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HW 3 CS6240 Parallel Data Processing – Spring 19.

[https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/tree/master/SocialTriagleSpark/](https://github.ccs.neu.edu/vaibhavdave5/parallelDataProcessing/tree/master/SocialTriagleSpark/Spark-Demo)

**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")

1. 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

1. BroadCast the map
2. Path2 = edges.flatMap ( (id, follower) =>

broadcastedMap(follower).foreach((follower2) =>

emit(id, follower2)

)

1. 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

1. BroadCast the map
2. Path2 = edges.flatMap ( (id, follower) =>

broadcastedMap(follower).foreach((follower2) =>

emit(id, follower2)

)

1. 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

1. **R-Rep Join**

` 1) Read the csv

2)Filter the edges

1. Define the following dataFrames

val left = filtered.toDF("a","b")

val right = filtered.toDF("c","d")

val thirdEdge = filtered.toDF("p","q")

1. Left join for Path2

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

1. Join for fullTriangle

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

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

