Linear Algebra Assignment II

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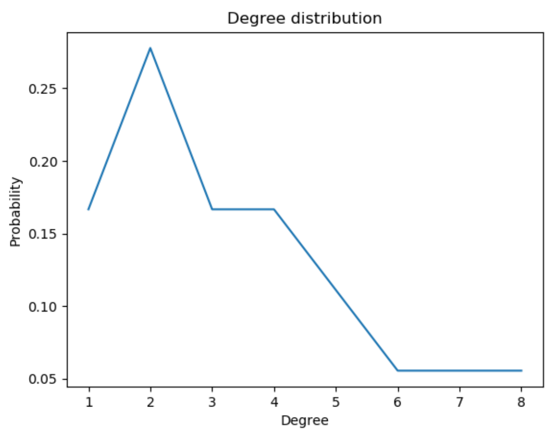
1 Problem - I

1.1 Task I

For the given dataset, the graph plotted is shown below.



We can see this distribution somewhat similar to inverse gaussian distribution.

1.2 Task V

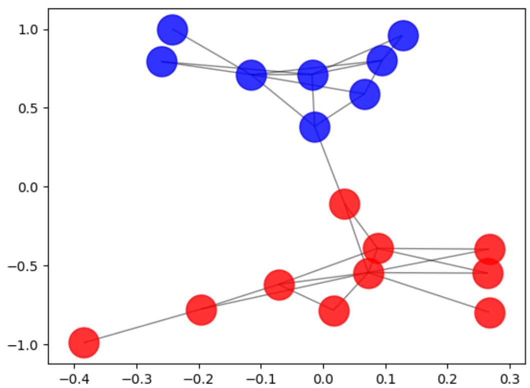
For the test data given, Min eigen value was found to be :

$$-1.3813844561213333e^{-16}$$

(which is close to zero)
and Eigen vector corresponding to the minimum eigen value is obtained as Transpose of [0.23570226039551526 0.2357022603955154 0.2357022603955153 0.23570226039551526 0.2357022603955154 0.23570226039551562, 0.23570226039551528 0.2357022603955153 0.23570226039551626, 0.23570226039551626 0.23570226039551626 0.23570226039551642, 0.23570226039551634 0.23570226039551628 0.23570226039551628, 0.23570226039551628 0.2357022603955163 0.23570226039551614] , which is a scaled version of all 1's

1.3 Task VI

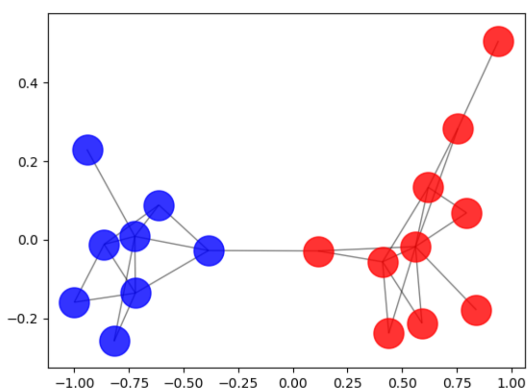
For the given test data, the following coloured plot is found



It is observed that, the points are being clustered into two different groups. The graph is being divided by the cut edge. The edge joining the two clusters is a cut edge (i.e. if it is removed the graph will have 2 connected components.)

1.4 Bonus I

For the given test data, the following coloured plot is found using **numpy**



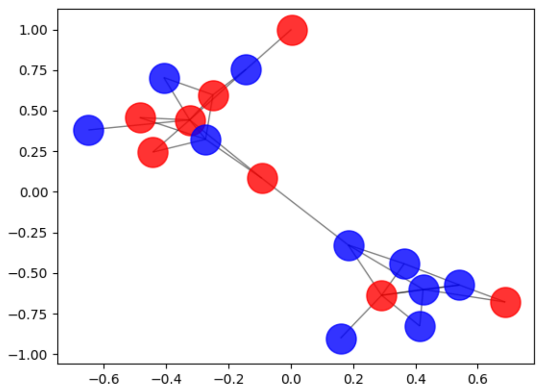
No difference in clustering is observed.

1.5 Bonus II

If we are asked to divide into more than 2 clusters, then we can do so by taking more than 1 eigen vectors. For example, we can take the eigen vectors corresponding to second smallest and third smallest eigen value. Now we can divide the nodes into 4 clusters (according to sign of the corresponding entries of eigen vector elements) [i.e. + + , + - , - - , - +] In this way, if we take m eigen vectors, we can cluster the nodes into 2^n clusters.

1.6 Bonus III

The below plot is observed if we take the second largest eigen vector instead of second smallest.



My observation is that the clustering is not perfect as it was with the second smallest eigen vector.

1.7 Bonus IV

The central edge of the graph is the edge that has one node in each of the clusters.(as observed)

2 Problem - II

2.1 Task II

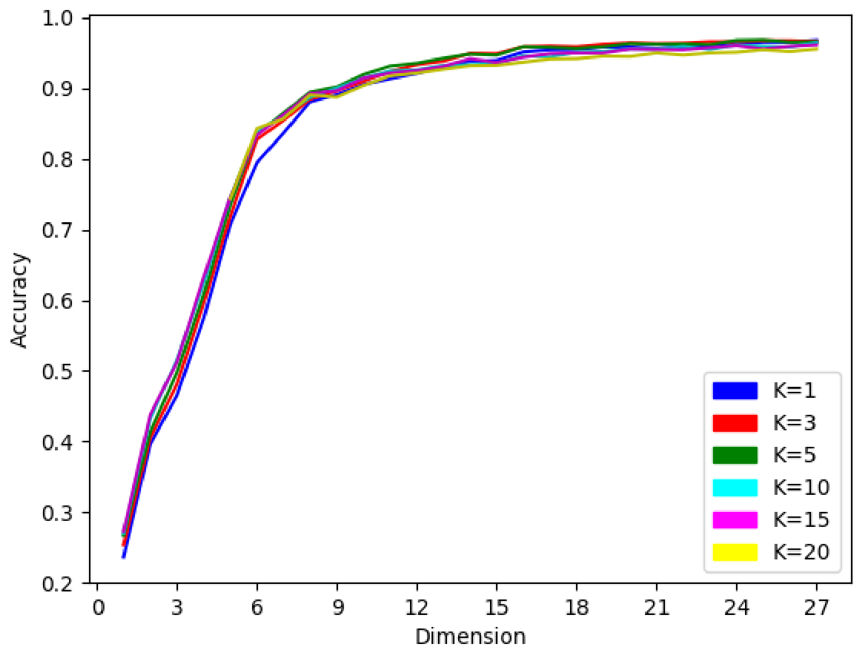
M	K	Accuracy
1	1	0.2365
1	3	0.2535
2	1	0.396
2	3	0.405
3	1	0.465
3	3	0.481
4	1	0.573
4	3	0.5945
1	5	0.267

1	10	0.27
1	15	0.273
2	5	0.4135
2	10	0.4325
2	15	0.438
3	5	0.4975
3	10	0.515
3	15	0.512
4	5	0.607
4	10	0.6235
4	15	0.6315
5	1	0.707
5	3	0.7185
5	5	0.7345
5	10	0.745
5	15	0.7455
5	20	0.7435
6	1	0.7945
6	3	0.8275
6	5	0.835
6	10	0.8375
6	15	0.8335
6	20	0.843
7	1	0.8365
7	3	0.8545
7	5	0.865
7	10	0.8615
7	15	0.8625
7	20	0.857
8	1	0.881
8	3	0.8845
8	5	0.8945
8	10	0.887
8	15	0.8925
8	20	0.8905
9	1	0.891
9	3	0.8965
9	5	0.902
9	10	0.9005
9	15	0.8965
9	20	0.8875
10	1	0.9055
10	3	0.91
10	5	0.9195
10	10	0.9145

10	15	0.9145
10	20	0.904
11	1	0.9135
11	3	0.924
11	5	0.9315
11	10	0.9245
11	15	0.9215
11	20	0.9175
12	1	0.921
12	3	0.9335
12	5	0.9355
12	10	0.926
12	15	0.925
12	20	0.9215
13	1	0.9305
13	3	0.9385
13	5	0.9425
13	10	0.9325
13	15	0.931
13	20	0.927
14	1	0.9385
14	3	0.9495
14	5	0.9485
14	10	0.9335
14	15	0.942
14	20	0.932
15	1	0.9395
15	3	0.949
15	5	0.947
15	10	0.9355
15	15	0.9365
15	20	0.9325
16	1	0.9515
16	3	0.959
16	5	0.959
16	10	0.946
16	15	0.944
16	20	0.937
17	1	0.9545
17	3	0.96
17	5	0.958
17	10	0.9445
17	15	0.949
17	20	0.9415
18	1	0.955

18	3	0.959
18	5	0.9565
18	10	0.951
18	15	0.95
18	20	0.942
19	1	0.9585
19	3	0.9625
19	5	0.959
19	10	0.952
19	15	0.95
19	20	0.9455
20	1	0.9585
20	3	0.9645
20	5	0.9635
20	10	0.956
20	15	0.9555
20	20	0.945
21	1	0.9565
21	3	0.9635
21	5	0.9625
21	10	0.9555
21	15	0.955
21	20	0.95
22	1	0.959
22	3	0.964
22	5	0.963
22	10	0.9595
22	15	0.9545
22	20	0.947
23	1	0.9605
23	3	0.966
23	5	0.962
23	10	0.955
23	15	0.9575
23	20	0.95
24	1	0.963
24	3	0.966
24	5	0.968
24	10	0.9615
24	15	0.9605
24	20	0.951
25	1	0.9655
25	3	0.9675
25	5	0.9685
25	10	0.9595

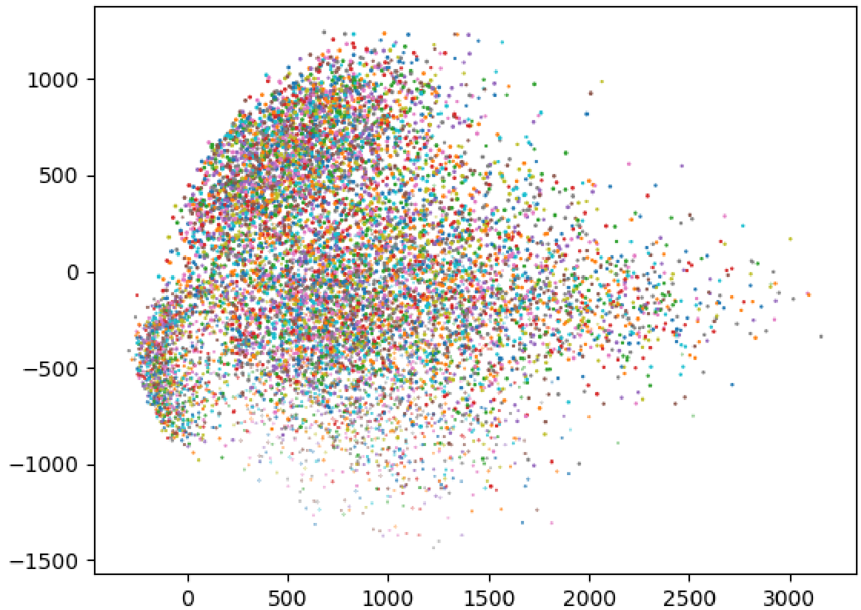
25	15	0.9555
25	20	0.9545
26	1	0.9655
26	3	0.9675
26	5	0.9655
26	10	0.9585
26	15	0.9595
26	20	0.952
27	1	0.968
27	3	0.9665
27	5	0.966
27	10	0.965
27	15	0.9615
27	20	0.9555
28	1	0.9695
28	3	0.9655
28	5	0.9665
28	10	0.964
28	15	0.9635
28	20	0.953
29	1	0.9695
29	3	0.9665
29	5	0.9685
29	10	0.9625
29	15	0.9595
29	20	0.9505



The above graph represents the data that is reported in above table.
By observing the above accuracy plots, I choose **M=20** and **K=3** for the model.

2.2 Bonus I

The vectors, when projected to 2D space resulted in the below figure:



No observation could be made from above figure.

2.3 Bonus II

References

1. https://stackoverflow.com/questions/16569613/how-does-numpy-linalg-inv-calculate-the-inverse-of-an-orthogonal-matrix