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HW 3 CS6240 Parallel Data Processing – Spring 19.

https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/tree/master/SocialTriagleSpark/

Combining in Spark:

1) RDD_R

```
//Reading csv file
   val textFile = sc.textFile(inputPath)

//Using reduceByKey with a function to perform summation
   val counts = textFile.map(line => line.split(",")(0))
    .map(word => (word, 1))
    .reduceByKey(_ + _)

   counts.saveAsTextFile(outputPath)
```

Corresponding toDebugString()

```
(40) ShuffledRDD[4] at reduceByKey at WordCount.scala:28 []
 +-(40) MapPartitionsRDD[3] at map at WordCount.scala:27 []
    |   MapPartitionsRDD[2] at map at WordCount.scala:26 []
    |   input/edges.csv MapPartitionsRDD[1] at textFile at WordCount.scala:25 []
    |   input/edges.csv HadoopRDD[0] at textFile at WordCount.scala:25 []
```

DOES NOT PERFORM AGGREGATION BEFORE SHUFFLING

2) **RDD_G**

```
// Reading csv file
   val textFile = sc.textFile(inputPath)

//Using groupByKey with a function to perform summation
   val counts = textFile.map(line => line.split(",")(0))
     .map(word => (word, 1))
     .groupByKey()
     .mapValues(id => id.sum)

   counts.saveAsTextFile(outputPath)

 }
```

Corresponding toDebugString()

```
(40) MapPartitionsRDD[5] at mapValues at WordCount.scala:43 []
 |   ShuffledRDD[4] at groupByKey at WordCount.scala:42 []
 +-(40) MapPartitionsRDD[3] at map at WordCount.scala:41 []
    |   MapPartitionsRDD[2] at map at WordCount.scala:40 []
    |   input/edges.csv MapPartitionsRDD[1] at textFile at WordCount.scala:38 []
    |   input/edges.csv HadoopRDD[0] at textFile at WordCount.scala:38 []
```

DOES NOT PERFORM AGGREGATION BEFORE SHUFFLING

3) **RDD_F**

```
// Reading csv file
   val textFile = sc.textFile(inputPath)

//Using foldByKey with a function to perform summation
   val counts = textFile.map(line => line.split(",")(0))
    .map(word => (word, 1))
    .foldByKey(0)(_ + _)
   counts.saveAsTextFile(outputPath)

 }
```

Corresponding toDebugString()

```
(40) ShuffledRDD[4] at foldByKey at WordCount.scala:58 []
 +-(40) MapPartitionsRDD[3] at map at WordCount.scala:57 []
   |   MapPartitionsRDD[2] at map at WordCount.scala:56 []
   |   input/edges.csv MapPartitionsRDD[1] at textFile at WordCount.scala:54 []
   |   input/edges.csv HadoopRDD[0] at textFile at WordCount.scala:54 []
```

DOES PERFORM AGGREGATION BEFORE SHUFFLING

4) **RDD_A**

```
// Reading csv file
   val textFile = sc.textFile(inputPath)

//Using aggregateByKey with a function to perform summation
   val counts = textFile.map(line => line.split(",")(0))
    .map(word => (word, 1))
    .aggregateByKey(0)(_ + _, _ + _)

            counts.saveAsTextFile(outputPath)

   // Printing the RDD lineage graph
   println(counts.toDebugString);

 }
```

Corresponding toDebugString()

```
(40) ShuffledRDD[4] at aggregateByKey at WordCount.scala:73 []
 +-(40) MapPartitionsRDD[3] at map at WordCount.scala:72 []
    |   MapPartitionsRDD[2] at map at WordCount.scala:71 []
    |   input/edges.csv MapPartitionsRDD[1] at textFile at WordCount.scala:69 []
    |   input/edges.csv HadoopRDD[0] at textFile at WordCount.scala:69 []
```

DOES PERFORM AGGREGATION BEFORE SHUFFLING

5) **DSET**

```
  val word = spark.read.csv(inputPath).groupBy("_c1").count()
  println(word.explain(extended = true))
  word.coalesce(1).write.csv(outputPath)

 }
```

Coressponding Explain

```
Start
2019-02-21 21:26:04 INFO  FileSourceStrategy:54 - Pruning directories with:
2019-02-21 21:26:04 INFO  FileSourceStrategy:54 - Post-Scan Filters:
2019-02-21 21:26:04 INFO  FileSourceStrategy:54 - Output Data Schema: struct<_c1: string>
2019-02-21 21:26:04 INFO  FileSourceScanExec:54 - Pushed Filters:
== Parsed Logical Plan ==
Aggregate [_c1#11], [_c1#11, count(1) AS count#17L]
+- AnalysisBarrier
     +- Relation[_c0#10,_c1#11] csv

== Analyzed Logical Plan ==
_c1: string, count: bigint
Aggregate [_c1#11], [_c1#11, count(1) AS count#17L]
+- Relation[_c0#10,_c1#11] csv

== Optimized Logical Plan ==
Aggregate [_c1#11], [_c1#11, count(1) AS count#17L]
+- Project [_c1#11]
  +- Relation[_c0#10,_c1#11] csv

== Physical Plan ==
*(2) HashAggregate(keys=[_c1#11], functions=[count(1)], output=[_c1#11, count#17L])
+- Exchange hashpartitioning(_c1#11, 200)
  +- *(1) HashAggregate(keys=[_c1#11], functions=[partial_count(1)], output=[_c1#11, count#22L])
     +- *(1) FileScan csv [_c1#11] Batched: false, Format: CSV, Location:
InMemoryFileIndex[file:/home/vaibhav/Desktop/lspdpNew/parallelDataProcessing/SocialTriagleSpark/S...,
PartitionFilters: [], PushedFilters: [], ReadSchema: struct<_c1:string>
()
End
```

DOES PERFORM AGGREGATION BEFORE SHUFFLING

Join Implementation

1) R-RS Join

Psuedo code:

```
1)    Set max filter
val maxFilter = 15000
val textFile = sc.textFile("s3://mr-input/edges.csv")

2)  Filter using the maxfilter
val filteredEdges = textFile.map(line => line.split(","))
                            .filter(edge => edge(0).toInt < maxFilter &&  edge(1).toInt < maxFilter)
                    .map(edge => (edge(0), edge(1)))

3) To find pairs a→ b and b→c , we need to find pairs that have the common node 'b'.
// So join the edges dataset on a flipped version of the same dataset, to get Path2.
val edgesOnce = filteredEdges.map(edge => (edge._2, edge._1)) //flip all edges
val edgesTwice = filteredEdges.map(edge => (edge._1, edge._2)) //don't do anything
val edgesThrice = filteredEdges.map(edge => ((edge._1,edge._2) , 1))

4)Calculating path2
val path2 = edgesOnce.join(edgesTwice).map(pair => pair._2)

5)Reverse the endpoints of path2 edges to exactly match with the keys
//of the third edge dataset.
val revPath2 = path2.map(x => ((x._2 , x._1) , 1))

6)Divide by 3 to eliminate redundant counting of same triangles
//with different order of edges.
val matches = revPath2.join(edgesThrice).count()
val triangleCount =  matches/3
println("Number of triangles = "+ triangleCount)
```

Output:
https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/blob/master/SocialTriagleSpark/Spark-Demo/answer.txt

2) **R-Rep Join**

1) Read CSV file
2) Isolate edges and filter using max filter
3) Make RDD from the edges named edges
4) Make a map (userID , List[followers]) from the RDD named broadcastedMap
5) BroadCast the map
6) Path2 = edges.flatMap ((id, follower) =>

```
                broadcastedMap(follower).foreach((follower2) =>
                emit(id, follower2)
        )
```

7) FullTriangle = path2.flatMap ((id, follower) =>

```
                broadcastedMap(follower).foreach((follower2) =>
                if(follower2 == id)
                emit(if, follower2)
        )
```

8) val count = fullTriangle.count()/3 == Answer

OutPut:

https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/blob/master/SocialTriagleSpark/Spark-Demo/answer.txt

3) D-Rep Join

1) Read CSV file
2) Isolate edges and filter using max filter
3) Make DataSet from the edges named edges
4) Make a map (userID , List[followers]) from the RDD named broadcastedMap
5) BroadCast the map
6) Path2 = edges.flatMap ((id, follower) =>

```
        broadcastedMap(follower).foreach((follower2) =>
        emit(id, follower2)
    )
```

7) FullTriangle = path2.flatMap ((id, follower) =>

```
        broadcastedMap(follower).foreach((follower2) =>
        if(follower2 == id)
        emit(if, follower2)
    )
```

8) val count = fullTriangle.count()/3 == Answer

Output:

https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/blob/master/SocialTriagleSpark/Spark-Demo/answer.txt

4) R-Rep Join

`

1) Read the csv

2)Filter the edges

3) Define the following dataFrames

```
val left =  filtered.toDF("a","b")
val right = filtered.toDF("c","d")
val thirdEdge = filtered.toDF("p","q")
```

4) Left join for Path2

```
val path2 = left.join(right, $"b" === $"c").drop("b").drop("c")
```

5) Join for fullTriangle

```
val fullTriangle = path2.join(thirdEdge,$"d" === $"p" &&  $"a" === $"q")
```

6) Remove repeated counts

```
val triangleCount = fullTriangle.count()/3  == answer
```

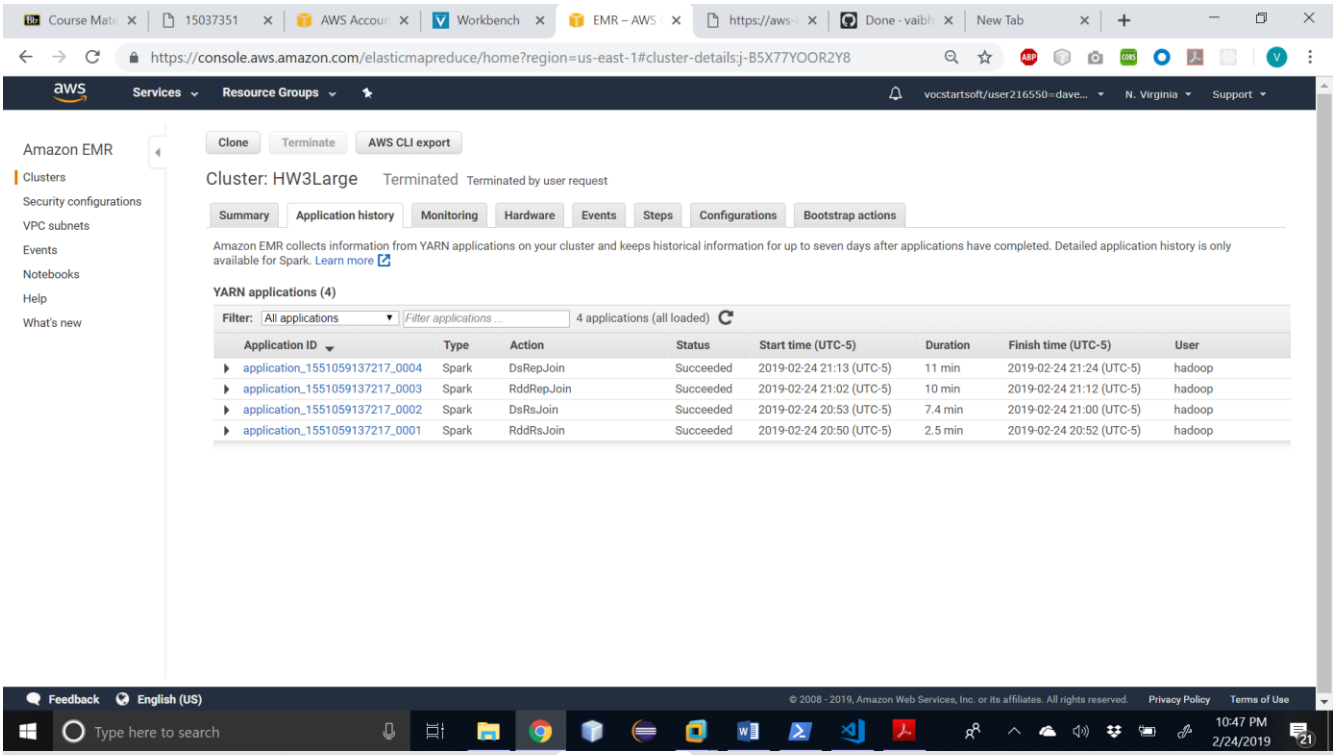
Output:

https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/blob/master/SocialTriagleSpark/Spark-Demo/answer.txt

Configuration	Small Cluster 4 machines	Large Cluster 7 machines
RS-R	Time =4.0min MaxF = 10000 Answer =520296	Time =2.5min MaxF = 10000 Answer =520296
RS-D	Time = 9.3 min MaxF = 10000 Answer =520296	Time = 7.4 min MaxF = 10000 Answer =520296
Rep-R	Time = 12 min MaxF = 500 Answer = 136	Time = 10 min MaxF = 500 Answer = 136
Rep-D	Time = 11min MaxF = 500 Answer = 136	Time = 11min MaxF = 500 Answer = 136

All the logs can be found here:

https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/tree/2bce0094419d184ce235908335b92fe0e351a157/SocialTriagleSpark/Spark-Demo/Logs


https://console.aws.amazon.com/elasticmapreduce/home?region=us-east-1#cluster-details:j-B5X77YOOR2Y8
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Filter applications ...
4 applications (all loaded)
Application ID
Type
Action
Status
Start time (UTC-5)
Duration
Finish time (UTC-5)
User
application_1551059137217_0004 Spark DsRepJoin Succeeded 2019-02-24 21:13 (UTC-5) 11 min 2019-02-24 21:24 (UTC-5) hadoop
application_1551059137217_0003 Spark RddRepJoin Succeeded 2019-02-24 21:02 (UTC-5) 10 min 2019-02-24 21:12 (UTC-5) hadoop
application_1551059137217_0002 Spark DsRsJoin Succeeded 2019-02-24 20:53 (UTC-5) 7.4 min 2019-02-24 21:00 (UTC-5) hadoop
application_1551059137217_0001 Spark RddRsJoin Succeeded 2019-02-24 20:50 (UTC-5) 2.5 min 2019-02-24 20:52 (UTC-5) hadoop
Feedback
English (US)
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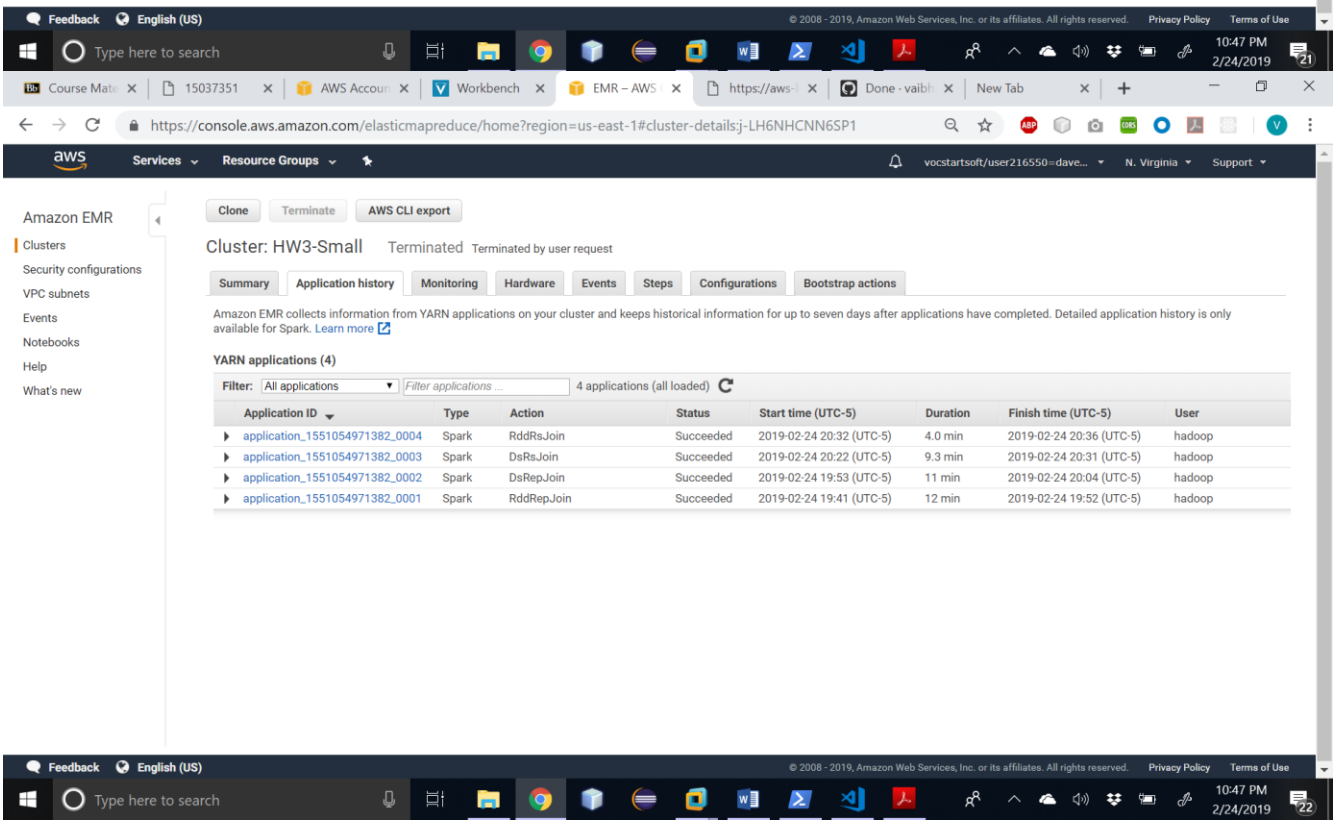
https://console.aws.amazon.com/elasticmapreduce/home?region=us-east-1#cluster-details:j-LH6NHCNN6SP1
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Cluster: HW3-Small
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YARN applications (4)
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Filter applications ...
4 applications (all loaded)
Application ID
Type
Action
Status
Start time (UTC-5)
Duration
Finish time (UTC-5)
User
application_1551054971382_0004 Spark RddRsJoin Succeeded 2019-02-24 20:32 (UTC-5) 4.0 min 2019-02-24 20:36 (UTC-5) hadoop
application_1551054971382_0003 Spark DsRsJoin Succeeded 2019-02-24 20:22 (UTC-5) 9.3 min 2019-02-24 20:31 (UTC-5) hadoop
application_1551054971382_0002 Spark DsRepJoin Succeeded 2019-02-24 19:53 (UTC-5) 11 min 2019-02-24 20:04 (UTC-5) hadoop
application_1551054971382_0001 Spark RddRepJoin Succeeded 2019-02-24 19:41 (UTC-5) 12 min 2019-02-24 19:52 (UTC-5) hadoop
Feedback
English (US)
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