Assignment 9.2

```
In [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, Struct
        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)
```

Configuration Parameters

'topic prefix': 'GreenertJosh',

'locations topic': 'GreenertJosh-locations',

TODO: Change the configuration prameters to the appropriate values for your setup.

```
In [2]: config = dict(
           bootstrap servers=['kafka.kafka.svc.cluster.local:9092'],
            first name='Josh',
            last name='Greenert'
        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
        {'bootstrap servers': ['kafka.kafka.svc.cluster.local:9092'],
Out[2]:
         'first name': 'Josh',
         'last name': 'Greenert',
         'client id': 'GreenertJosh',
```

```
'accelerations_topic': 'GreenertJosh-accelerations',
'windowed_topic': 'GreenertJosh-windowed'}
```

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.

```
In [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]
                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 "GreenertJosh-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.

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.

```
In [6]: 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 schem
        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 <code>json_value</code> column using the <code>select</code> method. For instance, if you saved the results of the previous code snippet to <code>df_locations_parsed</code> you could select columns from the <code>json_value</code> 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.

```
# Define the watermark duration and window duration
watermark duration = "30 seconds"
window duration = "30 seconds"
slide duration = "15 seconds"
# Apply watermark and group by ride id and speed using window duration
windowedSpeeds = df locations parsed \
    .withWatermark("timestamp", watermark duration) \
    .select(
        window("timestamp", window duration, slide duration).alias("window"),
        col("json value.ride id").alias("ride id"),
        col("json value.speed").alias("speed")
    .groupBy("window", "ride id") \
   .agg(mean("speed").alias("avg speed")) \
   .select(
        col("ride id").alias("key"),
        col("avg speed").alias("value")
windowedSpeeds
```

Out[13]: DataFrame[key: string, value: double]

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.

```
In [15]: 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")
23/05/14 02:01:47 WARN ResolveWriteToStream: spark.sql.adaptive.enabled is not supported
in streaming DataFrames/Datasets and will be disabled.
23/05/14 02:01:47 WARN AdminClientConfig: The configuration 'key.deserializer' was suppl
ied but isn't a known config.
23/05/14 02:01:47 WARN AdminClientConfig: The configuration 'value.deserializer' was sup
plied but isn't a known config.
23/05/14 02:01:47 WARN AdminClientConfig: The configuration 'enable.auto.commit' was sup
plied but isn't a known config.
23/05/14 02:01:47 WARN AdminClientConfig: The configuration 'max.poll.records' was suppl
ied but isn't a known config.
23/05/14 02:01:47 WARN AdminClientConfig: The configuration 'auto.offset.reset' was supp
lied but isn't a known config.
23/05/14 02:01:47 ERROR MicroBatchExecution: Query [id = 1951c86e-398b-40d1-8694-769049a
7049e, runId = bd6fec7f-b1fb-45c1-bba8-5265ed582044] terminated with error
java.lang.NoClassDefFoundError: org/apache/kafka/clients/admin/OffsetSpec
        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.$anonfun$fetchLatestOffs
ets$2(KafkaOffsetReaderAdmin.scala:298)
        at scala.collection.TraversableLike.$anonfun$map$1(TraversableLike.scala:286)
        at scala.collection.Iterator.foreach(Iterator.scala:943)
        at scala.collection.Iterator.foreach$(Iterator.scala:943)
        at scala.collection.AbstractIterator.foreach(Iterator.scala:1431)
        at scala.collection.IterableLike.foreach(IterableLike.scala:74)
        at scala.collection.IterableLike.foreach$(IterableLike.scala:73)
        at scala.collection.AbstractIterable.foreach(Iterable.scala:56)
       at scala.collection.TraversableLike.map(TraversableLike.scala:286)
        at scala.collection.TraversableLike.map$(TraversableLike.scala:279)
        at scala.collection.mutable.AbstractSet.scala$collection$SetLike$$super$map(Set.
scala:50)
        at scala.collection.SetLike.map(SetLike.scala:105)
        at scala.collection.SetLike.map$(SetLike.scala:105)
        at scala.collection.mutable.AbstractSet.map(Set.scala:50)
        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.$anonfun$fetchLatestOffs
ets$1(KafkaOffsetReaderAdmin.scala:298)
        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.$anonfun$partitionsAssig
nedToAdmin$1 (KafkaOffsetReaderAdmin.scala:501)
        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.withRetries(KafkaOffsetR
eaderAdmin.scala:518)
       at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.partitionsAssignedToAdmi
n(KafkaOffsetReaderAdmin.scala:498)
        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.fetchLatestOffsets(Kafka
OffsetReaderAdmin.scala:297)
        at org.apache.spark.sql.kafka010.KafkaMicroBatchStream.$anonfun$getOrCreateIniti
alPartitionOffsets$1(KafkaMicroBatchStream.scala:251)
        at scala.Option.getOrElse(Option.scala:189)
        at org.apache.spark.sql.kafka010.KafkaMicroBatchStream.getOrCreateInitialPartiti
onOffsets(KafkaMicroBatchStream.scala:246)
        at org.apache.spark.sql.kafka010.KafkaMicroBatchStream.initialOffset(KafkaMicroB
atchStream.scala:98)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$getStar
tOffset$2 (MicroBatchExecution.scala:455)
        at scala.Option.getOrElse(Option.scala:189)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.getStartOffset(M
icroBatchExecution.scala:455)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$constru
ctNextBatch$4 (MicroBatchExecution.scala:489)
        at org.apache.spark.sql.execution.streaming.ProgressReporter.reportTimeTaken(Pro
gressReporter.scala:411)
        at org.apache.spark.sql.execution.streaming.ProgressReporter.reportTimeTaken$(Pr
```

at org.apache.spark.sql.execution.streaming.StreamExecution.reportTimeTaken(Stre

ogressReporter.scala:409)

amExecution.scala:67)

```
at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$constru
ctNextBatch$2 (MicroBatchExecution.scala:488)
        at scala.collection.TraversableLike.$anonfun$map$1(TraversableLike.scala:286)
        at scala.collection.Iterator.foreach(Iterator.scala:943)
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        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$constru
ctNextBatch$1 (MicroBatchExecution.scala:477)
        at scala.runtime.java8.JFunction0$mcZ$sp.apply(JFunction0$mcZ$sp.java:23)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.withProgressLock
ed(MicroBatchExecution.scala:802)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.constructNextBat
ch (MicroBatchExecution.scala:473)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runActi
vatedStream$2 (MicroBatchExecution.scala:266)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
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ogressReporter.scala:409)
        at org.apache.spark.sql.execution.streaming.StreamExecution.reportTimeTaken(Stre
amExecution.scala:67)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runActi
vatedStream$1 (MicroBatchExecution.scala:247)
        at org.apache.spark.sql.execution.streaming.ProcessingTimeExecutor.execute(Trigg
erExecutor.scala:67)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.runActivatedStre
am (MicroBatchExecution.scala:237)
        at org.apache.spark.sql.execution.streaming.StreamExecution.$anonfun$runStream$1
(StreamExecution.scala:306)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at org.apache.spark.sql.SparkSession.withActive(SparkSession.scala:827)
        at org.apache.spark.sql.execution.streaming.StreamExecution.org$apache$spark$sql
$execution$streaming$StreamExecution$$runStream(StreamExecution.scala:284)
        at org.apache.spark.sql.execution.streaming.StreamExecution$$anon$1.run(StreamEx
ecution.scala:207)
Caused by: java.lang.ClassNotFoundException: org.apache.kafka.clients.admin.OffsetSpec
Exception in thread "stream execution thread for [id = 1951c86e-398b-40d1-8694-769049a70
49e, runId = bd6fec7f-b1fb-45c1-bba8-5265ed582044]" java.lang.NoClassDefFoundError: org/
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        at org.apache.spark.sql.kafka010.KafkaOffsetReaderAdmin.$anonfun$partitionsAssig
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        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.constructNextBat
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        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runActi
```

at org.apache.spark.sql.execution.streaming.ProcessingTimeExecutor.execute(Trigg

at org.apache.spark.sql.execution.streaming.MicroBatchExecution.runActivatedStre

at org.apache.spark.sql.execution.streaming.StreamExecution.\$anonfun\$runStream\$1

at org.apache.spark.sql.execution.streaming.StreamExecution.org\$apache\$spark\$sql

at scala.runtime.java8.JFunction0\$mcV\$sp.apply(JFunction0\$mcV\$sp.java:23) at org.apache.spark.sql.SparkSession.withActive(SparkSession.scala:827)

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am (MicroBatchExecution.scala:237)

(StreamExecution.scala:306)

erExecutor.scala:67)

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$execution$streaming$StreamExecution$$runStream(StreamExecution.scala:284)
       at org.apache.spark.sql.execution.streaming.StreamExecution$$anon$1.run(StreamEx
ecution.scala:207)
Caused by: java.lang.ClassNotFoundException: org.apache.kafka.clients.admin.OffsetSpec
       ... 58 more
StreamingQueryException
                                         Traceback (most recent call last)
Cell In[15], line 11
     1 ds locations windowed = windowedSpeeds \
        .selectExpr("CAST(key AS STRING)", "CAST(value AS STRING)") \
        .writeStream \
   (...)
         .option("checkpointLocation", str(locations windowed checkpoint dir)) \
     8
        .start()
    10 try:
           ds locations windowed.awaitTermination()
---> 11
    12 except KeyboardInterrupt:
    print("STOPPING STREAMING DATA")
File /opt/conda/lib/python3.10/site-packages/pyspark/sql/streaming/query.py:201, in Stre
amingQuery.awaitTermination(self, timeout)
          return self. jsq.awaitTermination(int(timeout * 1000))
   200 else:
--> 201 return self. jsq.awaitTermination()
File /opt/conda/lib/python3.10/site-packages/py4j/java gateway.py:1322, in JavaMember.
call (self, *args)
  1316 command = proto.CALL COMMAND NAME +\
  1317     self.command header +\
  1318
          args command +\
          proto.END COMMAND PART
  1319
  1321 answer = self.gateway client.send command(command)
-> 1322 return value = get return value(
  answer, self.gateway client, self.target id, self.name)
  1325 for temp arg in temp args:
  1326
         if hasattr(temp arg, " detach"):
File /opt/conda/lib/python3.10/site-packages/pyspark/errors/exceptions/captured.py:175,
in capture sql exception.<locals>.deco(*a, **kw)
   171 converted = convert exception(e.java exception)
   172 if not isinstance (converted, UnknownException):
           # Hide where the exception came from that shows a non-Pythonic
   173
   174
           # JVM exception message.
--> 175
          raise converted from None
   176 else:
   177 raise
StreamingQueryException: [STREAM FAILED] Query [id = 1951c86e-398b-40d1-8694-769049a7049
e, runId = bd6fec7f-b1fb-45c1-bba8-5265ed582044] terminated with exception: org/apache/k
afka/clients/admin/OffsetSpec
```