

Single & Complete Link:

Clustering starts by computing the distance between every pair of units that you want to cluster. A distance matrix will be symmetric (because the distance between x and y is the same as the distance between y and x) and will have zeros on the diagonal (because every item is distance zero from itself).

In our code, there is a common 'link' function to which the 'min' & 'max' functions are passed as a function pointer. Clusters A,B,C,D are represented as a 0,1,2,3 respectively.

Complete Link:

Example:

	0	1	2	3	4
0	0				
1	9	0			
2	3	7	0		
3	6	5	9	0	
4	11	10	2	8	0

The smallest distance is between 4 and 2 and they get linked up or merged first into a the cluster '24'. To obtain the new distance matrix, we need to remove the 2 and 4 entries, and replace it by an entry "24" . Since we are using complete linkage clustering, the distance between "24" and every other item is the maximum of the distance between this item and 2 and this item and 4. For example, $d(0,2) = 3$ and $d(0,4) = 11$. So, $D(0, "24") = 11$. This gives us the new distance matrix. The items with the smallest distance get clustered next.

	24	0	1	3
24	0			
0	11	0		
1	10	9	0	
3	9	6	5	0

Single Link:

For the same above example, it starts with cluster "24" i.e. smallest distance, but the distance between "24" and each item is now the minimum of $d(x,3)$ and $d(x,5)$. So $c(1,"35")=3$.

In our code, 'ret' returns the new clusters in every iteration. `vector<vector<int> > ind(n)` is used to store the 'row' and 'col' index of the clusters.

For the example,

	0(A)	1(B)	2(C)	3(D)
0(A)	0			
1(B)	1	0		
2(C)	4	2	0	
3(D)	5	6	3	0

The answer is,

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Using Single link:
minimum element is: 1
after merging cluster '0' and '1' we get matrix:
0
2 0
5 3 0
minimum element is: 2
after merging cluster '01' and '2' we get matrix:
0
3 0
combining clusters at each stage are:
0 1
01 2
012 3
```

```
Using complete link:
minimum element is: 1
after merging cluster '0' and '1' we get matrix:
0
4 0
6 3 0
minimum element is: 3
after merging cluster '2' and '3' we get matrix:
0
6 0
combining clusters at each stage are:
0 1
2 3
01 23
```

For single link ,
0 1 implies A B
01 2 implies AB C
012 3 implies ABC D

For complete link,
0 1 implies A B
2 3 implies C D
01 23 implies AB CD