Feedback — Week6A (Advanced)

Help Center

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Question 1

Using the matrix-vector multiplication described in Section 2.3.1, applied to the matrix and vector:

1	2	3	4	1
5	6	7	8	2
9	10	11	12	3
13	14	15	16	4

apply the Map function to this matrix and vector. Then, identify in the list below, one of the key-value pairs that are output of Map.

Your Answer		Score	Explanation
(3,45)			
(1,2)			
(3,9)	✔	1.00	
(3,11)			
Total		1.00 / 1.00	

Question Explanation

Each m_{ij} is multiplied by v_j, and this product forms the value of a key-value pair that has key i, the row number. Thus, in row-major order, the sixteen key-value pairs produced are:

(1,1)	(1,4)	(1,9)	(1,16)
(2,5)	(2,12)	(2,21)	(2,32)
(3,9)	(3,20)	(3,33)	(3,48)
(4,13)	(4,28)	(4,45)	(4,64)

Question 2

Suppose we use the algorithm of Section 2.3.10 to compute the product of matrices M and N. Let M have x rows and y columns, while N has y rows and z columns. As a function of x, y, and z, express the answers to the following questions:

1. The output of the Map function has how many different keys? How many key-value pairs are there with each key? How many key-value pairs are there in all?
2. The input to the Reduce function has how many keys? What is the length of the value (a list) associated with each key?

Then, identify the true statement in the list below.

Your Answer		Score	Explanation
○ The output of the Map function has x+z different keys.			
◉ The input to the Reduce function has pairs with lists of length 2y.	✔	1.00	
○ The output of the Map function has xz pairs.			
○ The input to the Reduce function has pairs with lists of length 2xz.			
Total		1.00 / 1.00	

Question Explanation

In the Map function, each element of M is turned into a pair whose key is itself a pair consisting of a row number of M and a column number of N. Thus, there are xz different keys. We get a particular key (i,k) from each value j that is a column number of M. Thus, M is turned into xyz key-value pairs. The Map function also turns elements of N into pairs with the same key values, so xz is the total number of different keys that Map produces. We get a pair with key (i,k) from each value j that is a row number of N. Thus, there are another xyz key-value pairs produced from N, and therefore a total of 2xyz key-value pairs output from the Map function.
As input to the Reduce function, these 2xyz pairs are sorted by key. Since the number of keys is xz, and each key is associated with y elements of M and y elements of N, the lists in the input elements for Reduce have length 2y.

Question 3

Suppose we use the two-stage algorithm of Section 2.3.9 to compute the product of matrices M and N. Let M have x rows and y columns, while N has y rows and z columns. As a function of x, y, and z, express the answers to the following questions:

1. The output of the first Map function has how many different keys? How many key-value pairs are there with each key? How many key-value pairs are there in all?

2. The output of the first Reduce function has how many keys? What is the length of the value (a list) associated with each key?
3. The output of the second Map function has how many different keys? How many key-value pairs are there with each key? How many key-value pairs are there in all?

Then, identify the true statement in the list below.

Your Answer		Score	Explanation
◉ The output of the first Map function has x+z pairs with each key.	✔	1.00	
○ The output of the first Reduce function has pairs with lists of length xyz.			
○ The output of the first Reduce function has pairs with lists of length y(x+z).			
○ The output of the first Map function has xz pairs with each key.			
Total		1.00 / 1.00	

Question Explanation

Consider the first Map function. Each element of M is mapped to one pair, and this pair has a key equal to its column number. There are y different columns of M, and therefore that number of keys. Each column of M has x rows, and therefore, M is transformed into x different pairs for each key. Similarly, each element of N is mapped to a single pair, and the key of this pair is one of its y row numbers. Thus, there are only y different keys among all the pairs generated from M and N. Each row of N has z elements, so z pairs are produced from N for each key. We conclude that the output of the first Map function has y different keys, each key appears in x+z different pairs, and the total number of pairs is y(x+z).

The first Reduce function has input consisting of y elements. Each element is a key (i.e., a number that is a column of M and a row of N, associated with a list of values giving that column of M and that row of N. The Reduce function pairs the x elements of M on that list with the z elements of N on the same list, producing another list associated with the same key. On that list is one element for each of the xz pairs --- one element from M and the other from N. Thus, the output of the first Reduce has y pairs, each with a list of length xz.

The second Map function takes each of the pairs from the first Reduce and turns each element on the pair's list into a key-value pair. Since there are a y input pairs, and each has a list of length xz, the number of key-value pairs output from the second Map is xyz. Notice that a key consists of a row number from M and a column number from N. Therefore, there are xz different keys, and there are y different key-value pairs for each key.

Question 4

Suppose we have the following relations:

R		S	
A	**B**	**B**	**C**
0	1	0	1
1	2	1	2
2	3	2	3

and we take their natural join by the algorithm of Section 2.3.7. Apply the Map function to the tuples of these relations. Then, construct the elements that are input to the Reduce function. Identify one of these elements in the list below.

Your Answer		Score	Explanation
(2, [(R,1), (S,3)])	✔	1.00	
(2, [(R,1)])			
(2, [(2,(R,1)), (2,(S,1))])			
(0, [(0,(S,1))])			
Total		1.00 / 1.00	

Question Explanation

Map turns the tuples of R into (1,(R,0)), (2,(R,1)), and (3,(R,2)). The reason is that each tuple has its B-value made the key, with an associated value that is R paired with the A-value of that tuple. Similarly, the tuples of S are turned into (0,(S,1)), (1,(S,2)), and (2,(S,3)). That is, each S-tuple has its B-value made the key, with an associated value that is S paired with the C-value of that tuple.
We then sort by key and for each key we construct an associated list of all values for that key. There are four keys, 0 through 3 in this example. The elements thus formed for these keys, and which are each input to one of the Reduce tasks, are:

(0, [(S,1)])
(1, [(R,0), (S,2)])
(2, [(R,1), (S,3)])
(3, [(R,2)])