Assignment 9.2

February 27, 2022

0.1 Assignment 9.2

```
[1]: import os
     import shutil
     import json
     from pathlib import Path

     import pandas as pd

     from kafka import KafkaProducer, KafkaAdminClient
     from kafka.admin.new_topic import NewTopic
     from kafka.errors import TopicAlreadyExistsError

     from pyspark.sql import SparkSession
     from pyspark.streaming import StreamingContext
     from pyspark import SparkConf
     from pyspark.sql.functions import window, from_json, col
     from pyspark.sql.types import StringType, TimestampType, DoubleType,␣
      ↪StructField, StructType
     from pyspark.sql.functions import udf

     current_dir = Path(os.getcwd()).absolute()
     checkpoint_dir = current_dir.joinpath('checkpoints')
     locations_windowed_checkpoint_dir = checkpoint_dir.
      ↪joinpath('locations-windowed')

     if locations_windowed_checkpoint_dir.exists():
         shutil.rmtree(locations_windowed_checkpoint_dir)

     locations_windowed_checkpoint_dir.mkdir(parents=True, exist_ok=True)
```

0.1.1 Configuration Parameters

```
[2]: config = dict(
         bootstrap_servers=['kafka.kafka.svc.cluster.local:9092'],
         first_name='Rachel',
         last_name='Nelson'
```

```
)

config['client_id'] = '{}{}'.format(
    config['last_name'],
    config['first_name']
)
config['topic_prefix'] = '{}{}'.format(
    config['last_name'],
    config['first_name']
)

config['locations_topic'] = '{}-locations'.format(config['topic_prefix'])
config['accelerations_topic'] = '{}-accelerations'.
 ↪format(config['topic_prefix'])
config['windowed_topic'] = '{}-windowed'.format(config['topic_prefix'])

config
```

```
[2]: {'bootstrap_servers': ['kafka.kafka.svc.cluster.local:9092'],
 'first_name': 'Rachel',
 'last_name': 'Nelson',
 'client_id': 'NelsonRachel',
 'topic_prefix': 'NelsonRachel',
 'locations_topic': 'NelsonRachel-locations',
 'accelerations_topic': 'NelsonRachel-accelerations',
 'windowed_topic': 'NelsonRachel-windowed'}
```

0.1.2 Create Topic Utility Function

The `create_kafka_topic` helps create a Kafka topic based on your configuration settings. For instance, if your first name is *John* and your last name is *Doe*, `create_kafka_topic('locations')` will create a topic with the name `DoeJohn-locations`. The function will not create the topic if it already exists.

```
[3]: def create_kafka_topic(topic_name, config=config, num_partitions=1,␣
     ↪replication_factor=1):
        bootstrap_servers = config['bootstrap_servers']
        client_id = config['client_id']
        topic_prefix = config['topic_prefix']
        name = '{}-{}'.format(topic_prefix, topic_name)

        admin_client = KafkaAdminClient(
            bootstrap_servers=bootstrap_servers,
            client_id=client_id
        )

        topic = NewTopic(
```

```
        name=name,
        num_partitions=num_partitions,
        replication_factor=replication_factor
    )

    topic_list = [topic]
    try:
        admin_client.create_topics(new_topics=topic_list)
        print('Created topic "{}"'.format(name))
    except TopicAlreadyExistsError as e:
        print('Topic "{}" already exists'.format(name))

create_kafka_topic('windowed')
```

```
Topic "NelsonRachel-windowed" already exists
```

TODO: This code is identical to the code used in 9.1 to publish acceleration and location data to the `LastnameFirstname-simple` topic. You will need to add in the code you used to create the `df_accelerations` dataframe. In order to read data from this topic, make sure that you are running the notebook you created in assignment 8 that publishes acceleration and location data to the LastnameFirstname-simple topic.

```
[4]: spark = SparkSession\
         .builder\
         .appName("Assignment09")\
         .getOrCreate()

     df_locations = spark \
       .readStream \
       .format("kafka") \
       .option("kafka.bootstrap.servers", "kafka.kafka.svc.cluster.local:9092") \
       .option("subscribe", config['locations_topic']) \
       .load()

     ## TODO: Add code to create the df_accelerations dataframe
     df_accelerations = spark \
         .readStream \
         .format("kafka") \
         .option("kafka.bootstrap.servers", "kafka.kafka.svc.cluster.local:9092") \
         .option("subscribe", config['accelerations_topic']) \
         .load()
```

The following code defines a Spark schema for location and acceleration data as well as a user-defined function (UDF) for parsing the location and acceleration JSON data.

```
[5]: location_schema = StructType([
         StructField('offset', DoubleType(), nullable=True),
         StructField('id', StringType(), nullable=True),
```

```
    StructField('ride_id', StringType(), nullable=True),
    StructField('uuid', StringType(), nullable=True),
    StructField('course', DoubleType(), nullable=True),
    StructField('latitude', DoubleType(), nullable=True),
    StructField('longitude', DoubleType(), nullable=True),
    StructField('geohash', StringType(), nullable=True),
    StructField('speed', DoubleType(), nullable=True),
    StructField('accuracy', DoubleType(), nullable=True),
])

acceleration_schema = StructType([
    StructField('offset', DoubleType(), nullable=True),
    StructField('id', StringType(), nullable=True),
    StructField('ride_id', StringType(), nullable=True),
    StructField('uuid', StringType(), nullable=True),
    StructField('x', DoubleType(), nullable=True),
    StructField('y', DoubleType(), nullable=True),
    StructField('z', DoubleType(), nullable=True),
])

udf_parse_acceleration = udf(lambda x: json.loads(x.decode('utf-8')),␣
 ↪acceleration_schema)
udf_parse_location = udf(lambda x: json.loads(x.decode('utf-8')),␣
 ↪location_schema)
```

See http://spark.apache.org/docs/latest/structured-streaming-programming-guide.html#window-operations-on-event-time for details on how to implement windowed operations.

The following code selects the `timestamp` column from the `df_locations` dataframe that reads from the `LastnameFirstname-locations` topic and parses the binary value using the `udf_parse_location` UDF and defines the result to the `json_value` column.

```
df_locations \
  .select(
    col('timestamp'),
    udf_parse_location(df_locations['value']).alias('json_value')
  )
```

From here, you can select data from the `json_value` column using the `select` method. For instance, if you saved the results of the previous code snippet to `df_locations_parsed` you could select columns from the `json_value` field and assign them aliases using the following code.

```
df_locations_parsed.select(
    col('timestamp'),
    col('json_value.ride_id').alias('ride_id'),
    col('json_value.uuid').alias('uuid'),
    col('json_value.speed').alias('speed')
  )
```

Next, you will want to add a watermark and group by `ride_id` and `speed` using a window duration

of *30 seconds* and a slide duration of *15 seconds*. Use the `withWatermark` method in conjunction with the `groupBy` method. The Spark streaming documentation should provide examples of how to do this.

Next use the `mean` aggregation method to compute the average values and rename the column `avg(speed)` to `value` and the column `ride_id` to `key`. The reason you are renaming these values is that the PySpark Kafka API expects `key` and `value` as inputs. In a production example, you would setup serialization that would handle these details for you.

When you are finished, you should have a streaming query with `key` and `value` as columns.

```
[6]: windowedSpeeds = spark \
         .readStream \
         .format("kafka") \
         .option("kafka.bootstrap.servers", "kafka.kafka.svc.cluster.local:9092") \
         .option("subscribe", config['accelerations_topic']) \
         .load()
     windowedSpeeds
```

```
[6]: DataFrame[key: binary, value: binary, topic: string, partition: int, offset:
     bigint, timestamp: timestamp, timestampType: int]
```

In the previous Jupyter cells, you should have created the `windowedSpeeds` streaming query. Next, you will need to write that to the `LastnameFirstname-windowed` topic. If you created the `windowsSpeeds` streaming query correctly, the following should publish the results to the `LastnameFirstname-windowed` topic.

```
[ ]: ds_locations_windowed = windowedSpeeds \
        .selectExpr("CAST(key AS STRING)", "CAST(value AS STRING)") \
        .writeStream \
        .format("kafka") \
        .option("kafka.bootstrap.servers", "kafka.kafka.svc.cluster.local:9092") \
        .option("topic", config['windowed_topic']) \
        .option("checkpointLocation", str(locations_windowed_checkpoint_dir)) \
        .start()

     try:
         ds_locations_windowed.awaitTermination()
     except KeyboardInterrupt:
         print("STOPPING STREAMING DATA")
```