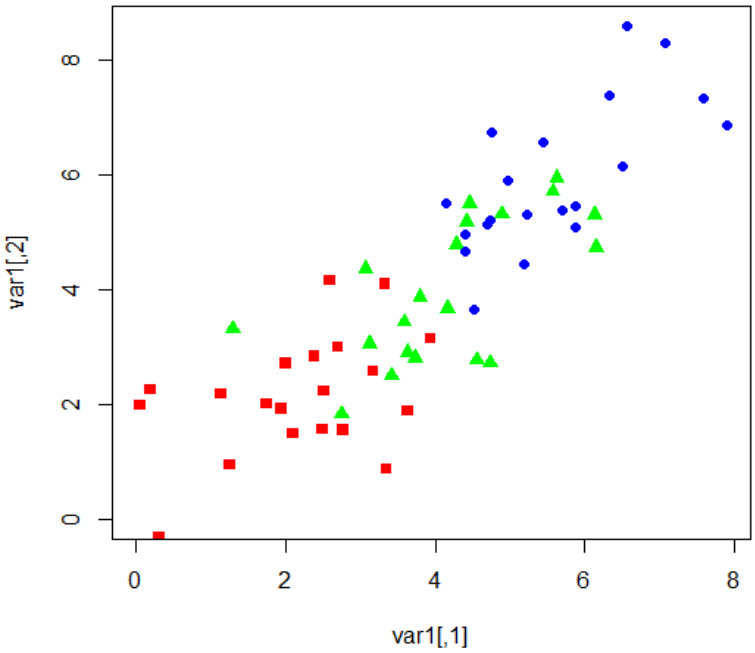
Homework 4

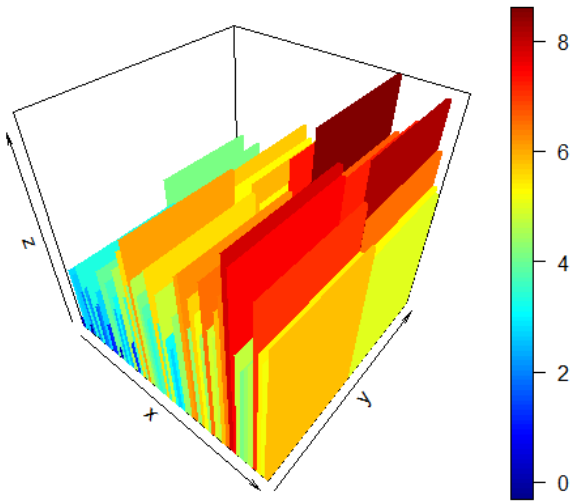
Problem1

Plots are as follows:

a).

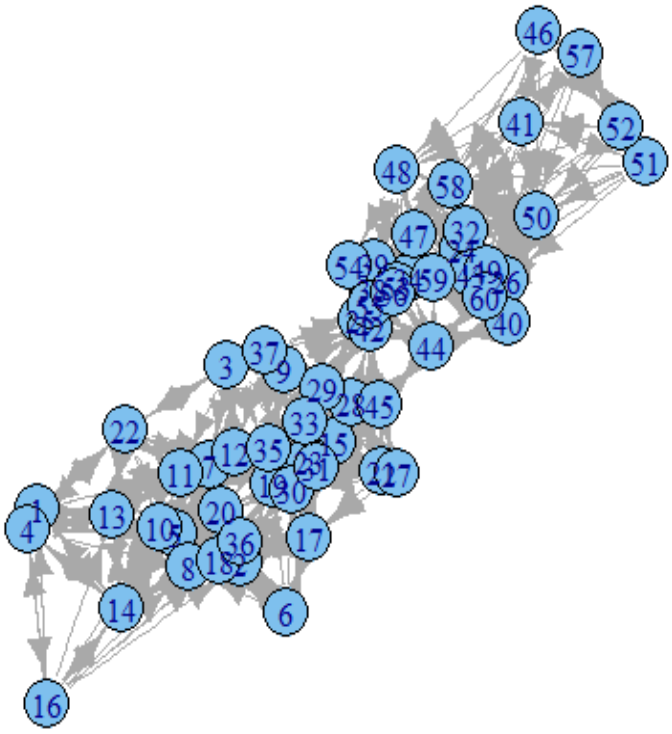


b).



Problem2

a).


46
57
41
52
51
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58
50
47
32
60
40
44
3
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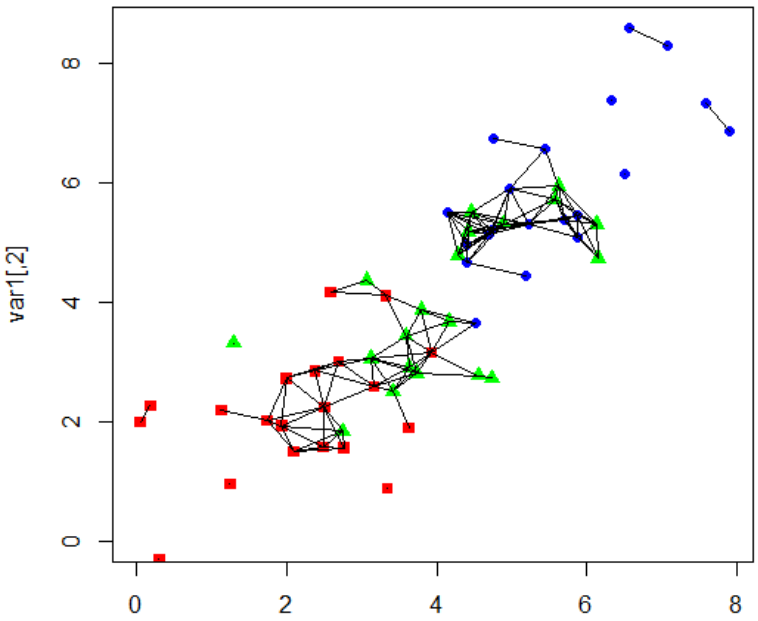
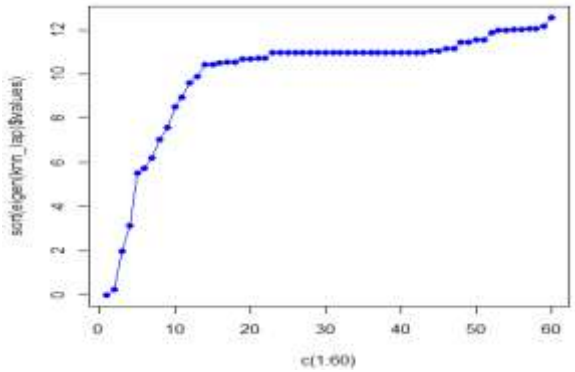
4

b).

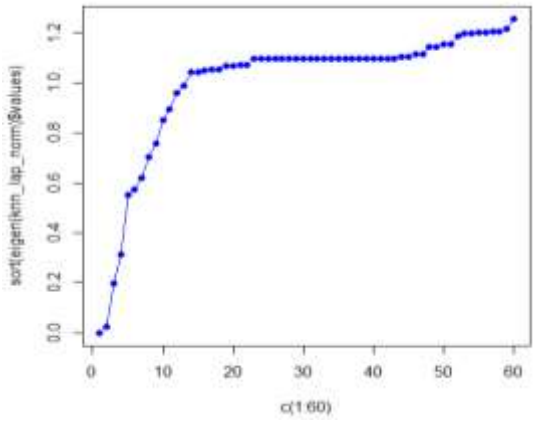

var1[,2]
0
2
4
6
8
0
2
4
6
8

Problem3

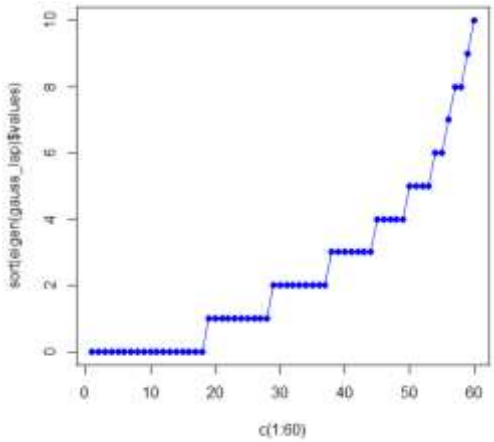
a) KNN Laplacian Eigen Values



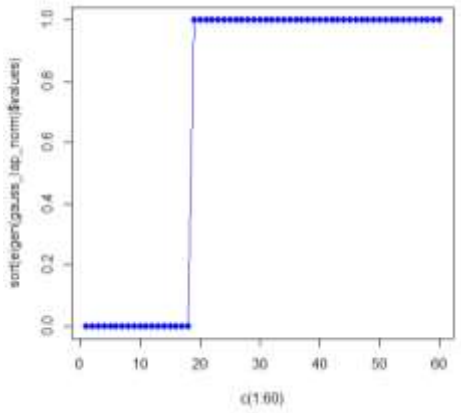
KNN Normalized laplacian Eigen Values



Gaussian Lalacian Eigen Values

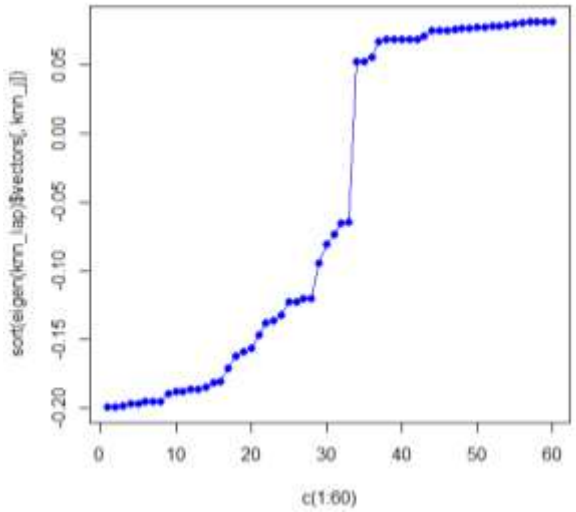


Gaussian Normalized Laplacian Eigen Values

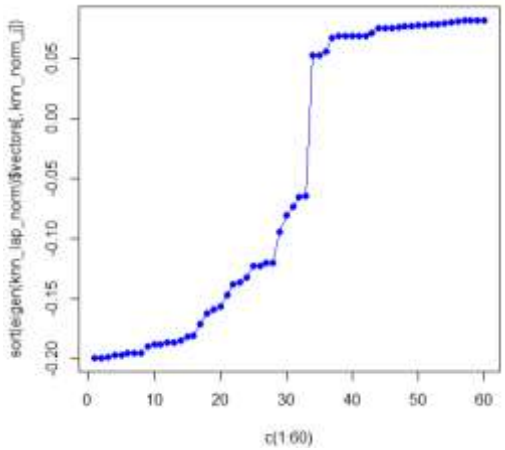


b).Yes the observations are completely consistent with lecture notes. The Eigen values of Gaussian laplacian have a step like form and they are also positive, semi-definite values. The close to 0 eigen values are there which suggest the possibility of a community. Also the multiplicity of 0 eigen values determine the number of connected components.

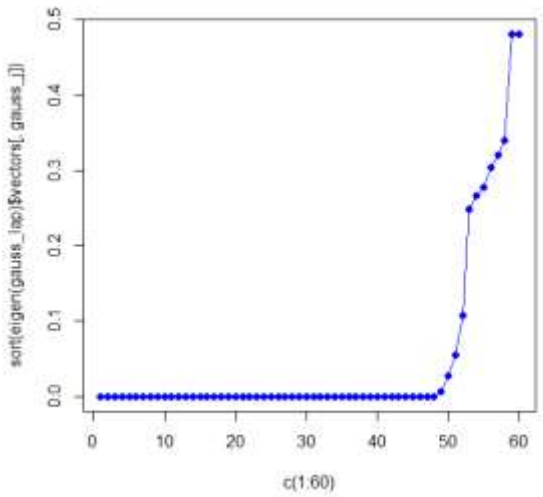
c). Eigen Vector for second smallest eigen value for knn laplacian.



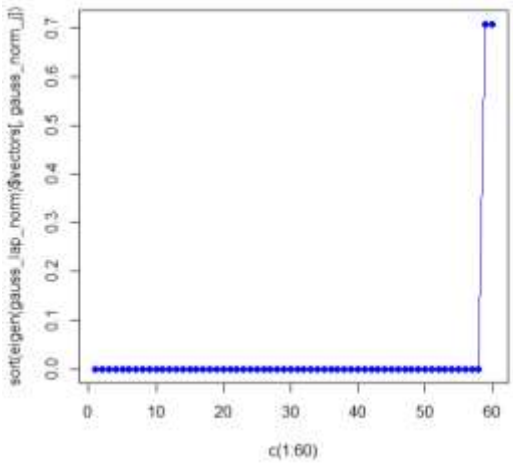
Eigen Vector for second smallest eigen value for normalized knn laplacian.



Eigen Vector for second smallest eigen value for Gaussian kernel laplacian.



Eigen Vector for second smallest eigen value for normalized Gaussian kernel laplacian.



d). For Knn graph using laplacian and normalized laplacian following two communities were found:

points_in_community1_knn

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 27 28

29 30 31 33 35 36 37 45

points_in_community2_knn

24 25 26 32 34 38 39 40 41 42 43 44 46 47 48 49 50 51 52 53 54 55 56 57 58

59 60

For Gaussian kernel similarity graph using laplacian following two communities were found:

> points_in_community1_gauss

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 26 27

28 29 30 31 32 33 35 36 37 40 41 43 44 45 46 48 49 50 51 52 56 57 58 59 60

> points_in_community2_gauss

24 25 34 38 39 42 47 53 54 55

For Gaussian kernel similarity graph using normalized laplacian following two communities were found:

> points_in_community1_gauss_norm

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52

53 54 55 56 57 58 59 60

> points_in_community2_gauss_norm

24 25

e). Conductance value using Normalized and unnormalized vectors for KNN graph is same.

Conductance for community1

[1 0.01694915

Conductance for community2

[1] 0.005586592

f). Yes the conductance follows cheeger's inequality.

Second smallest eigenvalue / 2 < graph conductance < sqrt(2* Second smallest eigenvalue)

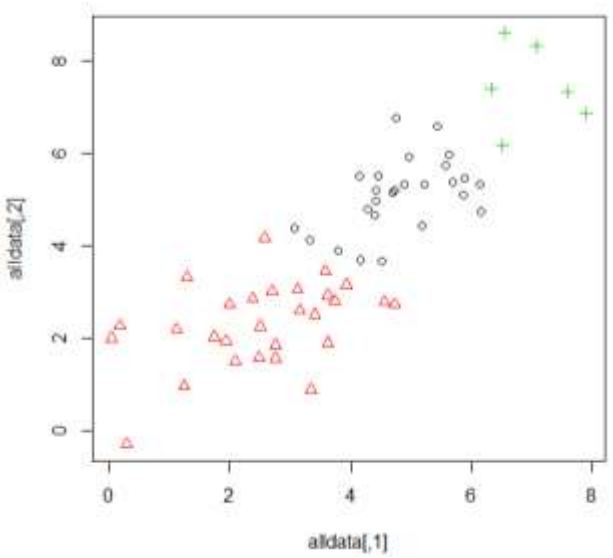
0.01258744 < graph conductance < 0.2243875

Lower bound = 0.01258744

Upper Bound = 0.2243875

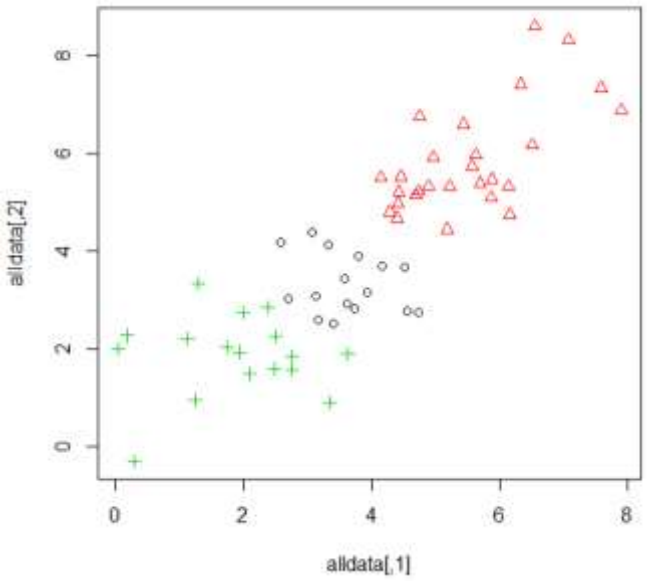
Problem 4

a). The clusters formed from normal kmeans clustering are as follows:



b). The clusters formed from spectral graph clustering are as follows:

KNN Graph



The clusters are different as can be seen above

Gaussian Graph