CS5560 Knowledge Discovery and Management

Spark MapReduce Programing

Problem Set (PS-2B)
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Spark MapReduce Programming – Calculate everyone's common friends for Facebook

Facebook has a list of friends (note that friends are a bi-directional thing on Facebook. If I'm your friend, you're mine). They also have lots of disk space and they serve hundreds of millions of requests everyday. They've decided to pre-compute calculations when they can to reduce the processing time of requests. One common processing request is the "You and Joe have 230 friends in common" feature. When you visit someone's profile, you see a list of friends that you have in common. We're going to use MapReduce so that we can calculate everyone's common friends once a day and store those results. Later on it's just a quick lookup. We've got lots of disk, it's cheap.

1) Draw a MapReduce diagram similar to the word count diagram below.
2) Sketch a MapReduce algorithm for the common Facebook friends (referring to the word count code below).
3) Sketch Spark Scala implementation (referring to the word count code below).

Example

Assume the friends are stored as Person->[List of Friends], our friends list is then:

A -> B C D
B -> A C D E
C -> A B D E
D -> A B C E
E -> B C D

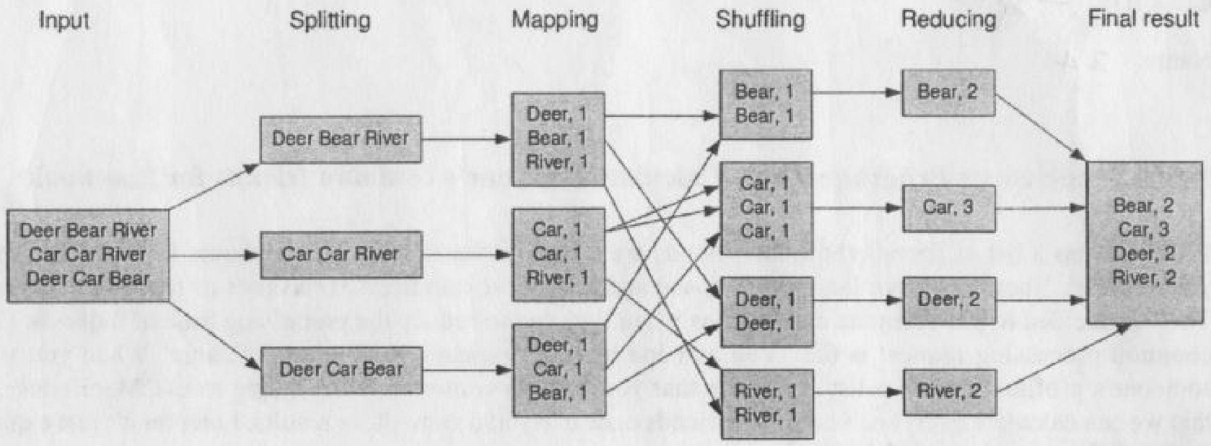
The result after reduction is:

(A B) -> (C D)
(A C) -> (B D)
(A D) -> (B C)
(B C) -> (A D E)
(B D) -> (A C E)
(B E) -> (C D)
(C D) -> (A B E)
(C E) -> (B D)
(D E) -> (B C)

Now when D visits B's profile, we can quickly look up (B D) and see that they have three friends in common, (A C E).

WORD COUNT EXAMPLE

The overall MapReduce word count process



Algorithm 2.1 Word count

The mapper emits an intermediate key-value pair for each word in a document. The reducer sums up all counts for each word.

```
1: class MAPPER
2:     method MAP(docid $a$, doc $d$)
3:         for all term $t \in$ doc $d$ do
4:             EMIT(term $t$, count 1)

1: class REDUCER
2:     method REDUCE(term $t$, counts $[c_1, c_2, \ldots]$)
3:         $sum \leftarrow 0$
4:         for all count $c \in$ counts $[c_1, c_2, \ldots]$ do
5:             $sum \leftarrow sum + c$
6:         EMIT(term $t$, count $sum$)
```

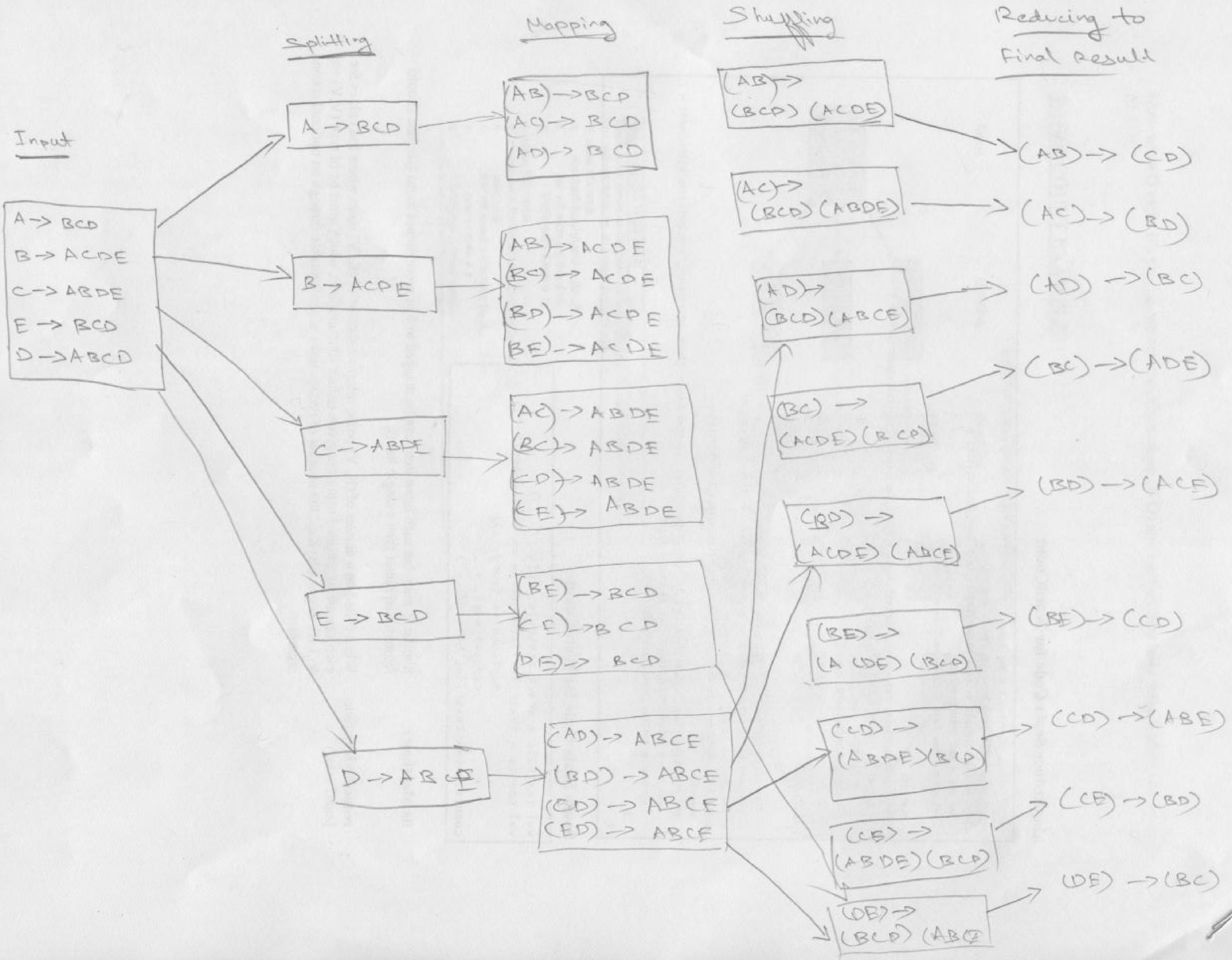
MapReduce Scala Code for WordCount

```
// This class performs the map operation, translating raw input into the key-value
// pairs we will feed into our reduce operation.
class TokenizerMapper extends Mapper[Object,Text,Text,IntWritable] {
  val one = new IntWritable(1)
  val word = new Text

  override
  def map(key:Object, value:Text, context:Mapper[Object,Text,Text,IntWritable]#Context) = {
    for (t <-  value.toString().split("\\s")) {
      word.set(t)
      context.write(word, one)
    }
  }
}

// This class performs the reduce operation, iterating over the key-value pairs
// produced by our map operation to produce a result. In this case we just
// calculate a simple total for each word seen.
class IntSumReducer extends Reducer[Text,IntWritable,Text,IntWritable] {
  override
  def reduce(key:Text, values:java.lang.Iterable[IntWritable], context:Reducer[Text,IntWritable,Text,IntWritable]#Context) = {
    val sum = values.foldLeft(0) { (t,i) => t + i.get }
    context.write(key, new IntWritable(sum))
  }
}
```

Spark Scala Code for WordCount

```
val textFile = spark.textFile("hdfs://...")
val counts = textFile.flatMap(line => line.split(" "))
                 .map(word => (word, 1))
                 .reduceByKey(_ + _)
counts.saveAsTextFile("hdfs://...")
```

flatMap(func)	Similar to map, but each input item can be mapped to 0 or more output items (so func should return a Seq rather than a single item).
reduceByKey(*func*, [*numTasks*])	When called on a dataset of (K, V) pairs, returns a dataset of (K, V) pairs where the values for each key are aggregated using the given reduce function *func*, which must be of type (V,V) => V. Like in groupByKey, the number of reduce tasks is configurable through an optional second argument.


Input
A -> BCD
B -> ACDE
C -> ABDE
E -> BCD
D -> ABCD
Splitting
A -> BCD
B -> ACDE
C -> ABDE
E -> BCD
D -> ABCE
Mapping
(AB) -> BCD
(AC) -> BCD
(AD) -> BCD
(AB) -> ACDE
(BC) -> ACDE
(BD) -> ACDE
(BE) -> ACDE
(AC) -> ABDE
(BC) -> ABDE
(CD) -> ABDE
(CE) -> ABDE
(BE) -> BCD
(CE) -> BCD
(DE) -> BCD
(AD) -> ABCE
(BD) -> ABCE
(CD) -> ABCE
(ED) -> ABCE
Shuffling
(AB) -> (BCD) (ACDE)
(AC) -> (BCD) (ABDE)
(AD) -> (BCD) (ABCE)
(BC) -> (ACDE) (BCD)
(BD) -> (ACDE) (ABCE)
(BE) -> (ACDE) (BCD)
(CD) -> (ABDE) (BCD)
(CE) -> (ABDE) (BCD)
(DE) -> (BCD) (ABCE)
Reducing to Final Result
(AB) -> (CD)
(AC) -> (BD)
(AD) -> (BC)
(BC) -> (ADE)
(BD) -> (ACE)
(BE) -> (CD)
(CD) -> (ABE)
(CE) -> (BD)
(DE) -> (BC)

② Algorithm for mutual friends

// The mapper emits an intermediate key-value for mapping the list of friends

// The reducer sums up the mutual friends for 2 friends at once.

```
1. Class Mapper
2. method Map (friend1 A, friend2b)
3.  for all friends n   in friends list
4.   EMIT (~~term~~ friends Pair , friendsList)


1. Class REDUCER
2. method REDUCE (friends Pair , friendsList)
3.  for each friends in friend Pair
4.   common-friends ← Mutual friends between shuffled friendsList
5.   EMIT (friend , mutual friends.
```

Spark Scala code

③
```
    Public class Mutal Friends Reducer {

        public void reduce ( FriendsPair key, Iterator (Text) values,

            OutputCollector < Null Writable ,Text> output,

            Reporter reporter ) {

Hashset<String> rec = new Hashset <String> ();

List <String> mutualFriends = new ArrayList <String>();

String friends = Values . next to String () ;

 String [ ] names = friends . split ( "->" );

 for (String name : names) {

   rec . add (name) ;

 }

 if (values . hasNext()) {

  friends = values . next() . toString() ;

   names = friends . split ( "->" );

  for (String name : name) {

     if (rec . contains (name)) {

    mutal friends . add (name) ;

  }

  }

 }
if (mutalFriends.size()>0){
 String val= key.toString() + "->" + " ";
 boolean CommonFlag = false;

 for (String mutual-frnd : mutal friends){
      if (commanflag){
          val += ",";
      }
     val + = mutualFriends;
     CommonFlag = true;
  }
Output.collect (Null Writable.get(), new Text(val));
 }
}
}

Public class MutualFriendMapper {
 String [] Lis of Friends = full Friends List[1].split("->");
  for (String friend : lis of Friends) {
      FriendPair fp= new FriendPair (new Text (frnd Name), new Text(frnd));
       output. collect (fp, new Text (full Friend List[1]));
    }
  }
}
```