This is a slight change of Task 3 inside Project 3:

3A.Part 1.

Do task 3 once. Obtain confusion matrix and computer accuracy. Re-ordered confusion matrix and Compute accuracy. Submit both confusion matrices and accuracies.

3A. Part 2.

Run Task 3 ten times. Each run K-means gives a different objective function value. Pick the run with the lowest (best) objective function value. Submit the confusion matrix and related accuray. Then do the optimal bipartite graph matching to obtain re-ordered confusion matrix. Compute accuracies. Submit them.

Does Part 2 accuracy is better than Part 1 accuracy?

---------- Project 3 ----------

Computer Project 3, due on Dec 1 Midnight. ----------

Data Cluster using K-means algorithm provided by the system.

1. Run k-means on AT&T 100 images, set K=10. Obtain confusion matrix. Re-order the confusion matrix using bipartite graph matching and obtain accuracy.
2. Run k-means on AT&T 400 images, set K=40. Obtain confusion matrix. Re-order the confusion matrix and obtain accuracy.
3. Run k-means on Hand-written-letters data, set K=26, as above.
4. ----------

3A. Part 1

```
Accuracy before: 0.47830374753451677
Confusion Matrix before:
[[19  2  0  0  0  1  0  2  0  0  1  0  1  3  0  9  1  0  0  0  0  0  0  0
   0  0]
 [ 1 19  2  3  1  0  0  0  0  7  0  1  0  0  1  2  0  0  2  0  0  0  0  0
   0  0]
 [ 0  0 30  0  1  0  0  0  0  0  0  6  0  0  2  0  0  0  0  0  0  0  0  0
   0  0]
 [ 0  1  1 27  0  1  0  0  0  3  0  1  0  0  3  0  0  0  0  1  1  0  0  0
   0  0]
 [ 0  1  0  0 31  0  0  0  1  1  0  4  0  0  0  1  0  0  0  0  0  0  0  0
   0  0]
 [ 2  0  0  0  2 15  0  0  0  0  0  1  0  0  0 19  0  0  0  0  0  0  0  0
   0  0]
 [ 0  1  7  0  2  8  0  0  0  0  0  1  0  0  5  0 10  0  0  0  3  1  0  1
   0  0]
 [ 1  0  0  0  0  0  0 19  0  0  9  0  3  3  0  3  0  0  0  0  1  0  0  0
   0  0]
```

```
 [ 0  0  0  1  0  0  0  0 13  2  0  1  0  0  0  0  1  0  0 19  0  1  0  1
   0  0]
 [ 0  0  0  1  0  0  0  0  0 23  0  0  0  0  0  0  0  0  0 14  0  1  0  0
   0  0]
 [ 6  0  0  0  0  0  0  1  1  0 22  4  1  0  0  1  0  0  0  0  0  1  0  2
   0  0]
 [ 0  0  4  0  0  0  0  0  1  0  3 14  0  0  1  0  0  0  0  0 15  0  0  0
   0  1]
 [ 1  0  0  0  0  0  0 19  0  0  3  0 13  2  0  0  0  0  0  1  0  0  0  0
   0  0]
 [ 2  0  0  0  0  0  0  5  0  0  4  0  1 19  1  3  0  0  0  0  1  2  0  1
   0  0]
 [ 0  2 17  3  0  0  0  0  0  0  0  0  0  0 16  0  0  0  0  0  1  0  0  0
   0  0]
 [ 0  0  0  0  0  2  0  0  0  0  0  0  0  0  3 31  2  0  0  0  1  0  0  0
   0  0]
 [ 0  0  2  0  0  3  0  0  0  0  2  0  0  0  5  0 24  0  0  1  2  0  0  0
   0  0]
 [ 2 12  0  0  6  1  0  0  1  0  3  0  1  0  0 10  2  0  0  0  0  0  0  0
   0  1]
 [ 0  5  0  0  0  0  0  0  0  9  0  3  0  0  1  0  0  0 20  1  0  0  0  0
   0  0]
 [ 0  0  0  0  0  4  0  0  1  1  0  3  1  0  0  3  0  0  0 22  0  0  0  4
   0  0]
 [ 0  1  0  0  0  0  0  1  0  0  0  0  0  0  5  0  1  0  0  0 31  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  3  0  0  1  0  0  0  0  0  0  8 27  0  0
   0  0]
 [ 0  0  0  0  0  1  0  0  0  0 14  0  1 16  0  0  0  0  0  0  5  2  0  0
   0  0]
 [ 8  0  0  0  0  0  0  0  0  0  6  0  1  0  0  0  0  0  0  0  0  1  0 23
   0  0]
 [ 0  0  0  0  0  0  0  1  0  0  1  0  5  3  0  0  0  0  0  0  0 20  0  9
   0  0]
 [ 0  0  0  2  0  0  0  0  2  2  0  6  0  0  0  0  0  0  0  0  0  0  0  0
   0 27]]
------------------------------------------------------------
Accuracy after: 0.47830374753451677
Confusion Matrix after:
[[19  2  0  0  0  1  0  2  0  0  1  0  1  3  0  9  1  0  0  0  0  0  0  0
   0  0]
 [ 1 19  2  3  1  0  0  0  0  7  0  1  0  0  1  2  0  0  2  0  0  0  0  0
   0  0]
 [ 0  0 30  0  1  0  0  0  0  0  0  6  0  0  2  0  0  0  0  0  0  0  0  0
   0  0]
 [ 0  1  1 27  0  1  0  0  0  3  0  1  0  0  3  0  0  0  0  1  1  0  0  0
   0  0]
 [ 0  1  0  0 31  0  0  0  1  1  0  4  0  0  0  1  0  0  0  0  0  0  0  0
   0  0]
 [ 2  0  0  0  2 15  0  0  0  0  0  1  0  0  0 19  0  0  0  0  0  0  0  0
   0  0]
 [ 0  1  7  0  2  8  0  0  0  0  0  1  0  0  5  0 10  0  0  0  3  1  0  1
   0  0]
 [ 1  0  0  0  0  0  0 19  0  0  9  0  3  3  0  3  0  0  0  0  1  0  0  0
```

```
   0  0]
 [ 0  0  0  1  0  0  0  0 13  2  0  1  0  0  0  0  1  0  0 19  0  1  0  1
   0  0]
 [ 0  0  0  1  0  0  0  0  0 23  0  0  0  0  0  0  0  0  0 14  0  1  0  0
   0  0]
 [ 6  0  0  0  0  0  0  1  1  0 22  4  1  0  0  1  0  0  0  0  0  1  0  2
   0  0]
 [ 0  0  4  0  0  0  0  0  1  0  3 14  0  0  1  0  0  0  0  0 15  0  0  0
   0  1]
 [ 1  0  0  0  0  0  0 19  0  0  3  0 13  2  0  0  0  0  0  1  0  0  0  0
   0  0]
 [ 2  0  0  0  0  0  0  5  0  0  4  0  1 19  1  3  0  0  0  0  1  2  0  1
   0  0]
 [ 0  2 17  3  0  0  0  0  0  0  0  0  0  0 16  0  0  0  0  0  1  0  0  0
   0  0]
 [ 0  0  0  0  0  2  0  0  0  0  0  0  0  0  3 31  2  0  0  0  1  0  0  0
   0  0]
 [ 0  0  2  0  0  3  0  0  0  0  2  0  0  0  5  0 24  0  0  1  2  0  0  0
   0  0]
 [ 2 12  0  0  6  1  0  0  1  0  3  0  1  0  0 10  2  0  0  0  0  0  0  0
   0  1]
 [ 0  5  0  0  0  0  0  0  0  9  0  3  0  0  1  0  0  0 20  1  0  0  0  0
   0  0]
 [ 0  0  0  0  0  4  0  0  1  1  0  3  1  0  0  3  0  0  0 22  0  0  0  4
   0  0]
 [ 0  1  0  0  0  0  0  1  0  0  0  0  0  0  5  0  1  0  0  0 31  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  3  0  0  1  0  0  0  0  0  0  8 27  0  0
   0  0]
 [ 0  0  0  0  0  1  0  0  0  0 14  0  1 16  0  0  0  0  0  0  5  2  0  0
   0  0]
 [ 8  0  0  0  0  0  0  0  0  0  6  0  1  0  0  0  0  0  0  0  0  1  0 23
   0  0]
 [ 0  0  0  0  0  0  0  1  0  0  1  0  5  3  0  0  0  0  0  0  0 20  0  9
   0  0]
 [ 0  0  0  2  0  0  0  0  2  2  0  6  0  0  0  0  0  0  0  0  0  0  0  0
   0 27]]
```

3A. Part 2

```
************** 3A. PartB ****************
Objective Values:
Iteration 0 : 7225.7633375944215
Iteration 1 : 7171.027938007031
Iteration 2 : 7201.969468412541
Iteration 3 : 7188.544084658077
Iteration 4 : 7171.6732665233085
Iteration 5 : 7189.906161756885
Iteration 6 : 7174.907846764192
Iteration 7 : 7195.865991992397
Iteration 8 : 7187.38720925404
Iteration 9 : 7194.104466802475
-------------
```

```
Selected objective value: 7171.027938007031
Accuracy before: 0.47928994082840237
Confusion Matrix before:
[[15  0  0  0  0  0  0 10  0  0  5  0  6  2  0  0  0  0  0  0  0  0  1  0
   0  0]
 [ 0  0  0 12  0  1  0  1  0  0  2  2  6  0  0  0  0  1 12  0  2  0  0  0
   0  0]
 [ 0  0 31  0  0  0  0  0  0  0  0  5  0  0  3  0  0  0  0  0  0  0  0  0
   0  0]
 [ 0  0  0 17  0  1  0  0  0  0  0  1  0  0 13  0  1  0  0  0  3  0  0  0
   0  3]
 [ 3  0  4  0  0  2  0  0  0  0  0 10  0  0  0  0  0  0 18  1  0  0  0  0
   0  1]
 [12  0  0  0  0 15  0  0  0  0  3  1  0  0  0  8  0  0  0  0  0  0  0  0
   0  0]
 [ 0  0  4  0  0  1  0  2  0  0  0  1  1  2  7  0 11  0  3  3  3  0  0  0
   1  0]
 [ 2  0  0  0  0  0  0 12  0  0  0  1 16  1  0  0  0  0  0  0  0  0  4  0
   3  0]
 [ 0  0  0  0  0  0  0  0  0 13  0  1  0  2  0  0  0  0  0  5  0  0  0  0
   0 18]
 [ 0  0  0 12  0  0  0  0  0 23  0  0  0  0  0  0  0  0  0  4  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0 16  5  0  0  0  0  0 15  0  1  0  1  0  0
   1  0]
 [ 0  0  5  0  0  0  0  0  0  0  0 29  0  0  1  0  0  3  0  0  0  0  0  0
   0  1]
 [ 0  0  0  0  0  0  0  6  0  0  0  0 30  0  0  0  0  0  0  1  1  0  0  0
   1  0]
 [ 1  0  0  0  0  0  0  3  0  0  1  0  4 11  2  0  0  0  0  1  1  0 11  0
   4  0]
 [ 0  0  1  2  0  0  0  0  0  0  0  0  0  0 34  0  0  0  0  0  2  0  0  0
   0  0]
 [12  0  0  0  0  2  0  0  0  0  0  0  0  0  1 19  2  0  0  0  3  0  0  0
   0  0]
 [ 0  0  1  1  0  1  0  0  0  0  0  0  0  1  6  0 26  0  0  0  3  0  0  0
   0  0]
 [ 3  0  3  0  0  0  0  0  0  0  0  3  1  0  0  7  1 20  0  0  0  1  0  0
   0  0]
 [ 0  0  1  9  0  0  0  0  0  4  0  2  1  0  0  0  0  0 21  0  0  0  0  0
   0  1]
 [ 0  0  1  1  0  3  0  0  0 10  1  5  0  0  0  0  0  0  0 16  0  0  0  0
   2  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  4  1  0  2  0  0  2  0  0 30  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  4 27  2  0
   1  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  3  0  2  0  0  0  1  0  0  3  2 26  0
   2  0]
 [ 1  0  0  0  0  0  0  0  0  1 13  0  0  0  0  0  0  1  0  0  0  3  0 19
   1  0]
 [ 0  0  0  1  0  0  0  0  0  0  0  0  2  1  0  0  0  0  0  0  0  6  2  9
  18  0]
 [ 0  0  0  1  0  0  0  0  0  1  0  6  0  0  0  0  0  0  0  0  0  0  0  0
```

```
   0 31]]
-----
Accuracy after: 0.47928994082840237
Confusion Matrix after:
[[15  0  0  0  0  0  0 10  0  0  5  0  6  2  0  0  0  0  0  0  0  0  1  0
   0  0]
 [ 0  0  0 12  0  1  0  1  0  0  2  2  6  0  0  0  0  1 12  0  2  0  0  0
   0  0]
 [ 0  0 31  0  0  0  0  0  0  0  0  5  0  0  3  0  0  0  0  0  0  0  0  0
   0  0]
 [ 0  0  0 17  0  1  0  0  0  0  0  1  0  0 13  0  1  0  0  0  3  0  0  0
   0  3]
 [ 3  0  4  0  0  2  0  0  0  0  0 10  0  0  0  0  0  0 18  1  0  0  0  0
   0  1]
 [12  0  0  0  0 15  0  0  0  0  3  1  0  0  0  8  0  0  0  0  0  0  0  0
   0  0]
 [ 0  0  4  0  0  1  0  2  0  0  0  1  1  2  7  0 11  0  3  3  3  0  0  0
   1  0]
 [ 2  0  0  0  0  0  0 12  0  0  0  1 16  1  0  0  0  0  0  0  0  0  4  0
   3  0]
 [ 0  0  0  0  0  0  0  0  0 13  0  1  0  2  0  0  0  0  0  5  0  0  0  0
   0 18]
 [ 0  0  0 12  0  0  0  0  0 23  0  0  0  0  0  0  0  0  0  4  0  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0 16  5  0  0  0  0  0 15  0  1  0  1  0  0
   1  0]
 [ 0  0  5  0  0  0  0  0  0  0  0 29  0  0  1  0  0  3  0  0  0  0  0  0
   0  1]
 [ 0  0  0  0  0  0  0  6  0  0  0  0 30  0  0  0  0  0  0  1  1  0  0  0
   1  0]
 [ 1  0  0  0  0  0  0  3  0  0  1  0  4 11  2  0  0  0  0  1  1  0 11  0
   4  0]
 [ 0  0  1  2  0  0  0  0  0  0  0  0  0  0 34  0  0  0  0  0  2  0  0  0
   0  0]
 [12  0  0  0  0  2  0  0  0  0  0  0  0  0  1 19  2  0  0  0  3  0  0  0
   0  0]
 [ 0  0  1  1  0  1  0  0  0  0  0  0  0  1  6  0 26  0  0  0  3  0  0  0
   0  0]
 [ 3  0  3  0  0  0  0  0  0  0  0  3  1  0  0  7  1 20  0  0  0  1  0  0
   0  0]
 [ 0  0  1  9  0  0  0  0  0  4  0  2  1  0  0  0  0  0 21  0  0  0  0  0
   0  1]
 [ 0  0  1  1  0  3  0  0  0 10  1  5  0  0  0  0  0  0  0 16  0  0  0  0
   2  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  4  1  0  2  0  0  2  0  0 30  0  0  0
   0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  4 27  2  0
   1  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  3  0  2  0  0  0  1  0  0  3  2 26  0
   2  0]
 [ 1  0  0  0  0  0  0  0  0  1 13  0  0  0  0  0  0  1  0  0  0  3  0 19
   1  0]
 [ 0  0  0  1  0  0  0  0  0  0  0  0  2  1  0  0  0  0  0  0  0  6  2  9
  18  0]
```

```
[ 0  0  0  1  0  0  0  0  0  1  0  6  0  0  0  0  0  0  0  0  0  0  0  0
  0 31]]
```