Group 10 Lab3 report

**Implementation**

* First we filter the stream to get the allNames column. Then use flatMapValues to map every topic to a key.

val topic:KStream[String, String] =

records.map((date,str)=> (date,str.split("\t")))

.filter((date,col)=>col.size>23 && col(23)!="") //get allNames column

.map((date,str)=>(date, str(23).split(";")

       .map(s=>s.split(",")(0)).distinct //get the topic

.mkString(",")))

.flatMapValues(topic => topic.toLowerCase.split(",")) //map topic to key

* Then we build a *statestore* using *StoreBuilder* for (topic,topic\_count).

//Build a persistent state store

val keyValueStoreBuilder: StoreBuilder[KeyValueStore[String,Long]] =

         Stores.keyValueStoreBuilder(Stores.persistentKeyValueStore("topicstate"),

                               Serdes.String,

                               Serdes.Long);

// register store

builder.addStateStore(keyValueStoreBuilder);

* Finally we call the transform function using the input stream. The transform function takes HistogramTransformer object as a parameter which implements TransformerSupplier interface and returns a Transformer object. The output stream obtained is then published to (“gdelt-histogram”) .

//Transform each record of the input stream

val outputStream:KStream[String, Long] =

topic.transform(new HistogramTransformer(),"topicstate");

//publish Kafka topic

outputStream.to("gdelt-histogram")

* The get() method in HistogramTranfsormer class return Transformer object. The transformer consist of three methods: transform(), TopicCount\_increment() and TopicCount\_decrement(). The transform() method calls TopicCount\_increment() first to increment the count of topic and update the statestore. Then the TopicCount\_decrement() is scheduled to execute after 60 minutes only once. The incoming record is scheduled for a task to delete itself after an hour using wall clock time.

// Should return the current count of the name during the \_last\_ hour

     def transform(key: String, name: String): KeyValue[String, Long] = {

     val count = TopicCount\_increment(name) // Increment the topic count

  //schedule a cron\_job to decrement topic count after 1 hour

  var cron\_job: Cancellable = null

  cron\_job = this.context.schedule(1000 \* 60 \* 60, PunctuationType.WALL\_CLOCK\_TIME, (timestamp) => {

           TopicCount\_decrement(name) // Decrement the topic count after 1 hour

           cron\_job.cancel() // decremenmt once

           });

      return new KeyValue(name,count)

     }

* The TopicCount\_increment() method increments the count of a topic if the topic is already present else initiates count to 1 for a new topic. Similarly, Topic\_decrement() method decrements the count of topic after an hour. It deletes a topic if the count of the topic becomes zero and then updates the consumer using context.forward().

**Questions**

1. **What is the difference, in terms of data processing, between Kafka and Spark?**

* Apache Spark:
* Micro-batch processing. Input data is split into batches on which processing is done by the spark engine to generate batch of processed data.
* Higher latency as data is collected and grouped over some predetermined interval and then is sent for streaming.
* Kafka:
* Event-at-a-time processing. Messages are published on topics to which producers write and consumers read records. Therefore, applications can respond to new data events the very moment they are created.
* Lower latency as data is collected and processed as soon as it is generated.

1. **What is the difference between replications and partitions?**

* Partition : Topics in Kafka are divided into ordered and immutable sequences of messages called partitions for better load distribution and scalability.
* Replication : Replicas are backups of the partition. These are created for fault tolerance.

1. **What is Zookeeper’s role in the Kafka cluster? Why do we need a separate**

**entity for this?**

* Zookeeper is responsible for:
* Controller Selection: select another follower node as leader once the leader fails.
* Configuration of topics
* Access control list
* Membership of clusters : maintaining a list of all the functioning brokers in a cluster.

We need a separate entity for this as these roles should be handled by a centralized entity specifically designed to perform these roles so that other entities in the architecture can focus solely on the jobs they are responsible for.

1. **Why does Kafka by default not guarantee exactly once delivery semantics on producers?**

Kafka by default does not guarantee exactly once delivery semantics on producers because exactly-once processing requires a cluster of at least three brokers by default which is also recommended setting for production. User can simply change the “processor.guarantee” config to “exactly\_once” to change the delivery semantic.

1. **Kafka is a binary protocol (with a reference implementation in Java), whereas Spark is a framework. Name two (of the many) advantages of Kafka being a binary protocol in the context of Big Data. (max. 100 words)**

Two advantages of Kafka being a binary protocol:

* Event-at-a-time processing: The messages/events are processed as they arrive unlike spark needs to micro-batch the messages.
* Greater parallelism: Kafka client can connect through TCP to multiple brokers and transfer data in parallel across multiple partitions of the same topic.

**Questions Specific to the assignment**

1. **On average, how many bytes per second does the stream transformer have to consume? How many does it produce?**

* For calculating average bytes per second consumed by transform we can adopt the following approach in transformer:

      val execution\_time = (System.nanoTime – start\_time) / 1e9d

      total\_bytes= total\_bytes+name.length()+8 //size of string + size of long

      println(" Average bytes per second- "+(total\_bytes)/execution\_time)

The average bytes per second consumed by transform was found to be 600 Bytes/sec. The transformer would produce double of consumed (that is, 1200Bytes/sec) since it updates the state after decrementing the count of topic.

As we can see from the observations above, the RDD implementation and Dataframe Implementation don’t have much difference in terms of execution time for small number of segments. We expect DF implementation to be faster since it is compiled into execution plan and then executed. Spark can optimize the execution plan to reduce execution time.

1. **Could you use a Java/Scala data structure instead of a Kafka StateStore to manage your state in a processor/transformer ? Why,or why not? (max. 50words)**

* No, Java/ Scala data structure cannot be used since the application is stateful. For the processor/transformer to work correctly the state must be managed in a fault tolerant manner, which is possible through Kafka state store. The state store is frequently used by transformer to store and query data.

1. **Given that the histogram is stored in a Kafka State Store, how would you extract the top 100 topics? Is this eﬀicient? (max. 75words)**

* We can extract the top 100 topics from Kafka state store by implementing a Kafka consumer which would subscribe the histogram topic (considering it is stored and published). Also, a stream application can be implemented to query the data stored in Kafka state store. Considering, histogram is consumer too, the most efficient way to get the top 100 topics would be to subscribe the same topic as histogram and filter the topic to get the result.

1. **The visualizer draws the histogram in your web browser. A Kafka consumer has to communicate the current ‘state’ of the histogram to this visualizer. What do you think is an eﬀicient way of streaming the ‘state’ of the histogram to the webserver? (max. 75words)**

* An efficient way of streaming the state of the histogram to the webserver could be Apache Arrow. Apache Arrow would prevent serialization and de-serialization, therefore improving the efficiency. Moreover, it would facilitate communication between other components without worrying about data conversion.

1. **What are the two ways you can scale your Kafka implementation over multiple nodes? (max. 100words)**

* The two ways to scale Kafka implementation over multiple nodes are:
  + **Partitioning**: A topic can be streamed to multiple partitions. A producer can deliver topic a particular partition of that topic.
  + **Consumer groups**: Partitions can be divided among consumers if they subscribe the same topic and have same number/name.

1. **How could you use Kafka’s partitioning to compute the histogram in parallel? (max. 100words)**

* The number of partitions determines the maximum consumer (group) parallelism. The histogram consumer can be organized into consumer group for the given topic such that each consumer within the group reds from a unique partition and the group as whole consumes the whole stream and construct the histogram in parallel.