WINDOW TUMBLING (size 30 second) GROUP BY gender, regionid HAVING COUNT(*) > 1;
```

Query properties | Run | Stop


```
{
  "@type" : "currentStatus",
  "statementText" : "CREATE TABLE pageviews_regions AS SELECT gender, regionid , COUNT(*) AS numusers \nFROM pageviews_female WINDOW TI
  "commandId" : "table/PAGEVIEWS_REGIONS/create",
  "commandStatus" : {
    "status" : "SUCCESS",
    "message" : "Table created and running"
  },
  "commandSequenceNumber" : 5
}
```

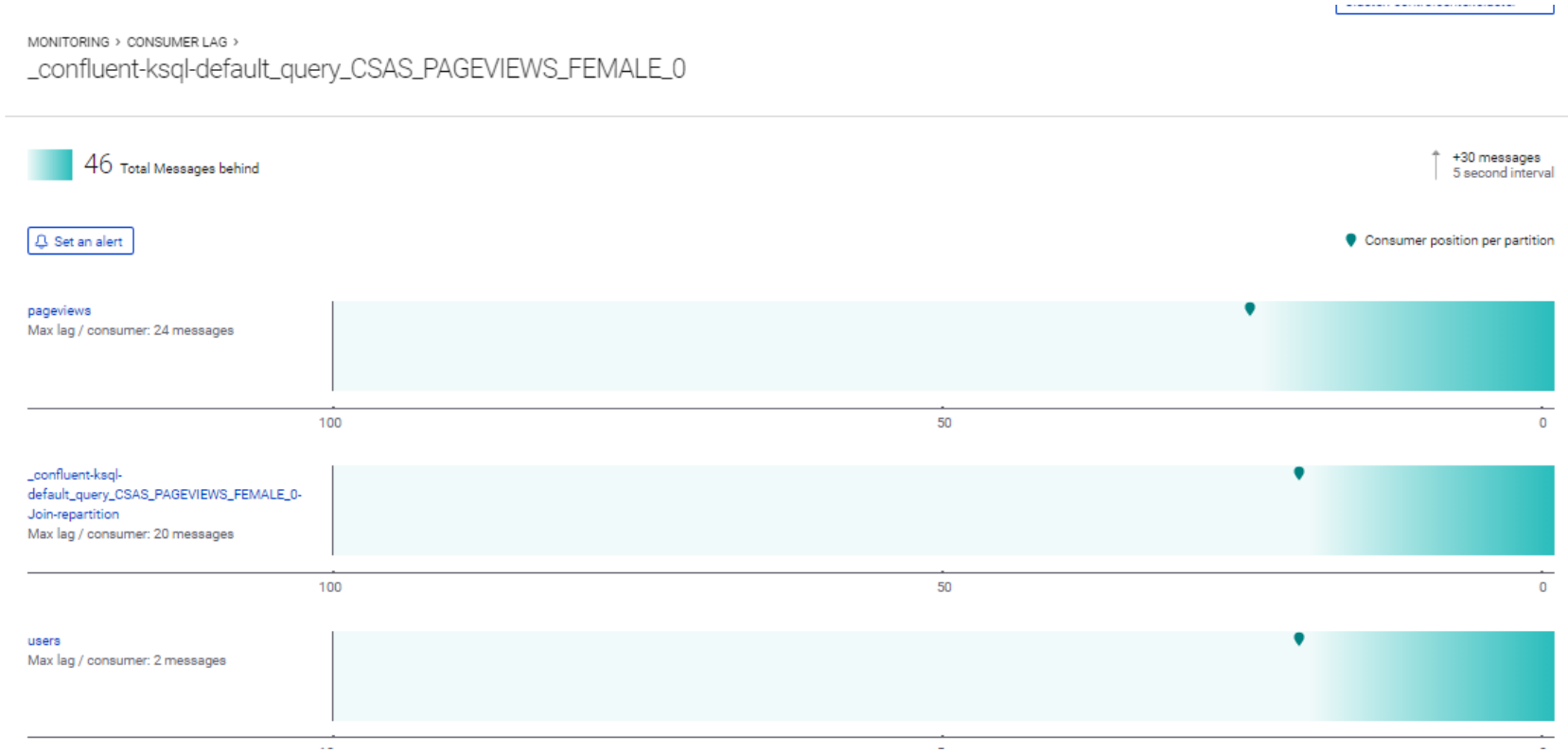

Click **RUNNING QUERIES**. You should see the following persisted queries:



View Your Stream in Control Center

Monitoring → Consumer lag → Consumer Group →

Click the consumer group ID to view details for the `_confluent-ksql-default_query_CSAS_PAGEVIEWS_FEMALE_0` consumer group.



From this page you can see the consumer lag and consumption values for your streaming query.

When you are done working with the local install, you can stop Confluent Platform.

1. Stop Confluent Platform using the Confluent CLI confluent local stop command.

2. <path-to-confluent>/bin/confluent stop

3. Destroy the data in the Confluent Platform instance with the confluent local destroy command.

```
<path-to-confluent>/bin/confluent local destroy
```

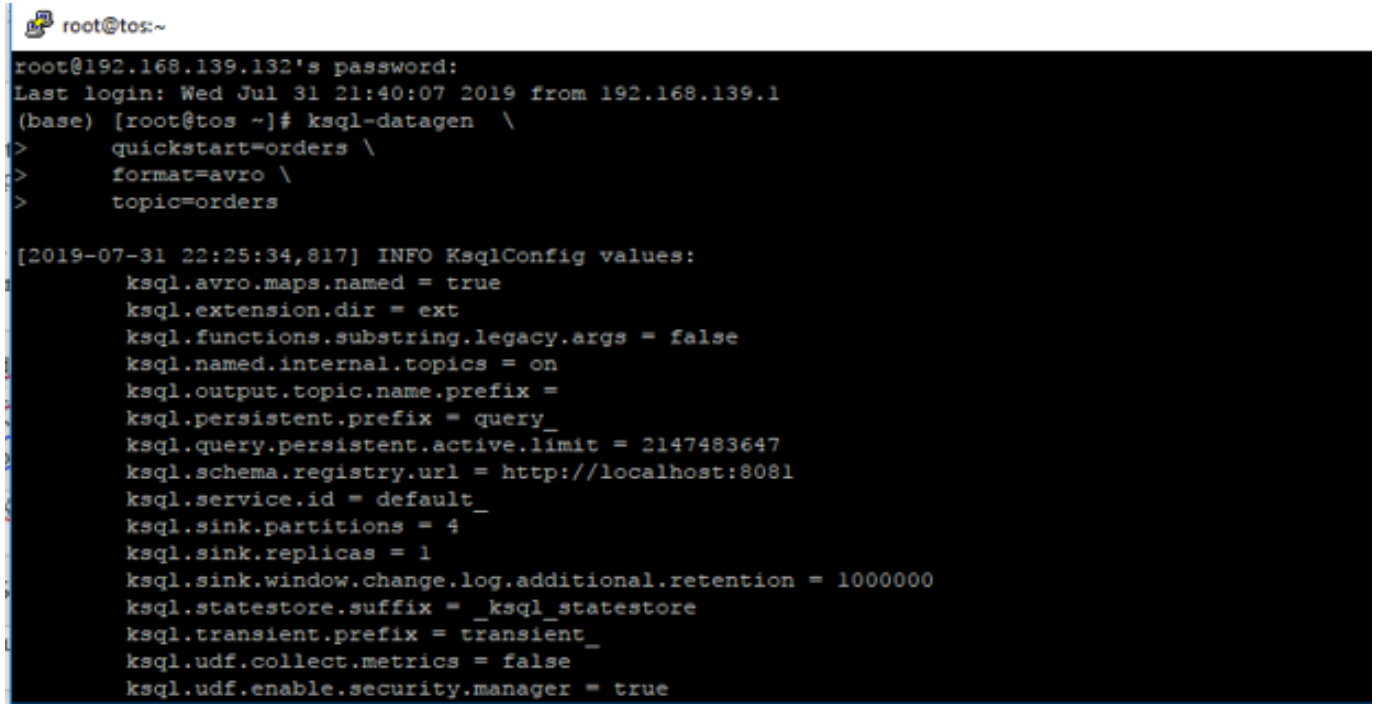
----------Lab Ends Here ----------

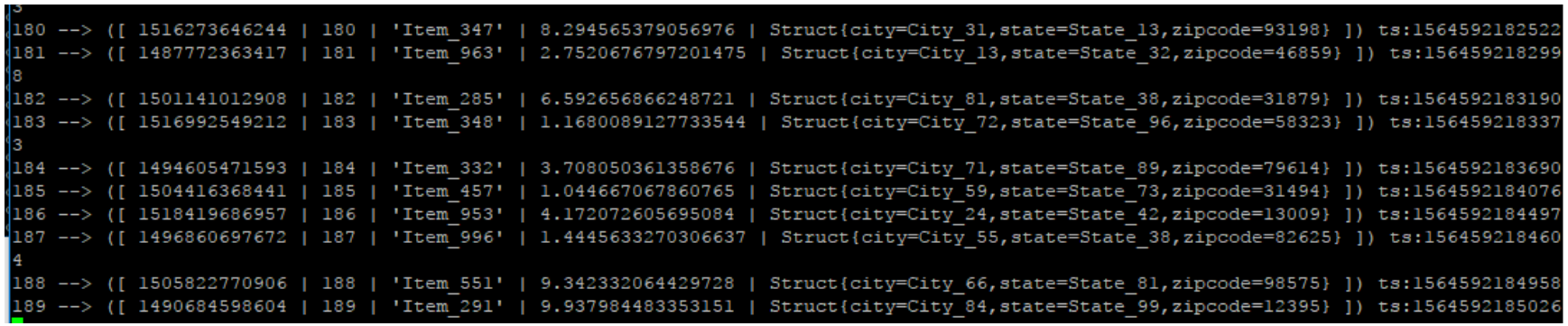
6. Message Data Format Using Nested Schemas (STRUCT) in KSQL

Struct support enables the modeling and access of nested data in Kafka topics, from both JSON and Avro.

Here we'll use the ksql-datagen tool to create some sample data which includes a nested address field. Run this in a new window, and leave it running.

```
$ ksql-datagen  \
    quickstart=orders \
    format=avro \
    topic=orders
```


root@tos:~
root@192.168.139.132's password:
Last login: Wed Jul 31 21:40:07 2019 from 192.168.139.1
(base) [root@tos ~]# ksql-datagen \
> quickstart=orders \
> format=avro \
> topic=orders
[2019-07-31 22:25:34,817] INFO KsqlConfig values:
ksql.avro.maps.named = true
ksql.extension.dir = ext
ksql.functions.substring.legacy.args = false
ksql.named.internal.topics = on
ksql.output.topic.name.prefix =
ksql.persistent.prefix = query_
ksql.query.persistent.active.limit = 2147483647
ksql.schema.registry.url = http://localhost:8081
ksql.service.id = default_
ksql.sink.partitions = 4
ksql.sink.replicas = 1
ksql.sink.window.change.log.additional.retention = 1000000
ksql.statestore.suffix = _ksql_statestore
ksql.transient.prefix = transient_
ksql.udf.collect.metrics = false
ksql.udf.enable.security.manager = true


180 --> ([1516273646244 | 180 | 'Item_347' | 8.294565379056976 | Struct{city=City_31,state=State_13,zipcode=93198}]) ts:1564592182522
181 --> ([1487772363417 | 181 | 'Item_963' | 2.7520676797201475 | Struct{city=City_13,state=State_32,zipcode=46859}]) ts:156459218299
182 --> ([1501141012908 | 182 | 'Item_285' | 6.592656866248721 | Struct{city=City_81,state=State_38,zipcode=31879}]) ts:1564592183190
183 --> ([1516992549212 | 183 | 'Item_348' | 1.1680089127733544 | Struct{city=City_72,state=State_96,zipcode=58323}]) ts:156459218337
184 --> ([1494605471593 | 184 | 'Item_332' | 3.708050361358676 | Struct{city=City_71,state=State_89,zipcode=79614}]) ts:1564592183690
185 --> ([1504416368441 | 185 | 'Item_457' | 1.044667067860765 | Struct{city=City_59,state=State_73,zipcode=31494}]) ts:1564592184076
186 --> ([1518419686957 | 186 | 'Item_953' | 4.172072605695084 | Struct{city=City_24,state=State_42,zipcode=13009}]) ts:1564592184497
187 --> ([1496860697672 | 187 | 'Item_996' | 1.4445633270306637 | Struct{city=City_55,state=State_38,zipcode=82625}]) ts:156459218460
188 --> ([1505822770906 | 188 | 'Item_551' | 9.342332064429728 | Struct{city=City_66,state=State_81,zipcode=98575}]) ts:1564592184958
189 --> ([1490684598604 | 189 | 'Item_291' | 9.937984483353151 | Struct{city=City_84,state=State_99,zipcode=12395}]) ts:1564592185026

From the KSQL command prompt, register the topic in KSQL:

```
CREATE STREAM ORDERS WITH (KAFKA_TOPIC='orders', VALUE_FORMAT='AVRO');
```

Your output should resemble:

```
 Message
----------------
 Stream created
----------------
```

Use the `DESCRIBE` function to observe the schema, which includes a `STRUCT`:

```
DESCRIBE ORDERS;
```

Your output should resemble:

```
---------------------------------------------------------------
ksql> CREATE STREAM ORDERS WITH (KAFKA_TOPIC='orders', VALUE_FORMAT='AVRO');

 Message
---------------
 Stream created
---------------
ksql> DESCRIBE ORDERS;

Name                 : ORDERS
 Field      | Type
-----------------------------------------------------------------------------------------
 ORDERTIME  | BIGINT
 ORDERID    | INTEGER
 ITEMID     | VARCHAR(STRING)
 ORDERUNITS | DOUBLE
 ADDRESS    | STRUCT<CITY VARCHAR(STRING), STATE VARCHAR(STRING), ZIPCODE BIGINT>
-----------------------------------------------------------------------------------------
For runtime statistics and query details run: DESCRIBE <Stream,Table> EXTENDED;
ksql>
```

Query the data, using `->` notation to access the Struct contents:

```
SELECT ORDERID, ADDRESS->CITY FROM ORDERS;
```

Your output should resemble:

```
0 | City_35
1 | City_21
```

```
2 | City_47
3 | City_57
4 | City_17
```

Press Ctrl+C to cancel the `SELECT` query.

---------- Lab Ends Here ----------

7. KSQL join – S-S/T-T – 60 Min(D)

Using a stream-stream join, it is possible to join two *streams* of events on a common key. An example of this could be a stream of order events, and a stream of shipment events. By joining these on the order key, it is possible to see shipment information alongside the order.

In a separate console window, populate the `new_orders` and `shipments` topics by using the kafkacat utility:

Open a terminal and paste the following commands. Excute as a single command.

```
 kafka-console-producer \
     --broker-list kafka0:9092 \
     --topic new_orders \
     --property "parse.key=true" \
     --property "key.separator=:"<<EOF
1:{"order_id":1,"total_amount":10.50,"customer_name":"Bob Smith"}
2:{"order_id":2,"total_amount":3.32,"customer_name":"Sarah Black"}
3:{"order_id":3,"total_amount":21.00,"customer_name":"Emma Turner"}
EOF
```

In another terminal

```
 kafka-console-producer \
     --broker-list kafka0:9092 \
     --topic shipments \
     --property "parse.key=true" \
     --property "key.separator=:"<<EOF
1:{"order_id":1,"shipment_id":42,"warehouse":"Nashville"}
3:{"order_id":3,"shipment_id":43,"warehouse":"Palo Alto"}
EOF
```

Tip

Note that you may see the following warning message when running the above statements—it can be safely ignored:

```
Error while fetching metadata with correlation id 1 : {new_orders=LEADER_NOT_AVAI
LABLE} (org.apache.kafka.clients.NetworkClient)
Error while fetching metadata with correlation id 1 : {shipments=LEADER_NOT_AVAIL
ABLE} (org.apache.kafka.clients.NetworkClient)
```

```
[root@kafka0 /]# kafka-console-producer \
>       --broker-list kafka0:9092 \
>       --topic new_orders \
>       --property "parse.key=true" \
>       --property "key.separator=:"<<EOF
> 1:{"order_id":1,"total_amount":10.50,"customer_name":"Bob Smith"}
> 2:{"order_id":2,"total_amount":3.32,"customer_name":"Sarah Black"}
> 3:{"order_id":3,"total_amount":21.00,"customer_name":"Emma Turner"}
> EOF

[root@kafka0 /]#
[root@kafka0 /]# kafka-console-producer \
>       --broker-list kafka0:9092 \
>       --topic shipments \
>       --property "parse.key=true" \
>       --property "key.separator=:"<<EOF
> 1:{"order_id":1,"shipment_id":42,"warehouse":"Nashville"}
> 3:{"order_id":3,"shipment_id":43,"warehouse":"Palo Alto"}
> EOF

[2023-03-30 16:02:17,462] WARN [Producer clientId=console-producer] Error while fetching metadata with correlation id 1 : {shipments=LEA
DER_NOT_AVAILABLE} (org.apache.kafka.clients.NetworkClient)
[root@kafka0 /]#
[root@kafka0 /]#
```

In the KSQL CLI, register both topics as KSQL streams:

```
CREATE STREAM NEW_ORDERS (ORDER_ID INT, TOTAL_AMOUNT DOUBLE,
CUSTOMER_NAME VARCHAR)
WITH (KAFKA_TOPIC='new_orders', VALUE_FORMAT='JSON');


CREATE STREAM SHIPMENTS (ORDER_ID INT, SHIPMENT_ID INT, WAREHOUSE VARCHAR)
WITH (KAFKA_TOPIC='shipments', VALUE_FORMAT='JSON');
```

After both `CREATE STREAM` statements, your output should resemble:

```
 Message
----------------
 Stream created
----------------
```

Query the data to confirm that it's present in the topics.

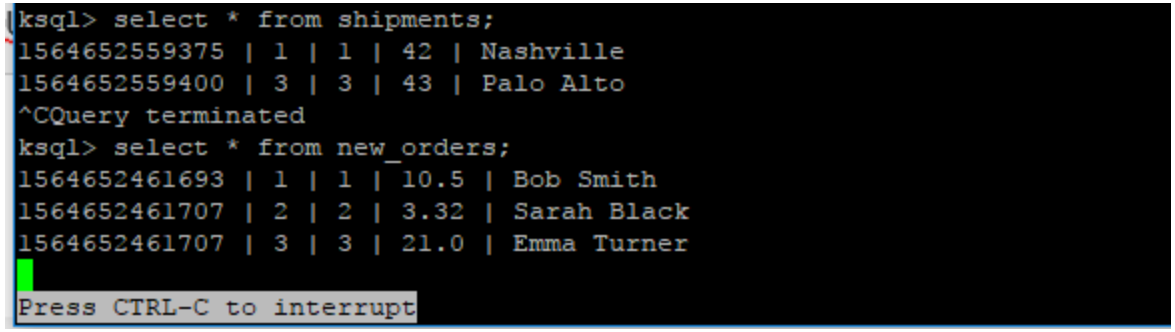
Tip

Run the following to tell KSQL to read from the *beginning* of the topic:

```
SET 'auto.offset.reset' = 'earliest';
```

You can skip this if you have already run it within your current KSQL CLI session.

```
select * from shipments;
select * from new_orders;
```



For the NEW_ORDERS topic, run:

```
SELECT ORDER_ID, TOTAL_AMOUNT, CUSTOMER_NAME FROM NEW_ORDERS;
```

Your output should resemble:

```
1 | 10.5 | Bob Smith
2 | 3.32 | Sarah Black
3 | 21.0 | Emma Turner
```

For the SHIPMENTS topic, run:

```
SELECT ORDER_ID, SHIPMENT_ID, WAREHOUSE FROM SHIPMENTS;
```

Your output should resemble:

```
1 | 42 | Nashville
```

```
3 | 43 | Palo Alto
```

Run the following query, which will show orders with associated shipments, based on a join window of 1 hour.

```
SELECT O.ORDER_ID, O.TOTAL_AMOUNT, O.CUSTOMER_NAME,
S.SHIPMENT_ID, S.WAREHOUSE
FROM NEW_ORDERS O
INNER JOIN SHIPMENTS S
  WITHIN 1 HOURS
  ON O.ORDER_ID = S.ORDER_ID EMIT CHANGES;
```

Your output should resemble:

```
1 | 10.5 | Bob Smith | 42 | Nashville
3 | 21.0 | Emma Turner | 43 | Palo Alto
```

Note that message with `ORDER_ID=2` has no corresponding `SHIPMENT_ID` or `WAREHOUSE` - this is because there is no corresponding row on the shipments stream within the time window specified.

Press Ctrl+C to cancel the `SELECT` query and return to the KSQL prompt.

Using a table-table join, it is possible to join two *tables* of on a common key. KSQL tables provide the latest *value* for a given *key*. They can only be joined on the *key*, and one-to-many (1:N) joins are not supported in the current semantic model.

In this example we have location data about a warehouse from one system, being enriched with data about the size of the warehouse from another.

In the KSQL CLI, register both topics as KSQL tables and a queryable too:

```
CREATE TABLE WAREHOUSE_LOCATION (WAREHOUSE_ID INT PRIMARY KEY, CITY VARCHAR,
COUNTRY VARCHAR)
WITH (KAFKA_TOPIC='warehouse_location', PARTITIONS=2,
    VALUE_FORMAT='AVRO');

CREATE TABLE QUERYABLE_WAREHOUSE_LOCATION AS SELECT * FROM
WAREHOUSE_LOCATION;



CREATE TABLE WAREHOUSE_SIZE (WAREHOUSE_ID INT PRIMARY KEY, SQUARE_FOOTAGE
DOUBLE)
WITH (KAFKA_TOPIC='warehouse_size', PARTITIONS=2,
    VALUE_FORMAT='AVRO');


CREATE TABLE QUERYABLE_WAREHOUSE_SIZE AS SELECT * FROM WAREHOUSE_SIZE;
```

After both `CREATE TABLE` statements, your output should resemble:

```
 Message
---------------
 Table created
---------------
```

Check both tables that the message key (`ROWKEY`) matches the declared key (`WAREHOUSE_ID`) - the output should show that they are equal. If they are not, the join will not succeed or behave as expected.

Insert few records:

In a separate console window, populate the two topics by using the KSQL utility:

```
INSERT INTO WAREHOUSE_LOCATION VALUES (1, 'Leeds', 'UK');
INSERT INTO WAREHOUSE_LOCATION VALUES (2, 'Shedfields', 'UK');
INSERT INTO WAREHOUSE_LOCATION VALUES (3, 'Berlin', 'Germany');

INSERT INTO WAREHOUSE_SIZE VALUES (1, 16000);
INSERT INTO WAREHOUSE_SIZE VALUES (2, 42000);
INSERT INTO WAREHOUSE_SIZE VALUES (3, 94000);
```

Tip

Run the following to tell KSQL to read from the *beginning* of the topic:

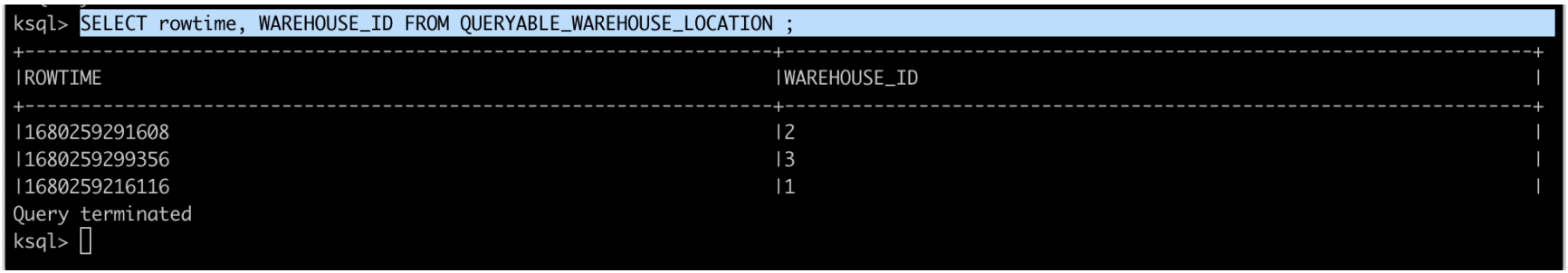
```
SET 'auto.offset.reset' = 'earliest';
```

You can skip this if you have already run it within your current KSQL CLI session.

Inspect the WAREHOUSE_LOCATION table:

```
SELECT rowtime, WAREHOUSE_ID FROM QUERYABLE_WAREHOUSE_LOCATION ;
```

Your output should resemble:



Inspect the WAREHOUSE_SIZE table:

```
SELECT ROWTIME, WAREHOUSE_ID FROM QUERYABLE_WAREHOUSE_SIZE;
```

Your output should resemble:

```
ksql> SELECT ROWTIME, WAREHOUSE_ID FROM QUERYABLE_WAREHOUSE_SIZE ;
+-------------------------------------------------------------------+-------------------------------------------------------------------+
|ROWTIME                                                            |WAREHOUSE_ID                                                       |
+-------------------------------------------------------------------+-------------------------------------------------------------------+
|1680259474404                                                      |1                                                                  |
|1680259479524                                                      |2                                                                  |
|1680259516323                                                      |3                                                                  |
Query terminated
ksql>
```

Now join the two tables:

```
SELECT WL.WAREHOUSE_ID, WL.CITY, WL.COUNTRY, WS.SQUARE_FOOTAGE
FROM WAREHOUSE_LOCATION WL
  LEFT JOIN WAREHOUSE_SIZE WS
    ON WL.WAREHOUSE_ID=WS.WAREHOUSE_ID
EMIT CHANGES;
```

Your output should resemble:

```
ksql> SELECT WL.WAREHOUSE_ID, WL.CITY, WL.COUNTRY, WS.SQUARE_FOOTAGE
>FROM WAREHOUSE_LOCATION WL
>  LEFT JOIN WAREHOUSE_SIZE WS
>    ON WL.WAREHOUSE_ID=WS.WAREHOUSE_ID
>EMIT CHANGES;
>
+------------------------------+------------------------------+------------------------------+------------------------------+
|WL_WAREHOUSE_ID               |CITY                          |COUNTRY                       |SQUARE_FOOTAGE                |
+------------------------------+------------------------------+------------------------------+------------------------------+
|1                             |Leeds                         |UK                            |16000.0                       |
|2                             |Shedfields                    |UK                            |42000.0                       |
|3                             |Berlin                        |Germany                       |94000.0                       |

Press CTRL-C to interrupt
```

KSQL - INSERT INTO

The `INSERT INTO` syntax can be used to merge the contents of multiple streams. An example of this could be where the same event type is coming from different sources.

Run two datagen processes, each writing to a different topic, simulating order data arriving from a local installation vs from a third-party:

Tip

Each of these commands should be run in a separate window. When the exercise is finished, exit them by pressing Ctrl-C.

```
ksql-datagen bootstrap-server=kafka0:9092 \
    quickstart=orders \
    format=avro \
    topic=orders_local


ksql-datagen bootstrap-server=kafka0:9092 \
    quickstart=orders \
    format=avro \
    topic=orders_3rdparty
```

In KSQL, register the source topic for each:

```
CREATE STREAM ORDERS_SRC_LOCAL
  WITH (KAFKA_TOPIC='orders_local', VALUE_FORMAT='AVRO');


CREATE STREAM ORDERS_SRC_3RDPARTY
  WITH (KAFKA_TOPIC='orders_3rdparty', VALUE_FORMAT='AVRO');
```

After each `CREATE STREAM` statement you should get the message:

```
 Message
----------------
 Stream created
----------------
```

Create the output stream, using the standard `CREATE STREAM ... AS` syntax. Because multiple sources of data are being joined into a common target, it is useful to add in lineage information. This can be done by simply including it as part of the `SELECT`:

```
CREATE STREAM ALL_ORDERS AS SELECT 'LOCAL' AS SRC, * FROM ORDERS_SRC_LOCAL;
```

Your output should resemble:

```
 Message
----------------------------
 Stream created and running
----------------------------
```

Use the DESCRIBE command to observe the schema of the target stream.

```
DESCRIBE ALL_ORDERS;
```

Your output should resemble:

```
----------------------
ksql> DESCRIBE ALL_ORDERS;

Name                 : ALL_ORDERS
 Field      | Type
-----------------------------------------------------------------------------------
 SRC        | VARCHAR(STRING)
 ORDERTIME  | BIGINT
 ORDERID    | INTEGER
 ITEMID     | VARCHAR(STRING)
 ORDERUNITS | DOUBLE
 ADDRESS    | STRUCT<CITY VARCHAR(STRING), STATE VARCHAR(STRING), ZIPCODE BIGINT>
-----------------------------------------------------------------------------------
For runtime statistics and query details run: DESCRIBE <Stream,Table> EXTENDED;
ksql>
```

Add stream of 3rd party orders into the existing output stream:

```
INSERT INTO ALL_ORDERS SELECT '3RD PARTY' AS SRC, * FROM ORDERS_SRC_3RDPARTY;
```

Your output should resemble:

```
 Message
----------------------------
 Insert Into query is running.
----------------------------
```

Query the output stream to verify that data from each source is being written to it:

```
SELECT * FROM ALL_ORDERS;
```

Your output should resemble the following. Note that there are messages from both source topics (denoted by `LOCAL` and `3RD PARTY` respectively).

```
|                |                |                |                |                |                |
|LOCAL           |1506137752102   |231             |Item_745        |2.999052429983412|{CITY=City_15, STATE=St|
|                |                |                |                |                |ate_83, ZIPCODE=52275} |
|LOCAL           |1502488368643   |232             |Item_887        |8.78768212663332|{CITY=City_78, STATE=St|
|                |                |                |                |                |ate_27, ZIPCODE=92344} |
|LOCAL           |1518168632975   |233             |Item_173        |8.272738152090659|{CITY=City_54, STATE=St|
|                |                |                |                |                |ate_11, ZIPCODE=66488} |
|LOCAL           |1489769917199   |234             |Item_793        |1.3408721487234327|{CITY=City_59, STATE=St|
|                |                |                |                |                |ate_56, ZIPCODE=18854} |
|LOCAL           |1513008988587   |235             |Item_291        |0.24396981207029764|{CITY=City_51, STATE=St|
|                |                |                |                |                |ate_29, ZIPCODE=11687} |
|LOCAL           |1489874732045   |236             |Item_552        |8.241197216427901|{CITY=City_75, STATE=St|
|                |                |                |                |                |ate_77, ZIPCODE=48186} |
|LOCAL           |1491773852422   |237             |Item_675        |7.021372448179115|{CITY=City_78, STATE=St|
|                |                |                |                |                |ate_79, ZIPCODE=82400} |
|LOCAL           |1508663717296   |238             |Item_257        |2.0645558791913188|{CITY=City_59, STATE=St|
|                |                |                |                |                |ate_62, ZIPCODE=42418} |
|LOCAL           |1489155932901   |239             |Item_237        |5.4630756042639295|{CITY=City_91, STATE=St|
|                |                |                |                |                |ate_87, ZIPCODE=27847} |
|LOCAL           |1517330614296   |240             |Item_123        |0.37773214371089814|{CITY=City_36, STATE=St|
|                |                |                |                |                |ate_95, ZIPCODE=46604} |
|LOCAL           |1495900583325   |241             |Item_790        |6.466394968684834|{CITY=City_96, STATE=St|
|                |                |                |                |                |ate_83, ZIPCODE=35591} |
```

Press Ctrl+C to cancel the `SELECT` query and return to the KSQL prompt.

You can view the two queries that are running using `SHOW QUERIES`:

```
SHOW QUERIES;
```

Your output should resemble:

```
Query ID        | Kafka Topic | Query String
-------------------------------------------------------------------------------------------------
---------
```

```
CSAS_ALL_ORDERS_0 | ALL_ORDERS  | CREATE STREAM ALL_ORDERS AS SELECT
'LOCAL' AS SRC, * FROM ORDERS_SRC_LOCAL;
InsertQuery_1     | ALL_ORDERS  | INSERT INTO ALL_ORDERS SELECT '3RD PARTY' A
S SRC, * FROM ORDERS_SRC_3RDPARTY;
-------------------------------------------------------------------------------------------
---------
```

Terminate and Exit

KSQL

Important: Persisted queries will continuously run as KSQL applications until they are manually terminated. Exiting KSQL CLI does not terminate persistent queries.

1. From the output of `SHOW QUERIES;` identify a query ID you would like to terminate. For example, if you wish to terminate query ID `CTAS_PAGEVIEWS_REGIONS`:

```
SHOW QUERIES;
TERMINATE CTAS_PAGEVIEWS_REGIONS;
```

Tip

The actual name of the query running may vary; refer to the output of `SHOW QUERIES;`.

2. Run the `exit` command to leave the KSQL CLI.

```
ksql> exit

Exiting KSQL.
```

Confluent CLI

If you are running Confluent Platform using the CLI, you can stop it with this command.

```
$ confluent stop
```

---------- Lab Ends Here ----------

8. KSQL - Kafka Aggregation- 45minutes(D)

In this examples, it will show how to aggregate data from an inbound stream of pageview records, named pageviews.

We will demonstrate two features:

- Aggregate Results in a KSQL Table
- Aggregate Over Windows

Load data using users datagen util.

- Create a topic users_w (a) - It will be done automatic using datgen.

```
ksql-datagen quickstart=users bootstrap-server=kafka0:9092 format=json topic=users_w
maxInterval=100
```

- Create stream users_ws (b)
- Create kSQL Table using the users_wt stream (c)

Let us verify the topic using KSQL;

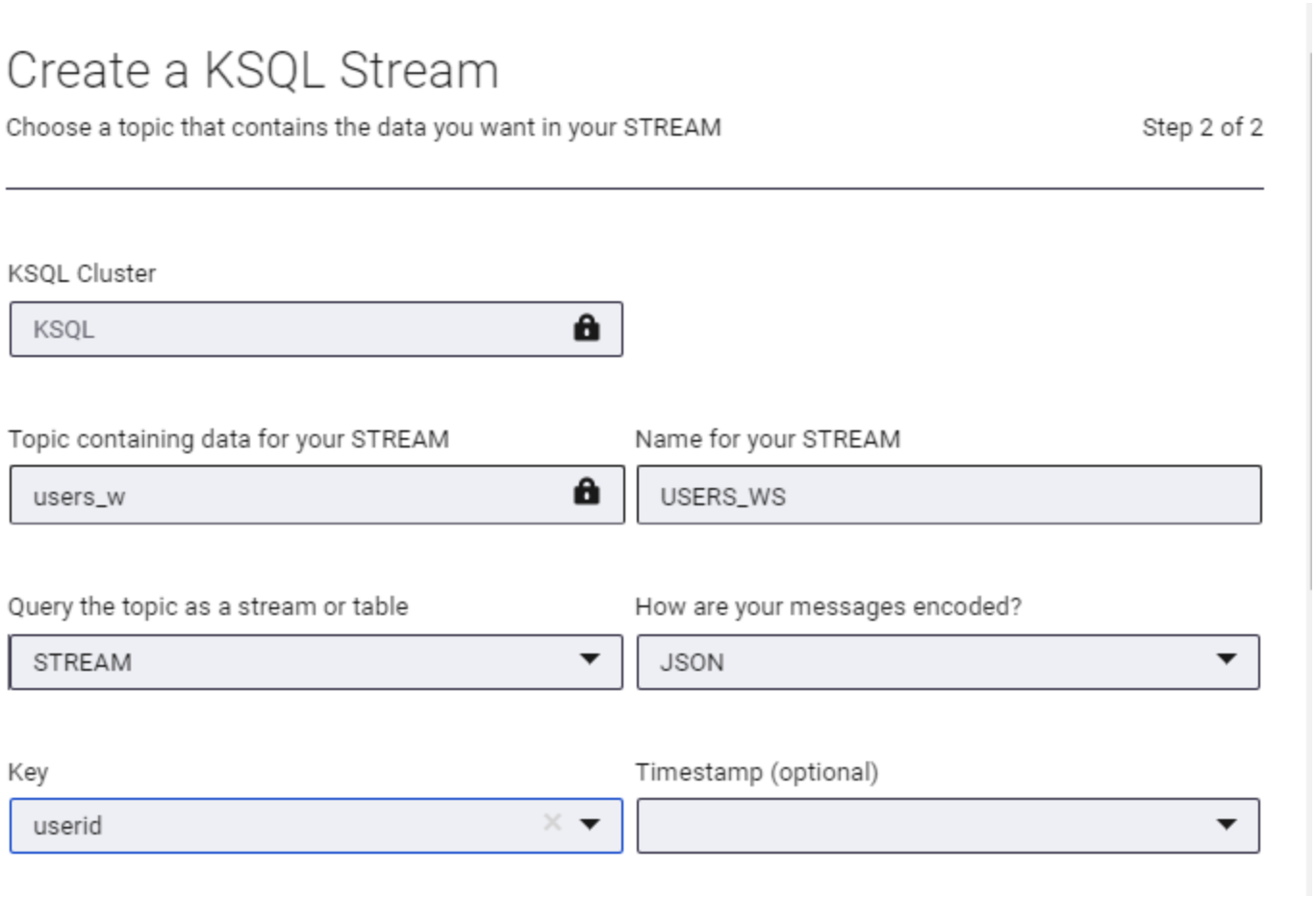
```
print 'users_w' limit 2;
```

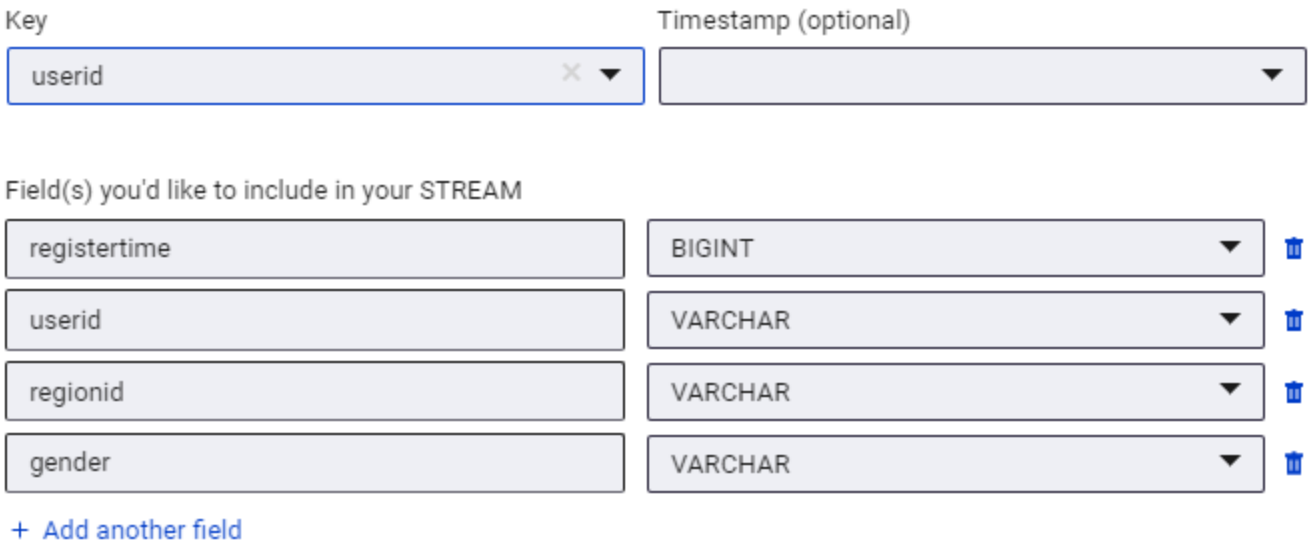
```
ksql> print 'users_w' limit 2;
Format:JSON
{"ROWTIME":1566382936529,"ROWKEY":"User_9","registertime":1496206465489,"userid"
:"User_9","regionid":"Region_3","gender":"FEMALE"}
{"ROWTIME":1566382936573,"ROWKEY":"User_4","registertime":1501550083198,"userid"
:"User_4","regionid":"Region_5","gender":"MALE"}
ksql>
```

You should be able to view two records as shown above.

(b) Create stream users_ws

```
CREATE STREAM users_ws (userid varchar key,regionid varchar,gender varchar,registertime bigint)
  WITH (KAFKA_TOPIC='users_w', VALUE_FORMAT='JSON');
```


Create a KSQL Stream
Choose a topic that contains the data you want in your STREAM
Step 2 of 2
KSQL Cluster
KSQL
Topic containing data for your STREAM
users_w
Name for your STREAM
USERS_WS
Query the topic as a stream or table
STREAM
How are your messages encoded?
JSON
Key
userid
Timestamp (optional)



Aggregate Results in a KSQL Table

The result of an aggregate query in KSQL is always a table, because KSQL computes the aggregate for each key, and possibly for each window per key, and updates these results as it processes new input data for a key.

Assume that you want to count the number of pageviews per region. The following query uses the COUNT function to count the pageviews from the time you start the query until you terminate it.

```
SELECT userid,  COUNT(*)  FROM users_ws  GROUP BY userid emit changes;
```

```
ksql> SELECT userid,  COUNT(*)  FROM users_ws  GROUP BY userid emit changes;
+-----------------------------------------------------------+-----------------------------------------------------------+
|USERID                                                     |KSQL_COL_0                                                 |
+-----------------------------------------------------------+-----------------------------------------------------------+
|User_4                                                     |3921                                                       |
|User_3                                                     |3995                                                       |
|User_2                                                     |4018                                                       |
|User_1                                                     |4052                                                       |
|User_5                                                     |3944                                                       |
|User_6                                                     |3924                                                       |
|User_9                                                     |3926                                                       |
|User_8                                                     |3911                                                       |
|User_7                                                     |3922                                                       |
|User_4                                                     |12004                                                      |
|User_3                                                     |11999                                                      |
|User_8                                                     |11967                                                      |
|User_7                                                     |11943                                                      |
|User_5                                                     |11906                                                      |
|User_2                                                     |11943                                                      |
|User_9                                                     |11928                                                      |
|User_1                                                     |12094                                                      |
|User_6                                                     |11856                                                      |
^CQuery terminated
ksql>
```

The query uses the CREATE TABLE AS SELECT statement, because the result of the query is a KSQL table.

```
CREATE TABLE pageviews_per_user AS
  SELECT userid,
        COUNT(*) as user_count
  FROM users_ws  GROUP BY userid;
```

```
CREATE TABLE pageviews_per_user AS
  SELECT userid,
         COUNT(*)
  FROM users_ws  GROUP BY userid;
```

Query properties | Run | Stop


```
{
  "@type" : "currentStatus",
  "statementText" : "CREATE TABLE pageviews_per_user AS\n  SELECT userid,\n       COUNT(*)\n  FROM users_ws  GROUP BY userid;",
  "commandId" : "table/PAGEVIEWS_PER_USER/create",
  "commandStatus" : {
    "status" : "SUCCESS",
    "message" : "Table created and running"
  },
  "commandSequenceNumber" : 21
}
```


Determine the value,

select * from pageviews_per_user ;

```
ksql> select * from pageviews_per_user ;
+------------------------------------------------------------------+------------------------------------------------------------------+
|USERID                                                            |KSQL_COL_0                                                        |
+------------------------------------------------------------------+------------------------------------------------------------------+
|User_1                                                            |127439                                                            |
|User_2                                                            |128239                                                            |
|User_3                                                            |127921                                                            |
|User_4                                                            |127620                                                            |
|User_5                                                            |127910                                                            |
|User_6                                                            |127739                                                            |
|User_7                                                            |128062                                                            |
|User_8                                                            |127497                                                            |
|User_9                                                            |128041                                                            |
Query terminated
ksql>
```

Tombstone Records

An important difference between tables and streams is that a record with a non-null key and a null value has a special semantic meaning: in a table, this kind of record is a *tombstone*, which tells KSQL to "DELETE this key from the table". For a stream, null is a value like any other, with no special meaning.

Aggregate Over Windows

KSQL supports aggregation using tumbling, hopping, and session windows.

In a windowed aggregation, the first seen message is written into the table for a particular key as a null. Downstream applications reading the data will see nulls, and if an application can't handle null values, it may need a separate stream that filters these null records with a WHERE clause.

Aggregate Records Over a Tumbling Window

This query computes the pageview count per region per minute:

```
CREATE TABLE pageviews_per_user_per_minute AS
 SELECT regionid,
       COUNT(*) as count_regionid
 FROM users_ws
 WINDOW TUMBLING (SIZE 1 MINUTE)
 GROUP BY regionid;
```

```
CREATE TABLE pageviews_per_user_per_minute AS
  SELECT regionid,
         COUNT(*)
  FROM users_ws
  WINDOW TUMBLING (SIZE 1 MINUTE)
  GROUP BY regionid;
```

Query properties | Run | Stop


```
{
  "@type": "currentStatus",
  "statementText": "CREATE TABLE pageviews_per_user_per_minute AS\n  SELECT regionid,\n         COUNT(*)\n  FROM users_ws\n  WINDOW TUMBLING (SIZE 1 MINUTE)\n
  "commandId": "table/PAGEVIEWS_PER_USER_PER_MINUTE/create",
  "commandStatus": {
    "status": "SUCCESS",
    "message": "Table created and running"
 },
  "commandSequenceNumber": 22
}
```


Verify the records:

select * from pageviews_per_user_per_minute ;

```
ksql> select * from pageviews_per_user_per_minute ;
+------------------------------+------------------------------+------------------------------+------------------------------+
|REGIONID                      |WINDOWSTART                   |WINDOWEND                     |COUNT_REGIONID                |
+------------------------------+------------------------------+------------------------------+------------------------------+
|Region_1                      |1687405560000                 |1687405620000                 |45220                         |
|Region_2                      |1687405560000                 |1687405620000                 |45152                         |
|Region_3                      |1687405560000                 |1687405620000                 |45700                         |
|Region_4                      |1687405560000                 |1687405620000                 |44857                         |
|Region_5                      |1687405560000                 |1687405620000                 |45491                         |
|Region_6                      |1687405560000                 |1687405620000                 |45183                         |
|Region_7                      |1687405560000                 |1687405620000                 |45393                         |
|Region_8                      |1687405560000                 |1687405620000                 |45341                         |
|Region_9                      |1687405560000                 |1687405620000                 |45426                         |
Query terminated
ksql>
```

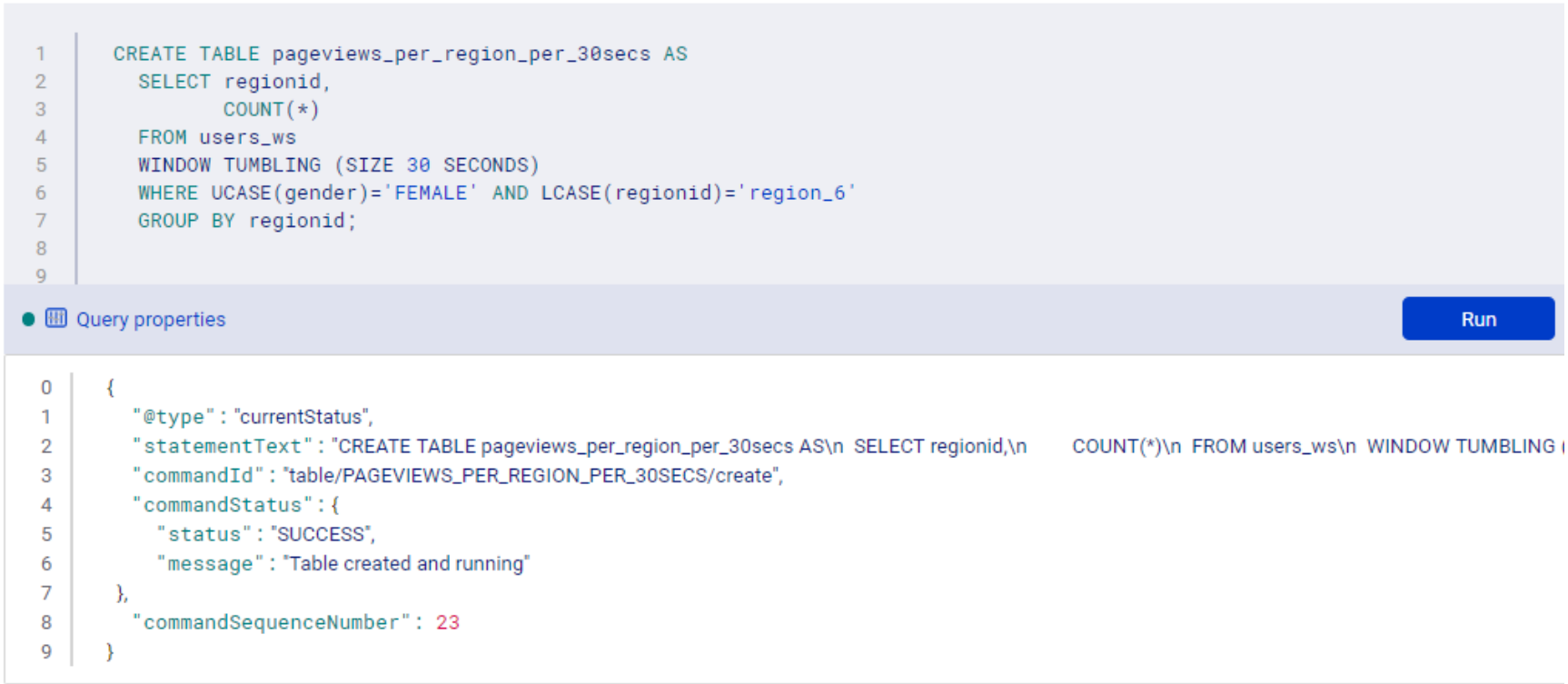
If you want to view for a particular region for example, we would like to fetch record related to regionId is equal to Region_1.

select * from pageviews_per_user_per_minute where regionid='Region_1';

```
ksql> select * from pageviews_per_user_per_minute where regionid='Region_1';
1566386957480 | Region_1 : Window{start=1566386940000 end=-} | Region_1 | 32
1566386959670 | Region_1 : Window{start=1566386940000 end=-} | Region_1 | 37
1566386962160 | Region_1 : Window{start=1566386940000 end=-} | Region_1 | 44
1566386964123 | Region_1 : Window{start=1566386940000 end=-} | Region_1 | 51
^C1566386966089 | Region_1 : Window{start=1566386940000 end=-} | Region_1 | 54
Query terminated
ksql>
```

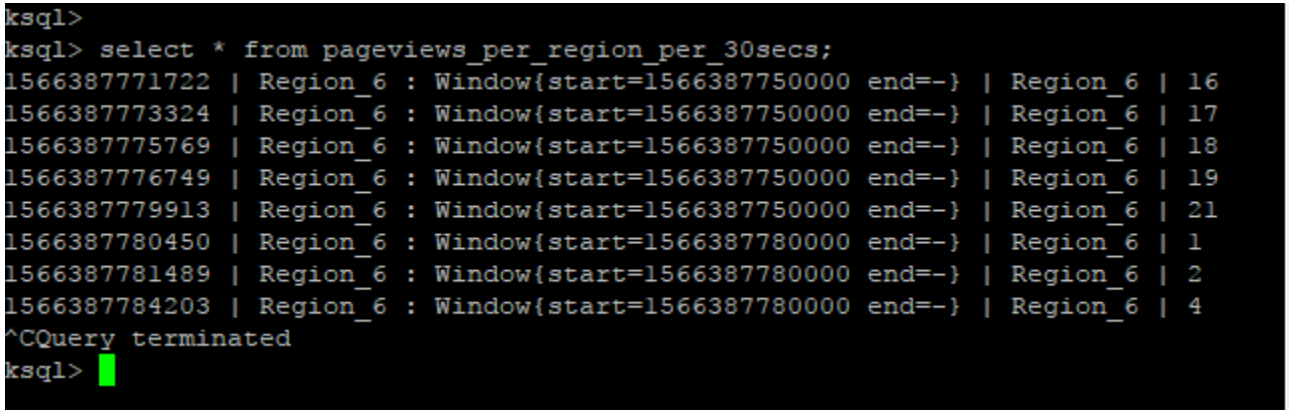
To count the pageviews for "Region_6" by female users every 30 seconds, you can change the previous query to the following:

```
CREATE TABLE pageviews_per_region_per_30secs AS
 SELECT regionid,
       COUNT(*)
 FROM users_ws
 WINDOW TUMBLING (SIZE 30 SECONDS)
 WHERE UCASE(gender)='FEMALE' AND LCASE(regionid)='region_6'
 GROUP BY regionid;
```



```
select * from pageviews_per_region_per_30secs;
```

Execute the above query to get the result set.



Aggregate Records Over a Hopping Window

This query computes the count for a hopping window of 30 seconds that advances by 10 seconds.

UCASE and LCASE functions are used to convert the values of `gender` and `regionid` columns to uppercase and lowercase, so that you can match them correctly. KSQL also supports the LIKE operator for prefix, suffix, and substring matching.

```
CREATE TABLE pageviews_per_region_per_30secs10secs AS
  SELECT regionid,
```

```
    COUNT(*)
FROM users_ws
WINDOW HOPPING (SIZE 30 SECONDS, ADVANCE BY 10 SECONDS)
WHERE UCASE(gender)='FEMALE' AND LCASE (regionid) LIKE '%_6'
GROUP BY regionid;
```

```
1  CREATE TABLE pageviews_per_region_per_30secs10secs AS
2    SELECT regionid,
3           COUNT(*)
4    FROM users_ws
5    WINDOW HOPPING (SIZE 30 SECONDS, ADVANCE BY 10 SECONDS)
6    WHERE UCASE(gender)='FEMALE' AND LCASE (regionid) LIKE '%_6'
7    GROUP BY regionid;
8
9
```

Query properties

Run


```
0  {
1    "@type" : "currentStatus",
2    "statementText" : "CREATE TABLE pageviews_per_region_per_30secs10secs AS\n  SELECT regionid,\n       COUNT(*)\n  FROM users_ws\n  WINDOW HOPP
3    "commandId" : "table/PAGEVIEWS_PER_REGION_PER_30SECS10SECS/create",
4    "commandStatus" : {
5      "status" : "SUCCESS",
6      "message" : "Table created and running"
7   },
8    "commandSequenceNumber" : 24
9  }
```


```
select * from pageviews_per_region_per_30secs10secs;
```

```
ksql> select * from pageviews_per_region_per_30secs10secs;
1566387927042 | Region_6 : Window{start=1566387900000 end=-} | Region_6 | 21
1566387927042 | Region_6 : Window{start=1566387910000 end=-} | Region_6 | 15
1566387927042 | Region_6 : Window{start=1566387920000 end=-} | Region_6 | 7
1566387929672 | Region_6 : Window{start=1566387900000 end=-} | Region_6 | 22
1566387929672 | Region_6 : Window{start=1566387910000 end=-} | Region_6 | 16
1566387929672 | Region_6 : Window{start=1566387920000 end=-} | Region_6 | 8
1566387931175 | Region_6 : Window{start=1566387910000 end=-} | Region_6 | 17
1566387931175 | Region_6 : Window{start=1566387920000 end=-} | Region_6 | 9
1566387931175 | Region_6 : Window{start=1566387930000 end=-} | Region_6 | 1
1566387935410 | Region_6 : Window{start=1566387910000 end=-} | Region_6 | 21
1566387935410 | Region_6 : Window{start=1566387920000 end=-} | Region_6 | 13
1566387935410 | Region_6 : Window{start=1566387930000 end=-} | Region_6 | 5
1566387939245 | Region_6 : Window{start=1566387910000 end=-} | Region_6 | 22
1566387939245 | Region_6 : Window{start=1566387920000 end=-} | Region_6 | 14
1566387939245 | Region_6 : Window{start=1566387930000 end=-} | Region_6 | 6
^CQuery terminated
ksql>
```

Aggregate Records Over a Session Window

The following query counts the number of pageviews per region for session windows, with a session inactivity gap of 60 seconds. This query *sessionizes* the input data and performs the counting step per region.

```
CREATE TABLE pageviews_per_region_per_session AS
  SELECT regionid,
        COUNT(*)
  FROM users_ws
  WINDOW SESSION (60 SECONDS)
  GROUP BY regionid;
```

```
CREATE TABLE pageviews_per_region_per_session AS
  SELECT regionid,
         COUNT(*)
  FROM users_ws
  WINDOW SESSION (60 SECONDS)
  GROUP BY regionid;
```

Query properties | Run | Stop


```
{
  "@type" : "currentStatus",
  "statementText" : "CREATE TABLE pageviews_per_region_per_session AS\n  SELECT regionid,\n         COUNT(*)\n  FROM users_ws\n  WINDOW SESSION (60 SECONDS)\n  G
  "commandId" : "table/PAGEVIEWS_PER_REGION_PER_SESSION/create",
  "commandStatus" : {
    "status" : "SUCCESS",
    "message" : "Table created and running"
 },
  "commandSequenceNumber" : 25
}
```


Verify the record:

select * from pageviews_per_region_per_session emit changes;

```
ksql> select * from pageviews_per_region_per_session;
1566388589563 | Region_9 : Window{start=1566388558855 end=1566388589563} | Regio
n_9 | 71
1566388590276 | Region_3 : Window{start=1566388557991 end=1566388590276} | Regio
n_3 | 66
1566388590619 | Region_2 : Window{start=1566388558275 end=1566388590619} | Regio
n_2 | 69
1566388590703 | Region_5 : Window{start=1566388558422 end=1566388590703} | Regio
n_5 | 68
1566388590931 | Region_8 : Window{start=1566388559473 end=1566388590931} | Regio
n_8 | 72
1566388591014 | Region_6 : Window{start=1566388557993 end=1566388591014} | Regio
n_6 | 74
1566388590645 | Region_4 : Window{start=1566388558141 end=1566388590645} | Regio
n_4 | 78
1566388590764 | Region_1 : Window{start=1566388558079 end=1566388590764} | Regio
n_1 | 84
1566388590832 | Region_7 : Window{start=1566388558257 end=1566388590832} | Regio
```

---------- Lab Ends Here ----------

9. Kafka – UDAF – 60 Minutes

In this lab we will learn how to to write UDAF and consume in KSQL. UDAFs can be used for computing aggregates against multiple rows of data.

It depends on: KSQL - Kafka Aggregation

This UDAF performs some basic math and adding the computations to a Map object. Returning a Map is one method for returning multiple values from a KSQL function. Using the example above for your own UDAF, take note of the following methods:

- initialize: used to specify the initial value of your aggregation
- aggregate: performs the actual aggregation by looking at the current row's value (i.e., the currentValue argument), as well as the current aggregation value (i.e., aggregateValue argument), and generates a new aggregate
- merge: describes how to merge two aggregations into one (e.g., when using session windows)

Create a class: ***SummaryStatsUdaf*** in the package - ***com.ostech.ksql.udf***

<!---------- UDAF Begins Here---------->

```
package com.ostech.ksql.udf;

import java.util.HashMap;
import java.util.Map;

import io.confluent.ksql.function.udaf.Udaf;
import io.confluent.ksql.function.udaf.UdafDescription;
import io.confluent.ksql.function.udaf.UdafFactory;

/**
 * In this example, we implement a UDAF for computing some summary
statistics
 * for a stream of doubles.
 * </pre>
 */
@UdafDescription(name = "summary_stats_big", description = "Example
UDAF that computes some summary stats for a stream of BigInt",
version = "1.0", author = "Henry P")
public final class SummaryStatsUdaf {

    private SummaryStatsUdaf() {
```

```
    }

    @UdafFactory(description = "compute summary stats for BigInt")
    // Can be used with stream aggregations. The input of our
aggregation will be
    // doubles,Intermediate will be a Map too
    // and the output will be a map
    public static Udaf<Long,Map<String, Long>, Map<String, Long>>
createUdaf() {

        return new Udaf<Long, Map<String, Long>, Map<String,
Long>>() {

            /**
             * Specify an initial value for our aggregation
             *
             * @return the initial state of the aggregate.
             */
            @Override
            public Map<String, Long> initialize() {
                final Map<String, Long> stats = new HashMap<>();
                stats.put("mean", Long.valueOf(0));
                stats.put("sample_size", Long.valueOf(0));
                stats.put("sum", Long.valueOf(0));
                return stats;
```

```
            }

            /**
             * Perform the aggregation whenever a new record appears
in our stream.
             *
             * @param newValue
             *            the new value to add to the {@code
aggregateValue}.
             * @param aggregateValue
             *            the current aggregate.
             * @return the new aggregate value.
             */
            @Override
            public Map<String, Long> aggregate(final Long newValue,
final Map<String, Long> aggregateValue) {
                final Long sampleSize = Long.valueOf(1) +
(aggregateValue.getOrDefault
                                                    ("sample_size",
Long.valueOf(0)));

                final Long sum = newValue +
(aggregateValue.getOrDefault("sum", Long.valueOf(0)));

                // calculate the new aggregate
```

```
                aggregateValue.put("mean", sum / (sampleSize));
                aggregateValue.put("sample_size", sampleSize);
                aggregateValue.put("sum", sum);
                return aggregateValue;
            }

            /**
             * Called to merge two aggregates together.
             *
             * @param aggOne
             *            the first aggregate
             * @param aggTwo
             *            the second aggregate
             * @return the merged result
             */
            @Override
            public Map<String, Long> merge(final Map<String, Long>
aggOne, final Map<String, Long> aggTwo) {
                final Long sampleSize =
aggOne.getOrDefault("sample_size", Long.valueOf(0)) + (
                        aggTwo.getOrDefault("sample_size",
Long.valueOf(0)));
                final Long sum = aggOne.getOrDefault("sum",
Long.valueOf(0)) +
```

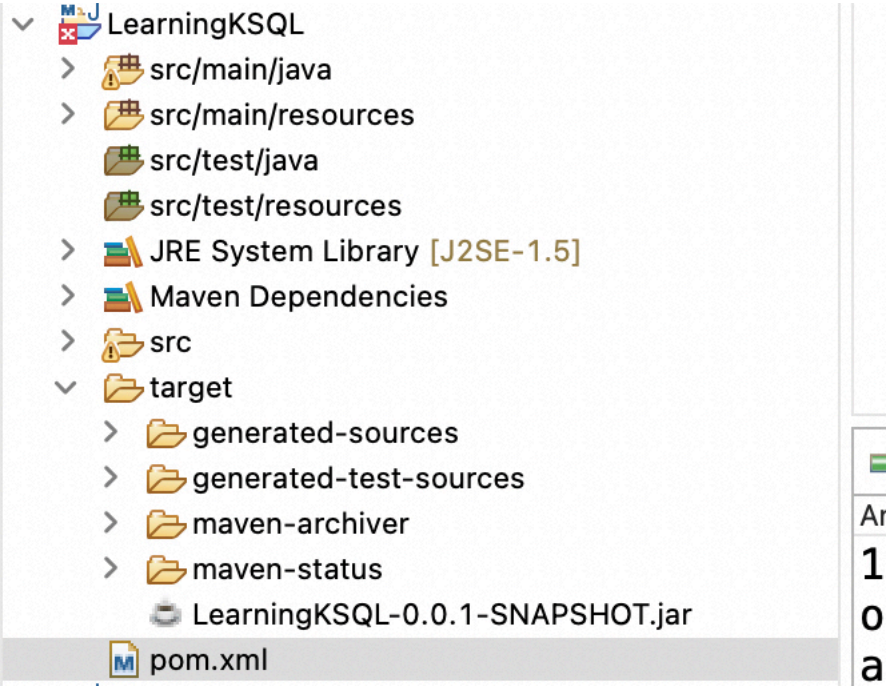
```
                                        (aggTwo.getOrDefault("sum",
Long.valueOf(0)));
                // calculate the new aggregate
                final Map<String, Long> newAggregate = new
HashMap<>();
                newAggregate.put("mean", sum / (sampleSize));
                newAggregate.put("sample_size", sampleSize);
                newAggregate.put("sum", sum);
                return newAggregate;
            }

            @Override
            public Map<String, Long> map(Map<String, Long> agg) {
                // TODO Auto-generated method stub
                return agg;
            }
        };
    }
}
```

<!---------- UDAF Ends Here ----------→

Once the UDAF logic is ready, then it's time to deploy your KSQL functions to a KSQL server. To begin, build the project by running the following command in the project root directory:

Maven → Run As →Maven Install

The following file will be generated and need to be deployed in the kafka cluster.



Now, simply copy this JAR file to the KSQL extension directory (see the ksql.extension.dir property in the ksql-server.properties file) and restart your KSQL server so that it can pick up the new JAR containing your custom KSQL function. If the

entry is not there; configure it by entering the following line in the ksql-server.properties file.

ksql.extension.dir=/opt/scripts/ksql
Create the folder structure and grant the access.

```
[root@kafka0 ksql]# pwd
/opt/scripts/ksql
[root@kafka0 ksql]# ls
LearningKSQL-0.0.1-SNAPSHOT.jar
[root@kafka0 ksql]#
```

Hints[mkdir, chmod 777]

Copy the jar.

Restart the confluent

Once KSQL has finished restarting and has connected to a running Apache Kafka® cluster, you can verify that the new functions exist by running the DESCRIBE FUNCTION command from the CLI:

```
DESCRIBE FUNCTION SUMMARY_STATS_BIG ;
```

```
ksql> DESCRIBE FUNCTION SUMMARY_STATS_BIG ;

Name        : SUMMARY_STATS_BIG
Author      : Henry P
Version     : 1.0
Overview    : Example UDAF that computes some summary stats for a stream of BigInt
Type        : AGGREGATE
Jar         : /opt/scripts/ksql/LearningKSQL-0.0.1-SNAPSHOT.jar
Variations  :

        Variation   : SUMMARY_STATS_BIG(val BIGINT)
        Returns     : MAP<VARCHAR, BIGINT>
        Description : compute summary stats for BigInt
ksql>
```

Let us generate data for using this UDAF in our query.

Use the following avro schema to generate the data.

Create ***impressions.avro*** file in ***/opt/scripts*** folder and execute the following command from that folder only.

<!----------Schema File : impressions.avro Begins---------->

```
{
    "namespace": "streams",
    "name": "impressions",
    "type": "record",
    "fields": [
        {"name": "impresssiontime", "type": {
          "type": "long",
          "format_as_time" : "unix_long",
          "arg.properties": {
            "iteration": { "start": 1, "step": 10}
          }
        }},
        {"name": "impressionid", "type": {
          "type": "string",
          "arg.properties": {
            "regex": "impression_[1-9][0-9][0-9]"
          }
        }},
        {"name": "userid", "type": {
          "type": "string",
          "arg.properties": {
            "regex": "user_[1-9][0-9]?"
          }
        }},
        {"name": "adid", "type": {
          "type": "string",
          "arg.properties": {
```

```
            "regex": "ad_[1-9][0-9]?"
          }
        }},
        {"name": "impresssionscore", "type": {
          "type": "long",
          "arg.properties": {
            "iteration": { "start": 1, "step": 2}
          }
        }}
    ]
}
<!-------------------- Schema File : impressions.avro  Ends ----------------------------->
```

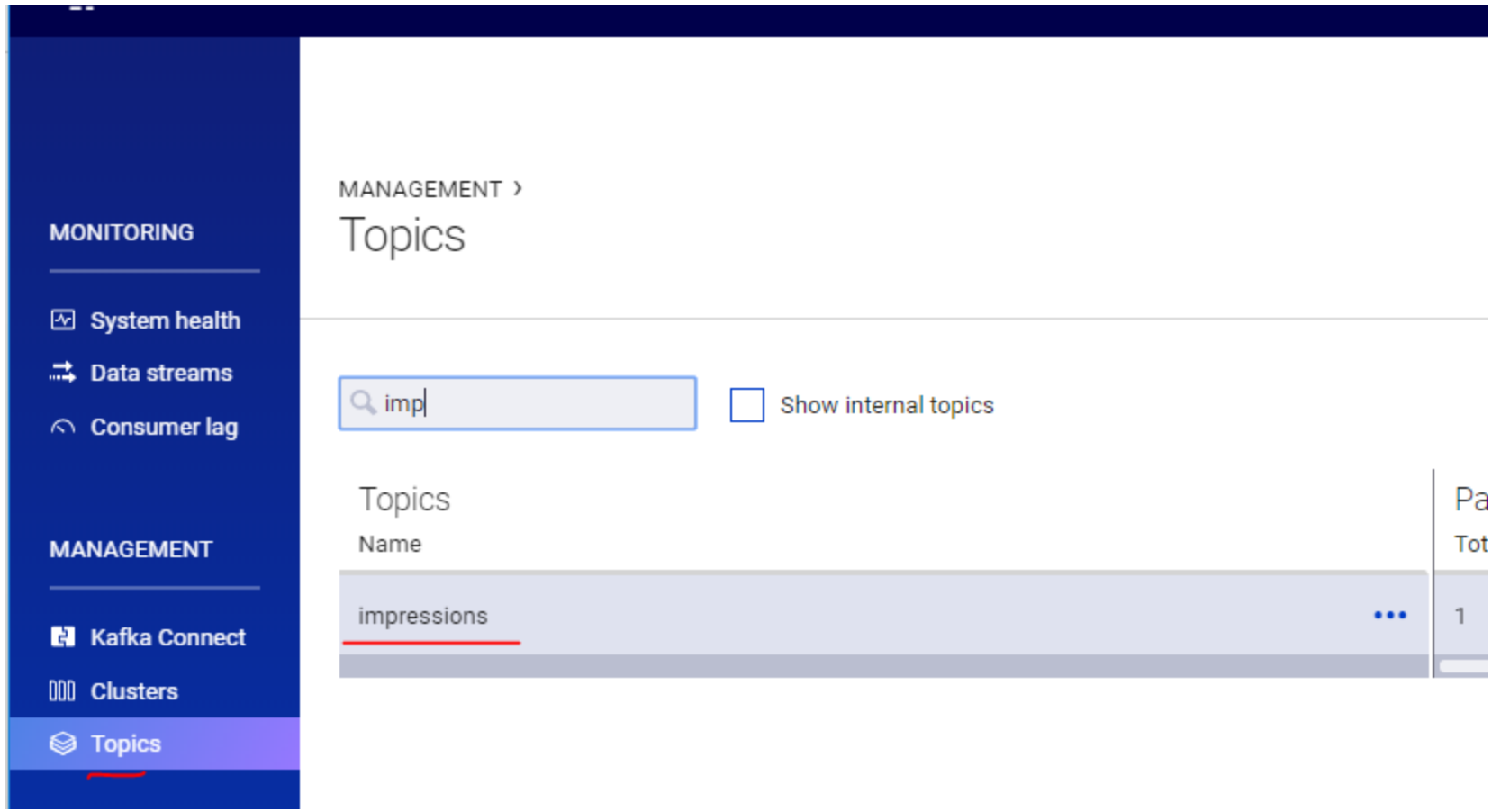
```
#cd /opt/scripts
ksql-datagen schema=impressions.avro format=avro topic=impressions key=impressionid bootstrap-server=kafka0:9092
```

When you have a custom schema registered, you can generate test data that's made up of random values that satisfy the schema requirements. In the `impressions` schema, advertisement identifiers are two-digit random numbers between 10 and 99, as specified by the regular expression `ad_[1-9][0-9]`. It has impresssionscore which is the score of impression for the advertisement. We will calculate stats on this column using the UDAF we have define earlier.

After a few startup messages, your output should resemble:

```
impression_162 --> ([ 1566555549459 | 'impression_162' | 'user_81' | 'ad_38' | 575 ]) ts:156655
5549459
impression_712 --> ([ 1566555549895 | 'impression_712' | 'user_33' | 'ad_26' | 577 ]) ts:156655
5549895
impression_279 --> ([ 1566555549920 | 'impression_279' | 'user_91' | 'ad_92' | 579 ]) ts:156655
5549920
impression_306 --> ([ 1566555550302 | 'impression_306' | 'user_34' | 'ad_78' | 581 ]) ts:156655
5550303
impression_522 --> ([ 1566555550475 | 'impression_522' | 'user_40' | 'ad_96' | 583 ]) ts:156655
5550476
impression_733 --> ([ 1566555550636 | 'impression_733' | 'user_80' | 'ad_31' | 585 ]) ts:156655
5550637
impression_318 --> ([ 1566555551108 | 'impression_318' | 'user_91' | 'ad_17' | 587 ]) ts:156655
5551109
impression_632 --> ([ 1566555551319 | 'impression_632' | 'user_25' | 'ad_80' | 589 ]) ts:156655
5551319
impression_959 --> ([ 1566555551366 | 'impression_959' | 'user_28' | 'ad_65' | 591 ]) ts:156655
5551366
```

By now, you should have a topic by the name, impressions as shown below.



Consume the Test Data Stream

In the KSQL CLI or in Control Center, register the impressions stream:

```
CREATE STREAM impressions (viewtime BIGINT, key VARCHAR, userid VARCHAR, adid VARCHAR , impresssionscore BIGINT) WITH (KAFKA_TOPIC='impressions', VALUE_FORMAT='avro');
```

You can query the stream now.

```
select * from impressions;
```

```
1566555480855 | impression_410 | null | null | user_74 | ad_22 | 1
1566555480926 | impression_631 | null | null | user_50 | ad_10 | 3
1566555481142 | impression_705 | null | null | user_31 | ad_12 | 5
1566555481574 | impression_365 | null | null | user_91 | ad_72 | 7
1566555481894 | impression_610 | null | null | user_91 | ad_14 | 9
1566555481970 | impression_526 | null | null | user_45 | ad_88 | 11
1566555482437 | impression_663 | null | null | user_15 | ad_24 | 13
1566555482725 | impression_939 | null | null | user_26 | ad_95 | 15
1566555482856 | impression_654 | null | null | user_39 | ad_73 | 17
```

At this point, invoking our UDF/UDAF is simply a matter of adding it to our KSQL query:

```
SELECT userid , summary_stats_big ( impresssionscore )
FROM impressions   GROUP BY userid EMIT CHANGES;
```

```
user_64 | {sample_size=1, mean=1223, sum=1223}
user_12 | {sample_size=1, mean=1225, sum=1225}
user_14 | {sample_size=1, mean=1227, sum=1227}
user_60 | {sample_size=1, mean=1229, sum=1229}
user_99 | {sample_size=1, mean=1231, sum=1231}
user_23 | {sample_size=1, mean=1233, sum=1233}
user_18 | {sample_size=1, mean=1237, sum=1237}
user_57 | {sample_size=2, mean=1237, sum=2474}
user_29 | {sample_size=1, mean=1241, sum=1241}
user_96 | {sample_size=1, mean=1243, sum=1243}
user_47 | {sample_size=1, mean=1245, sum=1245}
user_15 | {sample_size=1, mean=1247, sum=1247}
user_96 | {sample_size=2, mean=1246, sum=2492}
user_19 | {sample_size=1, mean=1251, sum=1251}
user_24 | {sample_size=1, mean=1253, sum=1253}
```

As you can observe for each userid it returns a stat calculated using the UDAF we have define earlier.

---------- Lab Ends Here ----------

10. Hands on: KSQL Complete Understanding - 120 Minutes.

In this lab, we will apply most of the features provided by KSQL DB. In this use case, there will be two streams –

Title : Which store information of a TV series's title and

production_changes : Which store information about the season length of the TV series mention in the Title stream.

Start

- Kafka
- Schema Registry
- ksqlDB server
- ksqlDB CLI

Define a custom structure that will store the season length information.

```
CREATE TYPE season_length AS STRUCT<season_id INT, episode_count INT> ;
```

You can have a view of the Structure type created above.

```
show types;
```

```
ksql> CREATE TYPE season_length AS STRUCT<season_id INT, episode_count INT> ;

 Message
----------------------------------------------------------------------------------------------------------------------
 Registered custom type with name 'SEASON_LENGTH' and SQL type STRUCT<`SEASON_ID` INTEGER, `EPISODE_COUNT` INTEGER>
----------------------------------------------------------------------------------------------------------------------
ksql> show types;

 Type Name     | Schema
-----------------------------------------------------------------
 SEASON_LENGTH | STRUCT<SEASON_ID INTEGER, EPISODE_COUNT INTEGER>
-----------------------------------------------------------------
ksql>
```

Define a table Titles, to store the information of TV series's Title.

```
CREATE TABLE titles (
        id INT PRIMARY KEY,
        title VARCHAR
) WITH (
        KAFKA_TOPIC='titles',
        VALUE_FORMAT='AVRO',
        PARTITIONS=4
);
```

Define a stream to store the title's episode details. You can observe that it uses the structure declare above (field name – after and before).

```
CREATE STREAM production_changes (
        rowkey VARCHAR KEY,
        uuid INT,
        title_id INT,
        change_type VARCHAR,
        before season_length,
        after season_length,
        created_at VARCHAR
) WITH (
        KAFKA_TOPIC='production_changes',
        PARTITIONS='4',
        VALUE_FORMAT='JSON',
        TIMESTAMP='created_at',
        TIMESTAMP_FORMAT='yyyy-MM-dd HH:mm:ss'
);
```

Observe carefully, in the above declaration created_earlier field is of type Timestamp and format is define in the with clause.

```
---------------
ksql> CREATE STREAM production_changes (
>rowkey VARCHAR KEY,
>uuid INT,
>title_id INT,
>change_type VARCHAR,
>before season_length,
>after season_length,
>created_at VARCHAR
>) WITH (
>KAFKA_TOPIC='production_changes',
>PARTITIONS='4',
>VALUE_FORMAT='JSON',
>TIMESTAMP='created_at',
>TIMESTAMP_FORMAT='yyyy-MM-dd HH:mm:ss'
>);
```

You can verify the strucures of Tables.

SHOW TABLES ;
SHOW TABLES EXTENDED;

```
ksql> SHOW TABLES ;

 Table Name | Kafka Topic | Key Format | Value Format | Windowed
-----------------------------------------------------------------
 TITLES     | titles      | KAFKA      | AVRO         | false
-----------------------------------------------------------------
ksql> SHOW TABLES EXTENDED;

Name                 : TITLES
Type                 : TABLE
Timestamp field      : Not set - using <ROWTIME>
Key format           : KAFKA
Value format         : AVRO
Kafka topic          : titles (partitions: 4, replication: 1)
Statement            : CREATE TABLE TITLES (ID INTEGER PRIMARY KEY, TITLE STRING) WITH (KAFKA_TOPIC='titles', KEY_FORMAT='KAFKA', PARTITIO
NS=4, VALUE_FORMAT='AVRO');

 Field | Type
----------------------------------------
 ID    | INTEGER          (primary key)
 TITLE | VARCHAR(STRING)
----------------------------------------

Local runtime statistics
------------------------


(Statistics of the local KSQL server interaction with the Kafka topic titles)
```

Likewise, you can verify your stream.

```
SHOW STREAMS ;
```

Let us insert a couple of records in the production_changes stream.

```
INSERT INTO production_changes (
uuid,
title_id,
change_type,
before,
after,
 created_at
) VALUES (
1,
1,
'season_length',
STRUCT(season_id := 1, episode_count := 12),
STRUCT(season_id := 1, episode_count := 8),
'2021-02-08 10:00:00'
);

INSERT INTO production_changes (
ROWKEY,
ROWTIME,
uuid,
title_id,
change_type,
before,
after,
created_at
```

```
) VALUES (
'2',
1581161400000,
2,
2,
'release_date',
STRUCT(season_id := 1, episode_count := 14),
STRUCT(season_id := 1, episode_count := 21),
'2021-02-08 10:00:00'
);
```

Corresponding Titles information.

```
INSERT INTO titles VALUES (1, 'Stranger Things');
INSERT INTO titles VALUES (2, 'Black Mirror');
INSERT INTO titles VALUES (3, 'Bojack Horseman');
```

Now that we have prepopulated our table and stream with some test data, let's get to the exciting part: running queries against our collections.

Let's start by selecting all of the records from the production_changes stream:

```
SET 'auto.offset.reset' = 'earliest';
SELECT * FROM production_changes EMIT CHANGES ;
```

```
ksql> SELECT * FROM production_changes EMIT CHANGES ;
+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
|ROWKEY          |UUID            |TITLE_ID        |CHANGE_TYPE     |BEFORE          |AFTER           |CREATED_AT      |
+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
|2               |2               |2               |release_date    |{SEASON_ID=1, EPI|{SEASON_ID=1, EPI|2021-02-08 10:00:|
|                |                |                |                |SODE_COUNT=null}|SODE_COUNT=null}|00              |
|null            |1               |1               |season_length   |{SEASON_ID=1, EPI|{SEASON_ID=1, EPI|2021-02-08 10:00:|
|                |                |                |                |SODE_COUNT=12}  |SODE_COUNT=8}   |00              |
```

If you were to open another CLI session and execute another INSERT VALUES statement against the production_changes stream, the output of the results would be updated automatically.

```
INSERT INTO production_changes (
ROWKEY,
ROWTIME,
uuid,
title_id,
change_type,
before,
after,
created_at
) VALUES (
'3',
1681161400000,
3,
3,
```

```
'release_date',
STRUCT(season_id := 2, episode_count := 27 ),
STRUCT(season_id := 2, episode_count := 15),
'2022-02-08 10:00:00'
);
```

```
>
ksql> SELECT * FROM production_changes EMIT CHANGES ;
+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|ROWKEY           |UUID             |TITLE_ID         |CHANGE_TYPE      |BEFORE           |AFTER            |CREATED_AT       |
+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|2                |2                |2                |release_date     |{SEASON_ID=1, EPI|{SEASON_ID=1, EPI|2021-02-08 10:00:|
|                 |                 |                 |                 |SODE_COUNT=null} |SODE_COUNT=null} |00               |
|null             |1                |1                |season_length    |{SEASON_ID=1, EPI|{SEASON_ID=1, EPI|2021-02-08 10:00:|
|                 |                 |                 |                 |SODE_COUNT=12}   |SODE_COUNT=8}    |00               |
|3                |3                |3                |release_date     |{SEASON_ID=2, EPI|{SEASON_ID=2, EPI|2022-02-08 10:00:|
|                 |                 |                 |                 |SODE_COUNT=null} |SODE_COUNT=null} |00               |
```

Verify the records inserted on Titles till now.

SELECT * FROM titles EMIT CHANGES ;

All messages in the production_changes stream.

```
SELECT title_id, before, after, created_at
FROM production_changes
EMIT CHANGES ;
```

Filtering – Fetch the production information having change_type equals to ‘season_length’

```
SELECT title_id, before, after, created_at
FROM production_changes
WHERE change_type = 'season_length'
EMIT CHANGES ;
```

```
ksql> SELECT title_id, before, after, created_at
>FROM production_changes
>EMIT CHANGES ;
>
+----------------------------------+----------------------------------+----------------------------------+----------------------------------+
|TITLE_ID                          |BEFORE                            |AFTER                             |CREATED_AT                        |
+----------------------------------+----------------------------------+----------------------------------+----------------------------------+
|1                                 |{SEASON_ID=1, EPISODE_COUNT=12}   |{SEASON_ID=1, EPISODE_COUNT=8}    |2021-02-08 10:00:00               |
|3                                 |{SEASON_ID=2, EPISODE_COUNT=null} |{SEASON_ID=2, EPISODE_COUNT=null} |2022-02-08 10:00:00               |
|2                                 |{SEASON_ID=1, EPISODE_COUNT=null} |{SEASON_ID=1, EPISODE_COUNT=null} |2021-02-08 10:00:00               |
^CQuery terminated
ksql> SELECT title_id, before, after, created_at
>FROM production_changes
>WHERE change_type = 'season_length'
>EMIT CHANGES ;
>
+----------------------------------+----------------------------------+----------------------------------+----------------------------------+
|TITLE_ID                          |BEFORE                            |AFTER                             |CREATED_AT                        |
+----------------------------------+----------------------------------+----------------------------------+----------------------------------+
|1                                 |{SEASON_ID=1, EPISODE_COUNT=12}   |{SEASON_ID=1, EPISODE_COUNT=8}    |2021-02-08 10:00:00               |

Press CTRL-C to interrupt
```

Flattening values involves breaking out nested fields in a complex structure (e.g., a STRUCT) into top-level, single-value columns. – [after->season_id]

```
SELECT
title_id,
after->season_id,
after->episode_count,
created_at
FROM production_changes
WHERE change_type = 'season_length'
```

```
EMIT CHANGES ;
```

```
ksql> SELECT
>title_id,
>after->season_id,
>after->episode_count,
>created_at
>FROM production_changes
>WHERE change_type = 'season_length'
>EMIT CHANGES ;
+------------------------------+------------------------------+------------------------------+------------------------------+
|TITLE_ID                      |SEASON_ID                     |EPISODE_COUNT                 |CREATED_AT                    |
+------------------------------+------------------------------+------------------------------+------------------------------+
|1                             |1                             |8                             |2021-02-08 10:00:00           |

Press CTRL-C to interrupt
```

Derived collections are the product of creating streams and tables from other streams and tables.

```
CREATE STREAM season_length_changes
WITH (
KAFKA_TOPIC = 'season_length_changes',
VALUE_FORMAT = 'AVRO',
PARTITIONS = 4,
REPLICAS = 1
```

```
) AS SELECT
ROWKEY,
title_id,
IFNULL(after->season_id, before->season_id) AS season_id,
before->episode_count AS old_episode_count,
after->episode_count AS new_episode_count,
created_at
FROM production_changes
WHERE change_type = 'season_length'
EMIT CHANGES ;
```

```
ksql> CREATE STREAM season_length_changes
>WITH (
>KAFKA_TOPIC = 'season_length_changes',
>VALUE_FORMAT = 'AVRO',
>PARTITIONS = 4,
>REPLICAS = 1
>) AS SELECT
>ROWKEY,
>title_id,
>IFNULL(after->season_id, before->season_id) AS season_id,
>before->episode_count AS old_episode_count,
>after->episode_count AS new_episode_count,
>created_at
>FROM production_changes
>WHERE change_type = 'season_length'
>EMIT CHANGES ;

 Message
----------------------------------------------------
 Created query with ID CSAS_SEASON_LENGTH_CHANGES_7
----------------------------------------------------
ksql>
```

Fetch information from the above stream.

select * from season_length_changes;

```
ksql> select * from season_length_changes;
+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+
|ROWKEY              |TITLE_ID            |SEASON_ID           |OLD_EPISODE_COUNT   |NEW_EPISODE_COUNT   |CREATED_AT          |
+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+
|null                |1                   |1                   |12                  |8                   |2021-02-08 10:00:00 |
|null                |1                   |1                   |12                  |8                   |2021-02-08 10:00:00 |
Query terminated
ksql>
```

You can view the Queries running in the KSQDL and get details of the stream as shown below.

SHOW QUERIES;

Next let us perform the following:

- joins and aggregations
- time-based (e.g., windowed operations)

Let's write a join query. In our tutorial, our preprocessed data stream, season_length_changes, includes a column called title_id.

We'd like to use this value to look up more information about a title (including the title name, e.g., Stranger Things or Black Mirror, which is stored in the titles table).

If we wanted to express this as an inner join, we could execute the SQL statement.

```
SELECT
        s.title_id,
        t.title,
        s.season_id,
        s.old_episode_count,
        s.new_episode_count,
        s.created_at
FROM season_length_changes s
INNER JOIN titles t
ON s.title_id = t.id
EMIT CHANGES ;
```

```
-------------------------------------------------
ksql> SELECT
>s.title_id,
>t.title,
>s.season_id,
>s.old_episode_count,
>s.new_episode_count,
>s.created_at
>FROM season_length_changes s
>INNER JOIN titles t
>ON s.title_id = t.id
>EMIT CHANGES ;
>
+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+
|TITLE_ID            |TITLE               |SEASON_ID           |OLD_EPISODE_COUNT   |NEW_EPISODE_COUNT   |CREATED_AT          |
+--------------------+--------------------+--------------------+--------------------+--------------------+--------------------+
|1                   |Stranger Things     |1                   |12                  |8                   |2021-02-08 10:00:00 |
```

Windowed joins use something called sliding windows under the hood, which group records that

fall within a configured time boundary.

To create a windowed join, you need to include the WITHIN expression in your join clause. The syntax is as follows:

```
WITHIN <number> <time_unit>
```

At Netflix, and you've decided to capture all shows or movies that get less than two minutes of watch time

before the user ends their watch session. The start-watching and stop-watching events are written to separate Kafka topics. This is a great use case for a windowed join since we need to join each record using a session_id (which identifies the watch session) and the event time. Translating this example into SQL, let's first create our two source streams using the DDL.

Create two separate streams for start- and stop-watching events.

```
CREATE STREAM start_watching_events (
        session_id STRING,
        title_id INT,
```

```
        created_at STRING
)
WITH (
        KAFKA_TOPIC='start_watching_events',
        VALUE_FORMAT='JSON',
        PARTITIONS=4,
        TIMESTAMP='created_at',
        TIMESTAMP_FORMAT='yyyy-MM-dd HH:mm:ss'
);

CREATE STREAM stop_watching_events (
        session_id STRING,
        title_id INT,
        created_at STRING
)
WITH (
        KAFKA_TOPIC='stop_watching_events',
        VALUE_FORMAT='JSON',
        PARTITIONS=4,
        TIMESTAMP='created_at',
        TIMESTAMP_FORMAT='yyyy-MM-dd HH:mm:ss'
);
```

Now, let's insert a couple of start- and stop-watching events for two different watch sessions (you can think of this as two different viewers watching two different shows). The first

session, session_123, will have a total watch time of 90 seconds. The second session, session_456, will have a total watch time of 25 minutes:

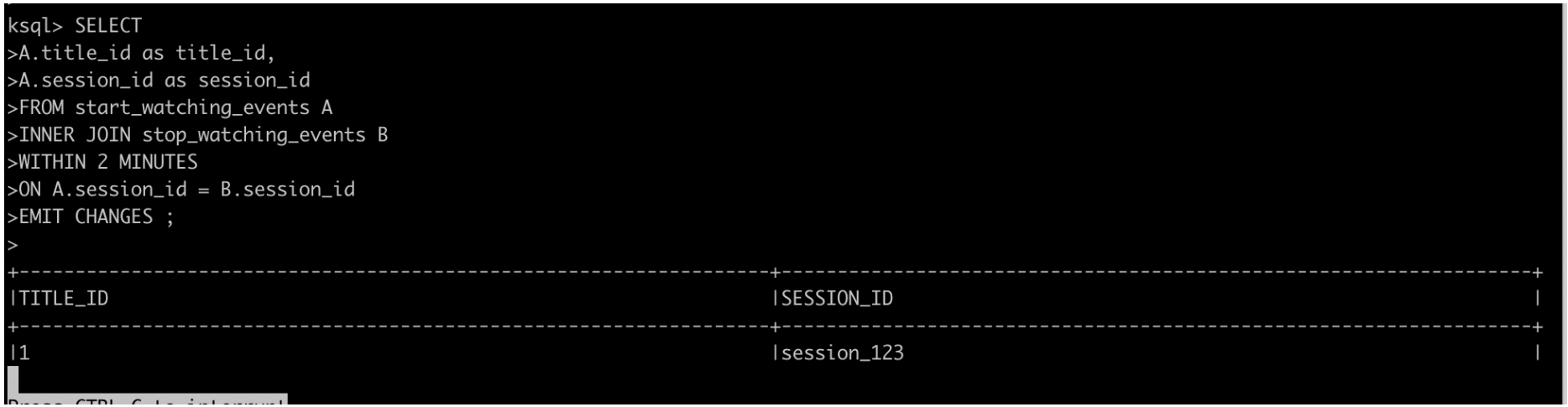
```
INSERT INTO start_watching_events
VALUES ('session_123', 1, '2021-02-08 02:00:00');

INSERT INTO stop_watching_events
VALUES ('session_123', 1, '2021-02-08 02:01:30');

INSERT INTO start_watching_events
VALUES ('session_456', 1, '2021-02-08 02:00:00');

INSERT INTO stop_watching_events
VALUES ('session_456', 1, '2021-02-08 02:25:00');
```

Finally, let's capture the watch sessions that were less than two minutes long using a windowed join. At a high level, we're simply asking the following question with our query: which watch sessions were terminated (as indicated by the stop-watching timestamp) within two minutes of their start time (as indicated by the start-watching timestamp)? The following SQL statement demonstrates how to ask this question in

ksqlDB:

```
SELECT
```

```
        A.title_id as title_id,
        A.session_id as session_id
FROM start_watching_events A
INNER JOIN stop_watching_events B
WITHIN 2 MINUTES
ON A.session_id = B.session_id
EMIT CHANGES ;
```



Aggregation

Persistent joins : You can persist the Join Query for continuous execution.

```
CREATE STREAM season_length_changes_enriched
WITH (
```

```
KAFKA_TOPIC = 'season_length_changes_enriched',
VALUE_FORMAT = 'AVRO',
PARTITIONS = 4,
TIMESTAMP='created_at',
TIMESTAMP_FORMAT='yyyy-MM-dd HH:mm:ss'
) AS
SELECT
        s.title_id,
        t.title,
        s.season_id,
        s.old_episode_count,
        s.new_episode_count,
        s.created_at
FROM season_length_changes s
INNER JOIN titles t
ON s.title_id = t.id
EMIT CHANGES ;
```

Aggregated Windows Query

```
SELECT
title_id,
season_id,
COUNT(*) AS change_count,
LATEST_BY_OFFSET(new_episode_count) AS latest_episode_count
FROM season_length_changes_enriched
WINDOW TUMBLING (SIZE 1 HOUR)
GROUP BY title_id, season_id
EMIT CHANGES ;
```

```
ksql> SELECT
>title_id,
>season_id,
>COUNT(*) AS change_count,
>LATEST_BY_OFFSET(new_episode_count) AS latest_episode_count
>FROM season_length_changes_enriched
>WINDOW TUMBLING (SIZE 1 HOUR)
>GROUP BY title_id, season_id
>EMIT CHANGES ;
+------------------------------+------------------------------+------------------------------+------------------------------+
|TITLE_ID                      |SEASON_ID                     |CHANGE_COUNT                  |LATEST_EPISODE_COUNT          |
+------------------------------+------------------------------+------------------------------+------------------------------+
|1                             |1                             |1                             |8                             |

Press CTRL-C to interrupt
```

let's create a materialized view from our windowed aggregation query that we created in

```
CREATE TABLE season_length_change_counts
WITH (
    KAFKA_TOPIC = 'season_length_change_counts',
    VALUE_FORMAT = 'AVRO',
    PARTITIONS = 1,
     KEY_FORMAT = 'JSON'
) AS
SELECT title_id, before->season_id  as season_id , COUNT(*) AS change_count,
LATEST_BY_OFFSET(after->EPISODE_COUNT) AS episode_count
FROM production_changes
WINDOW TUMBLING (
    SIZE 1 HOUR,
    RETENTION 2 DAYS,
```

```
        GRACE PERIOD 10 MINUTES
)
GROUP BY title_id, before->season_id
EMIT CHANGES ;
```

```
ksql> CREATE TABLE season_length_change_counts
>WITH (
>     KAFKA_TOPIC = 'season_length_change_counts',
>     VALUE_FORMAT = 'AVRO',
>     PARTITIONS = 1,
>      KEY_FORMAT = 'JSON'
>) AS
>SELECT title_id, before->season_id  as season_id , COUNT(*) AS change_count, LATEST_BY_OFFSET(after->EPISODE_COUNT) AS episode_count
>FROM production_changes
>WINDOW TUMBLING (
>     SIZE 1 HOUR,
>     RETENTION 2 DAYS,
>   GRACE PERIOD 10 MINUTES
>)
>GROUP BY title_id, before->season_id
>EMIT CHANGES ;
>

 Message
---------------------------------------------------------
 Created query with ID CTAS_SEASON_LENGTH_CHANGE_COUNTS_131
---------------------------------------------------------
ksql>
```

You can retrieve the column name as follow:

```
DESCRIBE season_length_change_counts ;
```

```
ksql> DESCRIBE season_length_change_counts ;

Name                 : SEASON_LENGTH_CHANGE_COUNTS
 Field         | Type
-------------------------------------------------------------------------------
 TITLE_ID      | INTEGER          (primary key) (Window type: TUMBLING)
 SEASON_ID     | INTEGER          (primary key) (Window type: TUMBLING)
 CHANGE_COUNT  | BIGINT
 EPISODE_COUNT | INTEGER
-------------------------------------------------------------------------------

ksql>
```

An example pull query

```
SELECT *
FROM season_length_change_counts
WHERE title_id = 1 and season_id =1 ;
```

```
ksql> SELECT *
>FROM season_length_change_counts
>WHERE title_id = 1 and season_id =1 ;
>
+----------------------+----------------------+----------------------+----------------------+----------------------+----------------------+
|TITLE_ID              |SEASON_ID             |WINDOWSTART           |WINDOWEND             |CHANGE_COUNT          |EPISODE_COUNT         |
+----------------------+----------------------+----------------------+----------------------+----------------------+----------------------+
|1                     |1                     |1612756800000         |1612760400000         |1                     |8                     |
Query terminated
ksql>
```

You can drop the stream as shown below.

DROP STREAM SEASON_LENGTH_CHANGES_ENRICHED delete topic;

```
ksql> DROP STREAM SEASON_LENGTH_CHANGES_ENRICHED delete topic;

 Message
----------------------------------------------------------------------------------------------
 Source `SEASON_LENGTH_CHANGES_ENRICHED` (topic: season_length_changes_enriched) was dropped.
----------------------------------------------------------------------------------------------
ksql>
```

---------- Lab Ends Here ----------

11. Testing and Troubleshooting – 60 Minutes

Testing Lab:

In this exercise, let us write a unit test for aggregation operation in Kafka Streams application.

Define Avro schema and store in the following file.

avro/electronic_order.avsc

Update the following in the above file.

```
{
  "namespace": "com.test.avro",
  "type": "record",
  "name": "ElectronicOrder",
  "fields": [
    {"name": "order_id", "type": "string" },
    {"name": "electronic_id", "type": "string" },
    {"name": "user_id", "type": "string" },
```

```
    {"name": "price", "type": "double", "default": 0.0 },
    {"name": "time", "type": "long" }
  ]
}
```

The Utility class to read stream properties file along with some helper methods are define in the below java file.

com/utils/stream/StreamsUtils.java

```
package com.utils.stream;



import java.io.FileInputStream;
import java.io.IOException;
import java.util.HashMap;
import java.util.Map;
import java.util.Properties;

import org.apache.avro.specific.SpecificRecord;
import org.apache.kafka.clients.admin.NewTopic;
```

```
import org.apache.kafka.clients.producer.Callback;


import io.confluent.kafka.streams.serdes.avro.SpecificAvroSerde;


    public class StreamsUtils {


        public static final String PROPERTIES_FILE_PATH =
"src/main/resources/streams.properties";
        public static final short REPLICATION_FACTOR = 3;
        public static final int PARTITIONS = 6;


        public static Properties loadProperties() throws
IOException {
                Properties properties = new Properties();
            try (FileInputStream fis = new
FileInputStream("src/main/resources/streams.properties")) {
```

```
                properties.load(fis);
                return properties;
            }
        }
    public static Map<String,Object> propertiesToMap(final
Properties properties) {
            final Map<String, Object> configs = new HashMap<>();
            properties.forEach((key, value) ->
configs.put((String)key, (String)value));
            return configs;
        }


    public static <T extends SpecificRecord>
SpecificAvroSerde<T> getSpecificAvroSerde(final Map<String, Object>
serdeConfig) {
```

```
            final SpecificAvroSerde<T> specificAvroSerde = new
SpecificAvroSerde<>();
            specificAvroSerde.configure(serdeConfig, false);
            return specificAvroSerde;
        }


        public static Callback callback() {
            return (metadata, exception) -> {
                if(exception != null) {
                    System.out.printf("Producing records
encountered error %s %n", exception);
                } else {
                    System.out.printf("Record produced - offset -
%d timestamp - %d %n", metadata.offset(), metadata.timestamp());
                }
```

```
            };
        }


        public static NewTopic createTopic(final String topicName){
                    return new NewTopic(topicName, PARTITIONS,
REPLICATION_FACTOR);
        }
    }
```

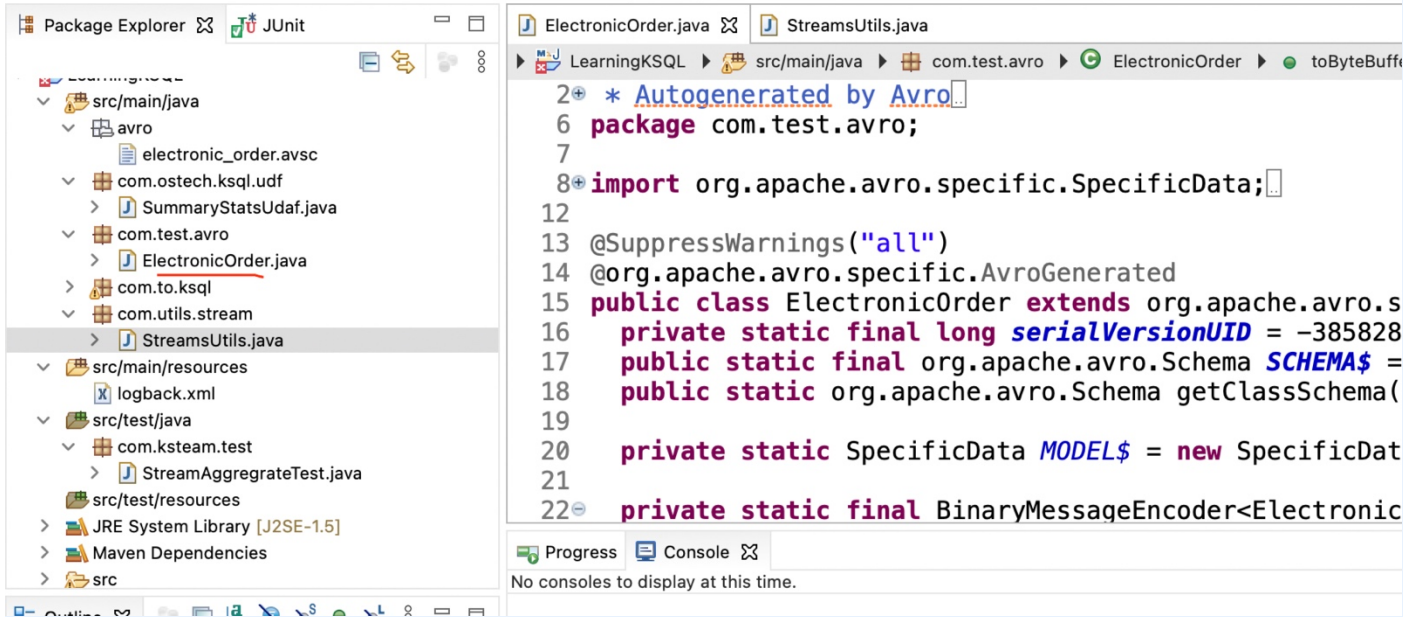
Generate Resources from Avro Schema.

ElectronicOrder.java object is being used in the stream application to map the record event in the stream application.

It will be generated from the above define Avro schema.

Pom.xml → Generate sources.

It will generate class file as shown below:



Finally, let us define the Unit Test Program

com/ksteam/test/StreamAggregrateTest.java

Import the following package.

```
package com.ksteam.test;
```

```
import static org.junit.Assert.assertEquals;
import io.confluent.kafka.streams.serdes.avro.SpecificAvroSerde;
import java.util.ArrayList;
import java.util.List;
import java.util.Map;
import java.util.Properties;

import org.apache.kafka.common.serialization.Serde;
import org.apache.kafka.common.serialization.Serdes;
import org.apache.kafka.streams.StreamsBuilder;
import org.apache.kafka.streams.StreamsConfig;
import org.apache.kafka.streams.TestInputTopic;
import org.apache.kafka.streams.TestOutputTopic;
import org.apache.kafka.streams.TopologyTestDriver;
```

```
import org.apache.kafka.streams.kstream.Consumed;
import org.apache.kafka.streams.kstream.KStream;
import org.apache.kafka.streams.kstream.Materialized;
import org.apache.kafka.streams.kstream.Produced;
import org.junit.Test;

import com.test.avro.ElectronicOrder;
import com.utils.stream.StreamsUtils;
```

Add the following test code.

```
@Test
    public void shouldAggregateRecords() {
```

```
        final Properties streamsProps = new Properties();
        streamsProps.put(StreamsConfig.APPLICATION_ID_CONFIG,
"aggregate-test");
        streamsProps.put("schema.registry.url",
"mock://aggregation-test");

        final String inputTopicName = "input";
        final String outputTopicName = "output";
        final Map<String, Object> configMap =
                StreamsUtils.propertiesToMap(streamsProps);

        final SpecificAvroSerde<ElectronicOrder> electronicSerde =
                StreamsUtils.getSpecificAvroSerde(configMap);
        final Serde<String> stringSerde = Serdes.String();
        final Serde<Double> doubleSerde = Serdes.Double();
```

```
        final StreamsBuilder builder = new StreamsBuilder();
        final KStream<String, ElectronicOrder> electronicStream =
                builder.stream(inputTopicName,
Consumed.with(Serdes.String(), electronicSerde));

        electronicStream.groupByKey().aggregate(() -> 0.0,
                (key, order, total) -> total + order.getPrice(),
                Materialized.with(stringSerde, doubleSerde))
                .toStream().to(outputTopicName,
Produced.with(Serdes.String(), Serdes.Double()));

        try (final TopologyTestDriver testDriver = new
TopologyTestDriver(builder.build(), streamsProps)) {
            final TestInputTopic<String, ElectronicOrder>
inputTopic =
```

```
                testDriver.createInputTopic(inputTopicName,
                        stringSerde.serializer(),
                        electronicSerde.serializer());
        final TestOutputTopic<String, Double> outputTopic =
                testDriver.createOutputTopic(outputTopicName,
                        stringSerde.deserializer(),
                        doubleSerde.deserializer());


        final List<ElectronicOrder> orders = new ArrayList<>();

orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setO
rderId("1").setUserId("vandeley").setTime(5L).setPrice(5.0).build()
);

orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setO
rderId("2").setUserId("penny-
packer").setTime(5L).setPrice(15.0).build());
```

```
orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setO
rderId("3").setUserId("romanov").setTime(5L).setPrice(25.0).build()
);


            // Successful Test case

            List<Double> expectedValues = List.of(5.0, 20.0, 45.0);

            orders.forEach(order ->
inputTopic.pipeInput(String.valueOf(order.getElectronicId()),
order));

            List<Double> actualValues =
outputTopic.readValuesToList();

            assertEquals(expectedValues, actualValues);


        }


    }
```

That completes the definition of the Test program.

Note:

Begin by adding a configuration to use a mock Schema Registry under your existing `streamsProps` configuration:

```
streamsProps.put("schema.registry.url", "mock://aggregation-test");
```

This is an in-memory version of your Schema Registry, suitable for unit testing.

Next, under your `groupByKey` statement, create a `TopologyTestDriver` with the application topology and configuration. (Note that we use a `try-with-resources` block to ensure that the test driver is closed at the end of the test, which is important for cleaning up state).

Create a test input topic with the `TopologyTestDriver` factory method `createInputTopic`; you'll use this in the test to drive input records into the Kafka Streams application. Provide a topic name and also SerDes, since a Kafka Streams application expects to see records in byte array format.

```
try (final TopologyTestDriver testDriver = new
TopologyTestDriver(builder.build(), streamsProps)) {
    final TestInputTopic<String, ElectronicOrder> inputTopic =
        testDriver.createInputTopic(inputTopicName,
                  stringSerde.serializer(),
                      electronicSerde.serializer());
```

Now create a `TestOutputTopic` with another `TopologyTestDriver` factory method. The `TestOutputTopic` captures results from the Kafka Streams application under test. Add the `outputTopicName` and SerDes. (Note that the Kafka Streams application output is also in byte array format.)

```
final TestOutputTopic<String, Double> outputTopic =
    testDriver.createOutputTopic(outputTopicName,
                stringSerde.deserializer(),
                    doubleSerde.deserializer());
```

Next, you need some sample events for the test. Create a list of `ElectronicOrder` objects for input into the topology. Here, each object is created using the builder provided by the generated Avro object code.

```
final List<ElectronicOrder> orders = new ArrayList<>();
orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setOrderId("1
").setUserId("vandeley").setTime(5L).setPrice(5.0).build());
orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setOrderId("2
").setUserId("penny-packer").setTime(5L).setPrice(15.0).build());
orders.add(ElectronicOrder.newBuilder().setElectronicId("one").setOrderId("3
").setUserId("romanov").setTime(5L).setPrice(25.0).build());
```

Create the list of expected aggregation results. Note that the `TopologyTestDriver` does not buffer out anything, so each input record emits a new update (similar to the behavior you see by setting the cache to zero bytes in the Kafka Streams application). Next, run some events into your test topology using `inputTopic.pipeInput`.

```
List<Double> expectedValues = List.of(5.0, 20.0, 45.0);
orders.forEach(order -> inputTopic.pipeInput(order.getElectronicId(),
order));
```

Get the output from Kafka Streams and use the `outputTopic.readValuesToList` method to read only the values, output into a list (since we only care about the aggregation results). Finally, confirm the results of the test by asserting that the `actualValues` list equals `expectedValues`.

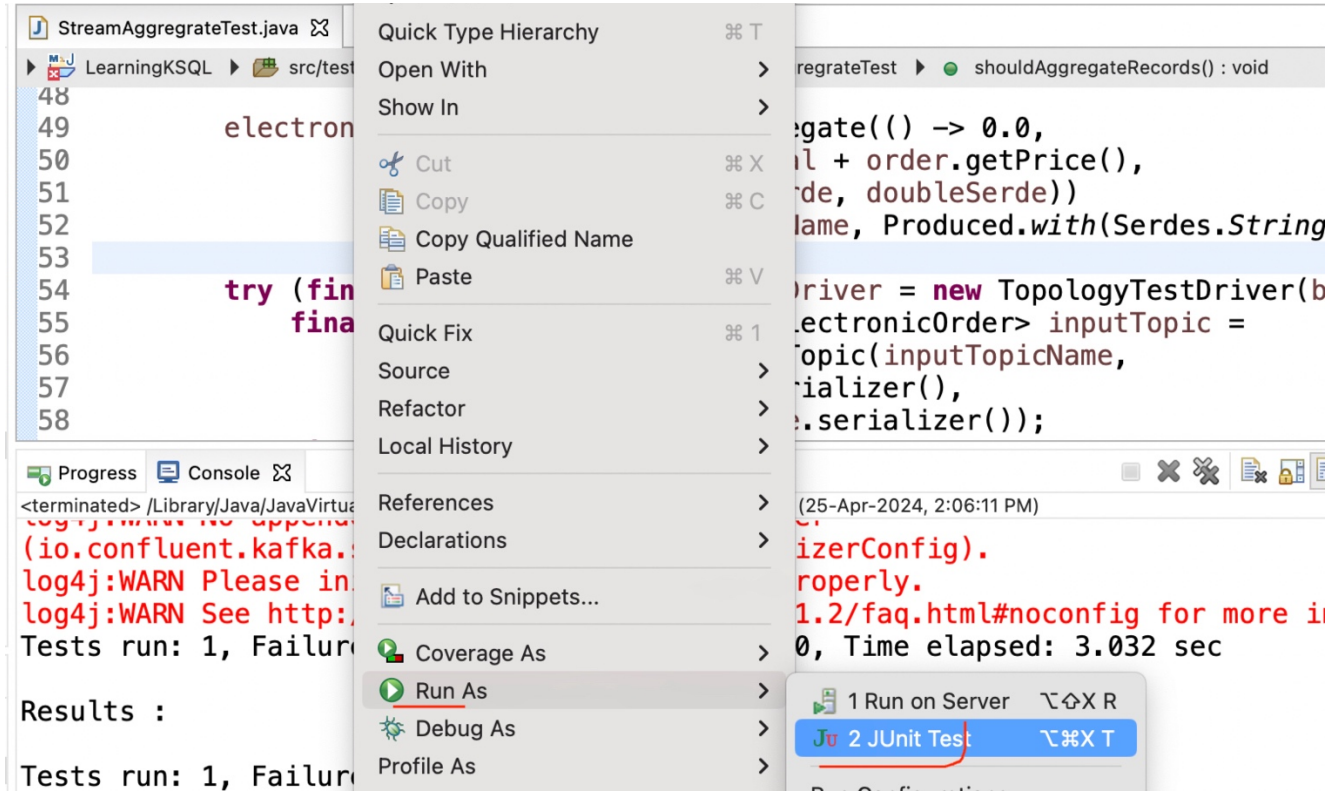
```
List<Double> actualValues = outputTopic.readValuesToList();
assertEquals(expectedValues, actualValues);
```

Execute Test Case using pom.xml

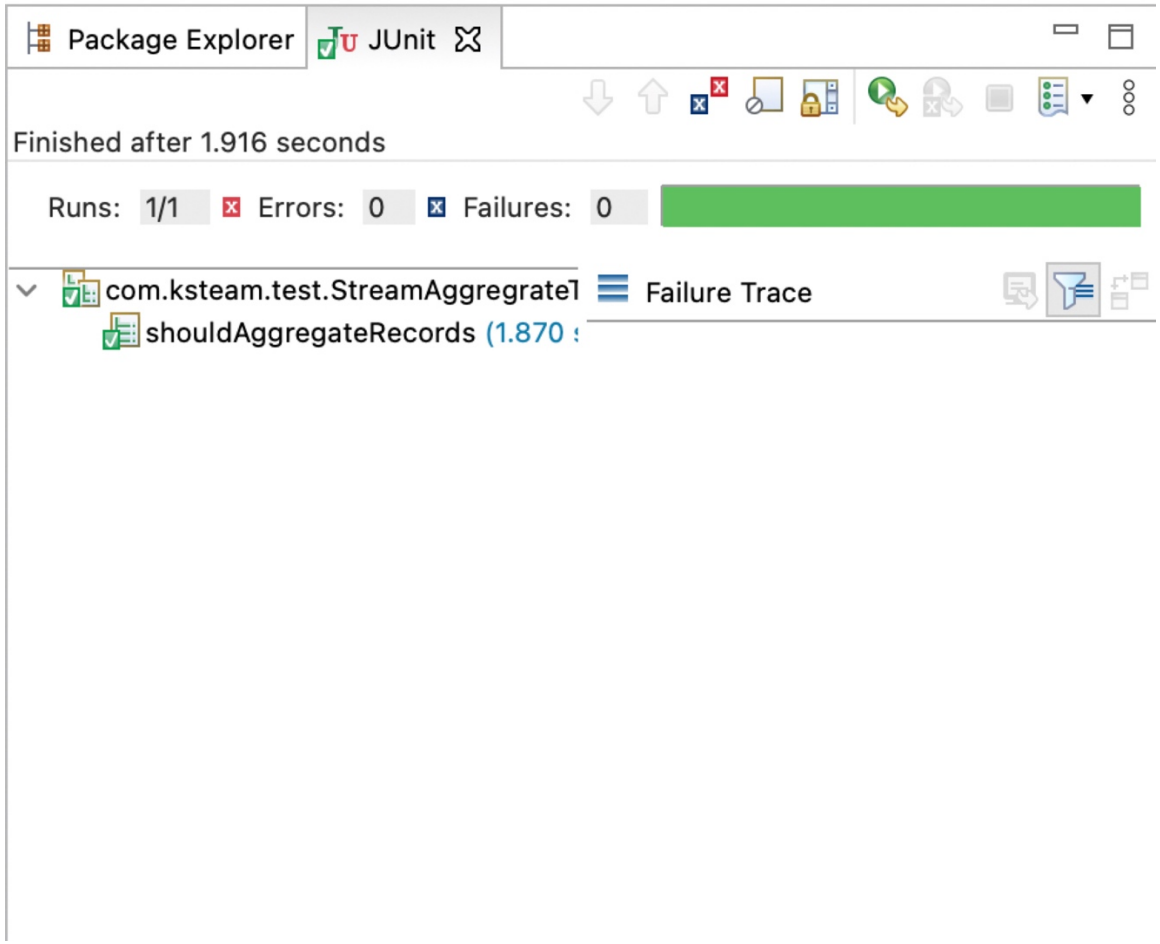
Pom.xml → Run as →Maven Test

```
<terminated> /Library/Java/JavaVirtualMachines/jdk-11.0.9.jdk/Contents/Home/bin/java (25-Apr-2024, 2:06:11 PM)
(io.confluent.kafka.serializers.KafkaAvroSerializerConfig).
log4j:WARN Please initialize the log4j system properly.
log4j:WARN See http://logging.apache.org/log4j/1.2/faq.html#noconfig for more info.
Tests run: 1, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 3.032 sec

Results :

Tests run: 1, Failures: 0, Errors: 0, Skipped: 0

[INFO] ------------------------------------┼------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time:  8.450 s
[INFO] Finished at: 2024-04-25T14:06:22+05:30
[INFO] ------------------------------------------------------------------------
```

Or Run as Junit application.



It should output as shown below:


Package Explorer
JUnit
Finished after 1.916 seconds
Runs: 1/1
Errors: 0
Failures: 0
com.ksteam.test.StreamAggregrateT
shouldAggregateRecords (1.870
Failure Trace

Troubleshooting:

In this section, build an example workload that enables experimenting with pull queries.

In the ksqlDB CLI, run the following statement to create an input stream.

```
CREATE STREAM pq_pageviews (user_id INTEGER KEY, url STRING, status INTEGER) WITH
 (kafka_topic='pq_pageviews', value_format='json', partitions=1);
```

Create a materialized view over this input stream. The materialized view aggregates events from the `pageviews` stream, grouped on the events' `url` field:

```
CREATE TABLE pq_pageviews_metrics AS
 SELECT url, COUNT(*) AS num_views
  FROM pq_pageviews
  GROUP BY url
  EMIT CHANGES;
```

Populate the materialized view by writing events to the `pageviews` input stream.

```
INSERT INTO pq_pageviews (user_id, url, status) VALUES (0, 'https://confluent.io', 200);
INSERT INTO pq_pageviews (user_id, url, status) VALUES (1, 'https://confluent.io/blog', 200);
```

Now that the materialized view contains some data, issue a pull query against it to retrieve the latest count for a given URL.

```
SELECT * FROM pq_pageviews_metrics WHERE url = 'https://confluent.io';
```

Your output should resemble:

```
ksql> SELECT * FROM pq_pageviews_metrics WHERE url = 'https://confluent.io';
+-----------------------------------------------------------------+-----------------------------------------------------------------+
|URL                                                              |NUM_VIEWS                                                        |
+-----------------------------------------------------------------+-----------------------------------------------------------------+
|https://confluent.io                                             |1                                                                |
Query terminated
ksql>
```

This pull query should return precisely one row. Each time the pull query runs, it will return the latest value for the targeted row.

Query Restarts

If your cluster is repeatedly hitting query restarts, you can see details about the underlying failures by running the ksqlDB EXPLAIN statement:

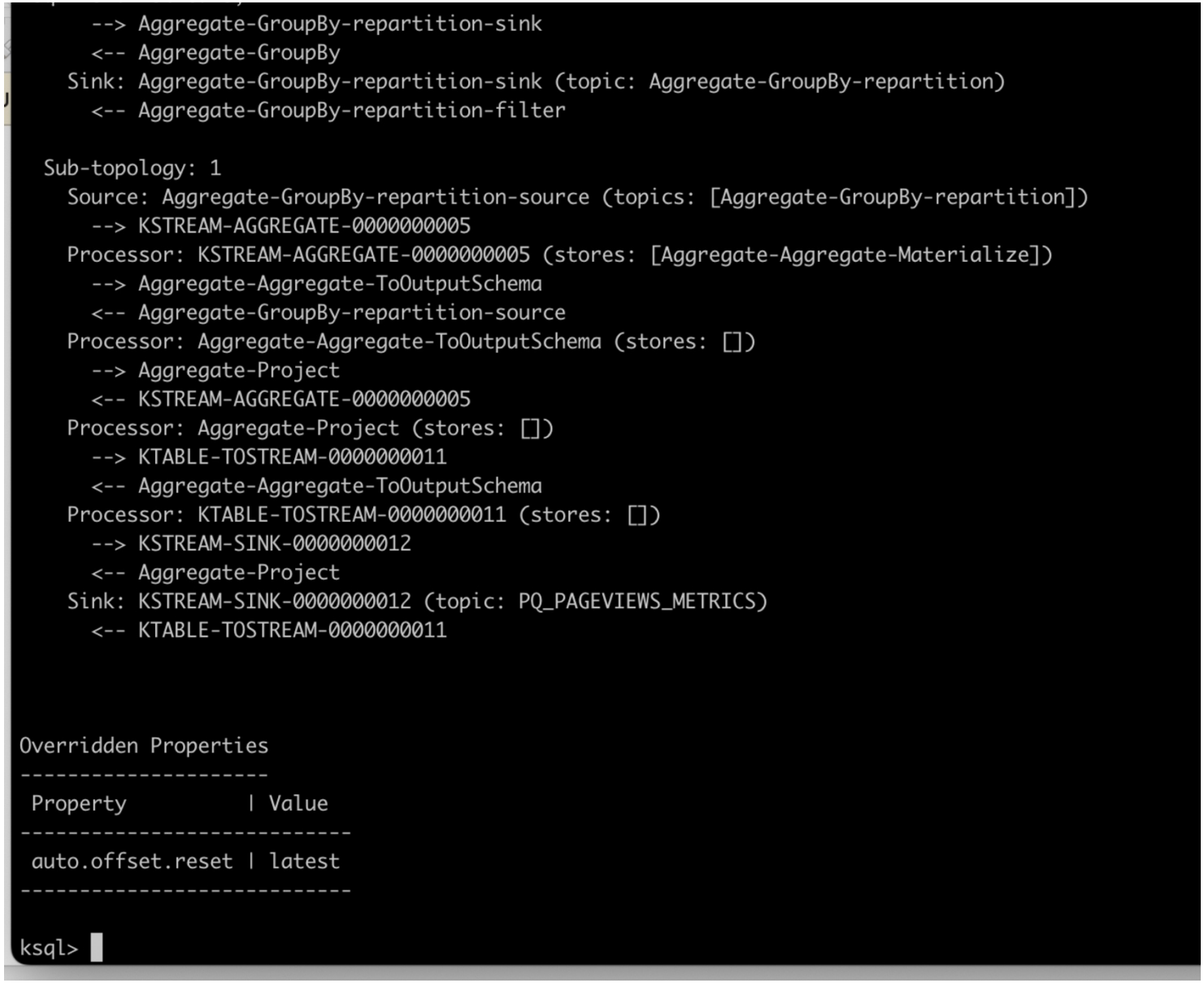
```
EXPLAIN <QUERY ID>;
```

How to find the Query ID

show queries;

```
ksql> show queries;

 Query ID                    | Query Type | Status    | Sink Name            | Sink Kafka Topic     | Query String

-------------------------------------------------------------------------------------------------------------------------------------------------------------------
 CTAS_PQ_PAGEVIEWS_METRICS_5 | PERSISTENT | RUNNING:1 | PQ_PAGEVIEWS_METRICS | PQ_PAGEVIEWS_METRICS | CREATE TABLE PQ_PAGEVIEWS_METRI
CS WITH (KAFKA_TOPIC='PQ_PAGEVIEWS_METRICS', PARTITIONS=1, REPLICAS=1) AS SELECT   PQ_PAGEVIEWS.URL URL,   COUNT(*) NUM_VIEWS FROM PQ
_PAGEVIEWS PQ_PAGEVIEWS GROUP BY PQ_PAGEVIEWS.URL EMIT CHANGES;
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
For detailed information on a Query run: EXPLAIN <Query ID>;
ksql>
```

#Explain CTAS_PQ_PAGEVIEWS_METRICS_5


--> Aggregate-GroupBy-repartition-sink
<-- Aggregate-GroupBy
Sink: Aggregate-GroupBy-repartition-sink (topic: Aggregate-GroupBy-repartition)
<-- Aggregate-GroupBy-repartition-filter
Sub-topology: 1
Source: Aggregate-GroupBy-repartition-source (topics: [Aggregate-GroupBy-repartition])
--> KSTREAM-AGGREGATE-0000000005
Processor: KSTREAM-AGGREGATE-0000000005 (stores: [Aggregate-Aggregate-Materialize])
--> Aggregate-Aggregate-ToOutputSchema
<-- Aggregate-GroupBy-repartition-source
Processor: Aggregate-Aggregate-ToOutputSchema (stores: [])
--> Aggregate-Project
<-- KSTREAM-AGGREGATE-0000000005
Processor: Aggregate-Project (stores: [])
--> KTABLE-TOSTREAM-0000000011
<-- Aggregate-Aggregate-ToOutputSchema
Processor: KTABLE-TOSTREAM-0000000011 (stores: [])
--> KSTREAM-SINK-0000000012
<-- Aggregate-Project
Sink: KSTREAM-SINK-0000000012 (topic: PQ_PAGEVIEWS_METRICS)
<-- KTABLE-TOSTREAM-0000000011
Overridden Properties
Property | Value
auto.offset.reset | latest
ksql>

Get Details about the stream

DESCRIBE pq_pageviews_metrics;

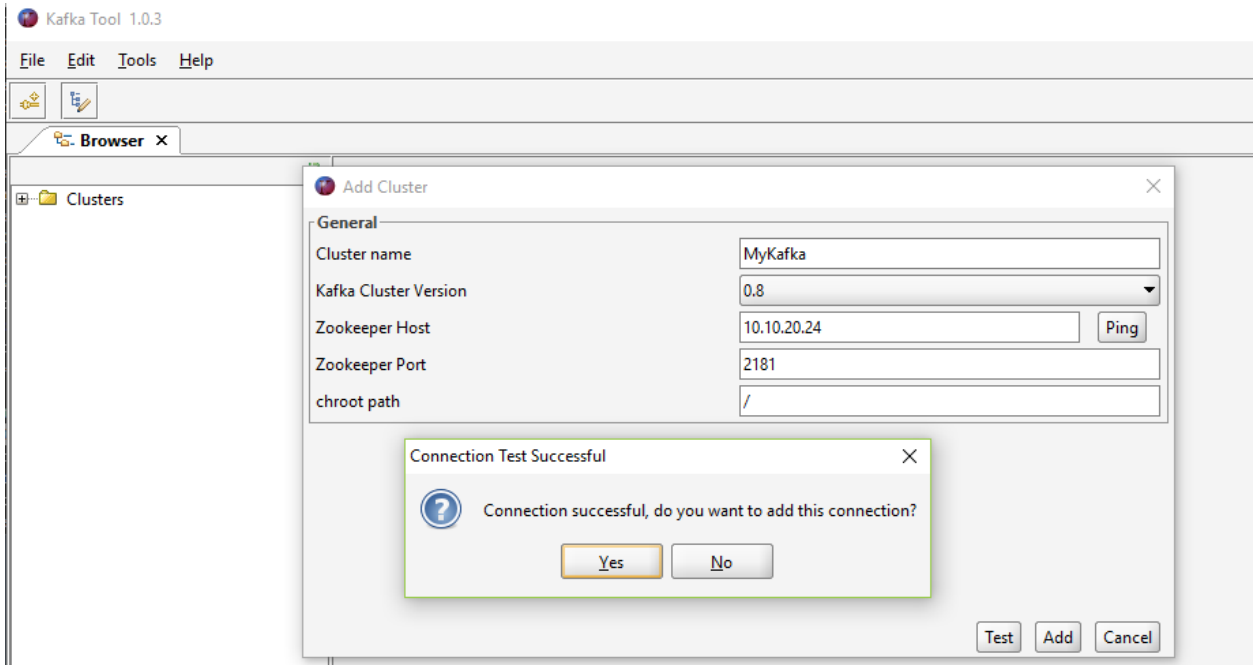
```
ksql> DESCRIBE pq_pageviews_metrics;

Name                 : PQ_PAGEVIEWS_METRICS
 Field     | Type
-----------------------------------------
 URL       | VARCHAR(STRING)  (primary key)
 NUM_VIEWS | BIGINT
-----------------------------------------
For runtime statistics and query details run: DESCRIBE <Stream,Table> EXTENDED;
ksql>
```

DESCRIBE pq_pageviews_metrics EXTENDED;

```
For query topology and execution plan please run: EXPLAIN <QueryId>

Runtime statistics by host
-------------------------
 Host        | Metric           | Value      | Last Message
-----------------------------------------------------------------------
 kafka0:8088 | messages-per-sec |          0 | 2024-04-27T06:09:49.806Z
 kafka0:8088 | total-messages   |          2 | 2024-04-27T06:09:49.806Z
-----------------------------------------------------------------------
(Statistics of the local KSQL server interaction with the Kafka topic PQ_PAGEVIEWS_METRICS)

Consumer Groups summary:

Consumer Group       : _confluent-ksql-default_query_CTAS_PQ_PAGEVIEWS_METRICS_5

Kafka topic          : _confluent-ksql-default_query_CTAS_PQ_PAGEVIEWS_METRICS_5-Aggregate-GroupBy-repartition
Max lag              : 0

 Partition | Start Offset | End Offset | Offset | Lag
-----------------------------------------------------
 0         | 2            | 2          | 2      | 0
-----------------------------------------------------

Kafka topic          : pq_pageviews
Max lag              : 0

 Partition | Start Offset | End Offset | Offset | Lag
-----------------------------------------------------
 0         | 0            | 2          | 2      | 0
-----------------------------------------------------
ksql>
```

---------- Lab Ends Here ----------

12. Kafkatools



13. Errors

I. LEADER_NOT_AVAILABLE

{test=LEADER_NOT_AVAILABLE} (org.apache.kafka.clients.NetworkClient)

```
[2018-05-15 23:46:40,132] WARN [Producer clientId=console-producer] Error while
fetching metadata with correlation id 14 : {test=LEADER_NOT_AVAILABLE} (org.apac
he.kafka.clients.NetworkClient)
[2018-05-15 23:46:40,266] WARN [Producer clientId=console-producer] Error while
fetching metadata with correlation id 15 : {test=LEADER_NOT_AVAILABLE} (org.apac
he.kafka.clients.NetworkClient)
^C[2018-05-15 23:46:40,394] WARN [Producer clientId=console-producer] Error whil
e fetching metadata with correlation id 16 : {test=LEADER_NOT_AVAILABLE} (org.ap
ache.kafka.clients.NetworkClient)
[root@tos opt]#  {test=LEADER_NOT_AVAILABLE} (org.apache.kafka.clients.NetworkCl
ient)
bash: syntax error near unexpected token `org.apache.kafka.clients.NetworkClient
```

Solutions: /opt/kafka/config/server.properties

Update the following information.

```
# it uses the value for "listeners" if configured.  Otherwise, it will use the v
alue
# returned from java.net.InetAddress.getCanonicalHostName().
advertised.listeners=PLAINTEXT://localhost:9092
```

java.util.concurrent.ExecutionException:

org.apache.kafka.common.errors.TimeoutException: Expiring 1 record(s) for my-kafka-topic-6: 30037 ms has passed since batch creation plus linger time

at org.apache.kafka.clients.producer.internals.FutureRecordMetadata.valueOrError(FutureRecordMetadata.java:94)

at org.apache.kafka.clients.producer.internals.FutureRecordMetadata.get(FutureRecordMetadata.java:64)

at org.apache.kafka.clients.producer.internals.FutureRecordMetadata.get(FutureRecordMetadata.java:29)

at com.tos.kafka.MyKafkaProducer.runProducer(MyKafkaProducer.java:97)

at com.tos.kafka.MyKafkaProducer.main(MyKafkaProducer.java:18)

Caused by: org.apache.kafka.common.errors.TimeoutException: Expiring 1 record(s) for my-kafka-topic-6: 30037 ms has passed since batch creation plus linger time.

Solution:

Update the following in all the server properties: /opt/kafka/config/server.properties

```
#     listeners = PLAINTEXT://your.host.name:9092
listeners=PLAINTEXT://tos.master.com:9093

# Hostname and port the broker will advertise to producers and consumers. If not
 set,
# it uses the value for "listeners" if configured.  Otherwise, it will use the v
alue
# returned from java.net.InetAddress.getCanonicalHostName().
advertised.listeners=PLAINTEXT://tos.master.com:9093

# Maps listener names to security protocols, the default is for them to be the s
ame. See the config documentation for more details
#listener.security.protocol.map=PLAINTEXT:PLAINTEXT,SSL:SSL,SASL_PLAINTEXT:SASL_
PLAINTEXT,SASL_SSL:SASL_SSL
```

Its should be updated with your hostname and restart the broker

Changes in the following file, if the hostname is to be changed.

//kafka/ Server.properties and control center

/apps/confluent/etc/confluent-control-center/control-center-dev.properties

/apps/confluent/etc/ksql/ksql-server.properties

/tmp/confluent.8A2Ii7O4/connect/connect.properties

Update localhost to resolve to the ip in /etc/hosts.

In case the hostname doesn’t started, updated with ip address and restart the broker.

14. Annexure Code:

II. DumplogSegment

```
/opt/kafka/bin/kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files \

/tmp/kafka-logs/my-kafka-connect-0/00000000000000000000.log | head -n 4
```

```
[root@tos test-topic-0]# more 00000000000000000000.log
[root@tos test-topic-0]# cd ../
[root@tos kafka-logs]# cd my-kafka-connect-0/
[root@tos my-kafka-connect-0]# ls
00000000000000000000.index      00000000000000000011.snapshot
00000000000000000000.log        leader-epoch-checkpoint
00000000000000000000.timeindex
[root@tos my-kafka-connect-0]# more *log
\▒▒▒▒▒▒▒▒afka Connector.--More--(53%)

[root@tos my-kafka-connect-0]# pwd
/tmp/kafka-logs/my-kafka-connect-0
[root@tos my-kafka-connect-0]# /opt/kafka/bin/kafka-run-class.sh kafka.tools.Dum
pLogSegments --deep-iteration --print-data-log --files \
> /tmp/kafka-logs/my-kafka-connect-0/00000000000000000000.log | head -n 4
Dumping /tmp/kafka-logs/my-kafka-connect-0/00000000000000000000.log
Starting offset: 0
offset: 0 position: 0 CreateTime: 1530552634675 isvalid: true keysize: -1 values
ize: 31 magic: 2 compresscodec: NONE producerId: -1 producerEpoch: -1 sequence:
-1 isTransactional: false headerKeys: [] payload: This Message is from Test File
.
offset: 1 position: 0 CreateTime: 1530552634677 isvalid: true keysize: -1 values
ize: 43 magic: 2 compresscodec: NONE producerId: -1 producerEpoch: -1 sequence:
-1 isTransactional: false headerKeys: [] payload: It will be consumed by the Kaf
ka Connector.
```

III. Data Generator – JSON

Streaming Json Data Generator

Downloading the generator

You can always find the most recent release over on github where you can download the bundle file that contains the runnable application and example configurations. Head there now and download a release to get started!

Configuration

The generator runs a Simulation which you get to define. The Simulation can specify one or many Workflows that will be run as part of your Simulation. The Workflows then generates Events and these Events are then sent somewhere. You will also need to define Producers that are used to send the Events generated by your Workflows to some destination. These destinations could be a log file, or something more complicated like a Kafka Queue.

You define the configuration for the json-data-generator using two configuration files. The first is a Simulation Config. The Simulation Config defines the Workflows that should be run and different Producers that events should be sent to. The second is a Workflow configuration (of which you can have multiple). The Workflow defines the frequency of Events and Steps that the Workflow uses to generate the Events. It is the Workflow that defines the format and content of your Events as well.

For our example, we are going to pretend that we have a programmable Jackie Chan robot. We can command Jackie Chan though a programmable interface that happens to take json as an input via a Kafka queue and you can command him to perform different fighting moves in different martial arts styles. A Jackie Chan command might look like this:

```
{
 "timestamp":"2015-05-20T22:05:44.789Z",
 "style":"DRUNKEN_BOXING",
 "action":"PUNCH",
 "weapon":"CHAIR",
 "target":"ARMS",
 "strength":8.3433
}
```

view rawexampleJackieChanCommand.json hosted with by **GitHub**

Now, we want to have some fun with our awesome Jackie Chan robot, so we are going to make him do random moves using our json-data-generator! First we need to define a Simulation Config and then a Workflow that Jackie will use.

SIMULATION CONFIG

Let's take a look at our example Simulation Config:

```
{
  "workflows": [{
      "workflowName": "jackieChan",
      "workflowFilename": "jackieChanWorkflow.json"
    }],
  "producers": [{
    "type": "kafka",
    "broker.server": "192.168.59.103",
    "broker.port": 9092,
    "topic": "jackieChanCommand",
    "flatten": false,
    "sync": false

  }]
```

```
}
```

view rawjackieChanSimConfig.json hosted with by GitHub

As you can see, there are two main parts to the Simulation Config. The Workflows name and list the workflow configurations you want to use. The Producers are where the Generator will send the events to. At the time of writing this, we have three supported Producers:

- A Logger that sends events to log files
- A Kafka Producer that will send events to your specified Kafka Broker
- A Tranquility Producer that will send events to a Druid cluster.

You can find the full configuration options for each on the github page. We used a Kafka producer because that is how you command our Jackie Chan robot.

WORKFLOW CONFIG

The Simulation Config above specifies that it will use a Workflow called jackieChanWorkflow.json. This is where the meat of your configuration would live. Let's take a look at the example Workflow config and see how we are going to control Jackie Chan:

```
{
  "eventFrequency": 400,
```

```
"varyEventFrequency": true,
"repeatWorkflow": true,
"timeBetweenRepeat": 1500,
"varyRepeatFrequency": true,
"steps": [{
    "config": [{
        "timestamp": "now()",
        "style": "random('KUNG_FU','WUSHU','DRUNKEN_BOXING')",
        "action": "random('KICK','PUNCH','BLOCK','JUMP')",
        "weapon": "random('BROAD_SWORD','STAFF','CHAIR','ROPE')",
        "target": "random('HEAD','BODY','LEGS','ARMS')",
        "strength": "double(1.0,10.0)"
      }
    ],
    "duration": 0
  }]
```

```
}
```

view rawjackieChanWorkflow.json hosted with by GitHub

The Workflow defines many things that are all defined on the github page, but here is a summary:

- At the top are the properties that define how often events should be generated and if / when this workflow should be repeated. So this is like saying we want Jackie Chan to do a martial arts move every 400 milliseconds (he's FAST!), then take a break for 1.5 seconds, and do another one.
- Next, are the Steps that this Workflow defines. Each Step has a config and a duration. The duration specifies how long to run this step. The config is where it gets interesting!

WORKFLOW STEP CONFIG

The Step Config is your specific definition of a json event. This can be any kind of json object you want. In our example, we want to generate a Jackie Chan command message that will be sent to his control unit via Kafka. So we define the command message in our config, and since we want this to be fun, we are going to randomly generate what kind of style, move, weapon, and target he will use.

You'll notice that the values for each of the object properties look a bit funny. These are special Functions that we have created that allow us to generate values for each of the properties. For instance, the "random('KICK','PUNCH','BLOCK','JUMP')" function will randomly choose one of the values and output it as the value of the "action" property in the

command message. The "now()" function will output the current date in an ISO8601 date formatted string. The "double(1.0,10.0)" will generate a random double between 1 and 10 to determine the strength of the action that Jackie Chan will perform. If we wanted to, we could make Jackie Chan perform combo moves by defining a number of Steps that will be executed in order.

There are many more Functions available in the generator with everything from random string generation, counters, random number generation, dates, and even support for randomly generating arrays of data. We also support the ability to reference other randomly generated values. For more info, please check out the full documentation on the github page.

Once we have defined the Workflow, we can run it using the json-data-generator. To do this, do the following:

1. If you have not already, go ahead and download the most recent release of the json-data-generator.
2. Unpack the file you downloaded to a directory.

   (tar -xvf json-data-generator-1.4.0-bin.tar -C /apps)

3. Copy your custom configs into the conf directory
4. Then run the generator like so:
    1. java -jar json-data-generator-1.4.0.jar jackieChanSimConfig.json

You will see logging in your console showing the events as they are being generated. The jackieChanSimConfig.json generates events like these:

{"timestamp":"2015-05-20T22:21:18.036Z","style":"WUSHU","action":"BLOCK","weapon":"CHAIR","target":"BODY","strength":4.7912}

{"timestamp":"2015-05-20T22:21:19.247Z","style":"DRUNKEN_BOXING","action":"PUNCH","weapon":"BROAD_SWORD","target":"ARMS","strength":3.0248}

{"timestamp":"2015-05-20T22:21:20.947Z","style":"DRUNKEN_BOXING","action":"BLOCK","weapon":"ROPE","target":"HEAD","strength":6.7571}

{"timestamp":"2015-05-20T22:21:22.715Z","style":"WUSHU","action":"KICK","weapon":"BROAD_SWORD","target":"ARMS","strength":9.2062}

{"timestamp":"2015-05-20T22:21:23.852Z","style":"KUNG_FU","action":"PUNCH","weapon":"BROAD_SWORD","target":"HEAD","strength":4.6202}

{"timestamp":"2015-05-20T22:21:25.195Z","style":"KUNG_FU","action":"JUMP","weapon":"ROPE","target":"ARMS","strength":7.5303}

{"timestamp":"2015-05-20T22:21:26.492Z","style":"DRUNKEN_BOXING","action":"PUNCH","weapon":"STAFF","target":"HEAD","strength":1.1247}

{"timestamp":"2015-05-20T22:21:28.042Z","style":"WUSHU","action":"BLOCK","weapon":"STAFF","target":"ARMS","strength":5.5976}

{"timestamp":"2015-05-20T22:21:29.422Z","style":"KUNG_FU","action":"BLOCK","weapon":"ROPE","target":"ARMS","strength":2.152}

{"timestamp":"2015-05-20T22:21:30.782Z","style":"DRUNKEN_BOXING","action":"BLOCK","weapon":"STAFF","target":"ARMS","strength":6.2686}

{"timestamp":"2015-05-20T22:21:32.128Z","style":"KUNG_FU","action":"KICK","weapon":"BROAD_SWORD","target":"BODY","strength":2.3534}

If you specified to repeat your Workflow, then the generator will continue to output events and send them to your Producer simulating a real world client, or in our case, continue to make Jackie Chan show off his awesome skills. If you also had a Chuck Norris robot, you could add another Workflow config to your Simulation and have the two robots fight it

out! Just another example of how you can use the generator to simulate real world situations.

IV. Configuration

```
export KSQL_HEAP_OPTS="-Xms1G -Xmx2G"
```

V. Resources

https://developer.ibm.com/hadoop/2017/04/10/kafka-security-mechanism-saslplain/

https://sharebigdata.wordpress.com/2018/01/21/implementing-sasl-plain/

https://developer.ibm.com/code/howtos/kafka-authn-authz

https://github.com/confluentinc/kafka-streams-examples/tree/4.1.x/

https://github.com/spring-cloud/spring-cloud-stream-samples/blob/master/kafka-streams-samples/kafka-streams-table-join/src/main/java/kafka/streams/table/join/KafkaStreamsTableJoin.java