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| Neural Network and Fuzzy Systems  (EECE 5860)  Project-1 Report |
| Submitted by – Mohammad Saber  (MUID: 005852837) |
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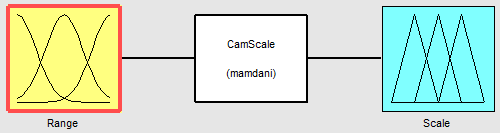
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# **Problem One: Develop a fuzzy inference system to simulate the camera tracking system**

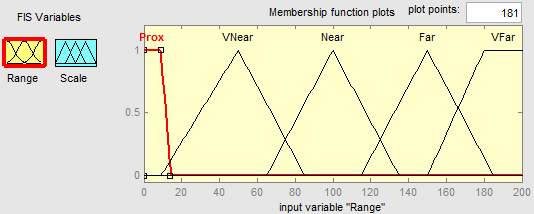
## A) Using fuzzy toolbox to generate Fuzzy Inference system:

Two fuzzy inference systems are required to solve the given problem. We can open the fuzzy system toolbox from MATLAB by typing ‘fuzzy’ in MATLAB command line. For first fuzzy inference system we need only one input named *Range* and one output named *Scale* as depicted in Figure 1.

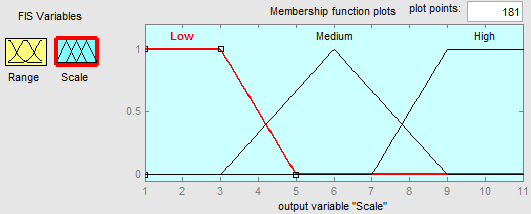


**Figure 1:** Fuzzy inference system to generate scale from input range

Now we have to create membership functions for Range and Scale. We can just click on the input box and output box (Figure 1) to set all membership functions according to the given problem. Figure 2 and 3 shows all membership functions used for this fuzzy inference system.

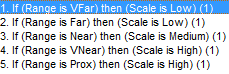


**Figure 2:** Membership functions for input variable “Range”



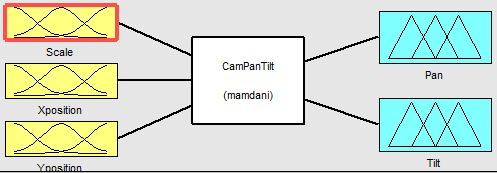
**Figure 3:** Membership functions for output variable “Scale”

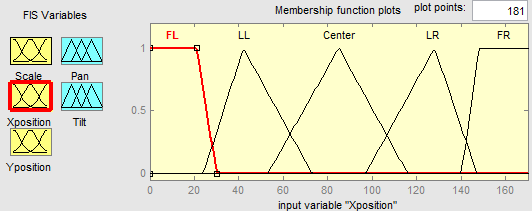
Then I have set the following rules by clicking on the middle white box of Figure 1.



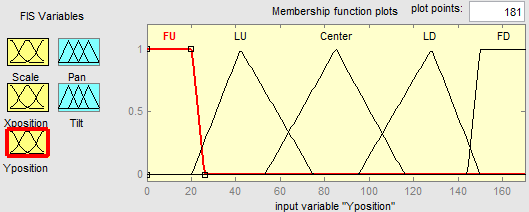
**Figure 4:** Set of rules for first fuzzy inference system

For second fuzzy system we have three inputs and two outputs (Figure 5). One of the inputs of second fuzzy system would be the output first fuzzy system. Thus the input variable “Range” will have same membership functions as output variable of first fuzzy inference system (Figure 3). Two output variables “Pan” and “Tilt” will also have the same membership functions according to the problem specification. Figure 6, 7 and 8 show membership functions for input and output variables required to implement second fuzzy inferences system.

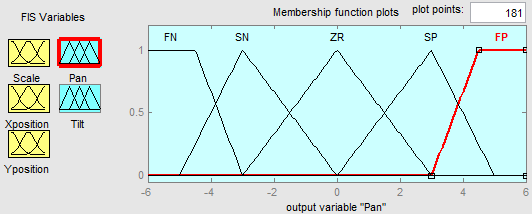
  
**Figure 5:** Second fuzzy inference system



**Figure 6:** Membership functions for input variable “Xposition”



**Figure 7:** Membership functions for input variable “Yposition”



**Figure 8:** Membership functions for output variable “Pan” and “Tilt”

Similarly like first fuzzy inference system, we have to set 30 rules for second fuzzy inference system which are shown in Figure 9.

|  |
| --- |
|  |

**Figure 9:** Set of rules for the second fuzzy inference system

Now, we save these two fuzzy inference systems as “CamScale.fis” and “CamPanTilt.fis” respectively for later use.

## B) Using matlab command line to simulate the camera tracking system:

In part A, we have created two fuzzy inference system using MATLAB GUI. Now, we will simulate this two systems in MATLAB command line. Table 1 shows the given input for the simulation.

|  |  |  |
| --- | --- | --- |
| Range | Xposition | Yposition |
| 100 | 85 | 100 |
| 200 | 150 | 20 |
| 50 | 30 | 53 |
| 101 | 150 | 20 |
| 200 | 0 | 0 |
| 0 | 170 | 170 |
| 100 | 85 | 85 |

**Table 1:** Given input to run simulation for the Camera Tracking System

After giving the first column of Table 1 as input for first fuzzy inference system we will get the following output for the scale variable.

|  |
| --- |
| Scale |
| 6.0000 |
| 2.5295 |
| 9.4705 |
| 6.0000 |
| 2.5295 |
| 9.4705 |
| 6.0000 |

**Table 2:** Output of first fuzzy inference system

Now we will use the result of Table 2 along with second and third column of Table 1 as input of second fuzzy inference system to generate the final output of “Pan” and “Tilt” variables. In MATLAB command line we have used functions *readfis()* and *evalfis()*for reading previously generated \*.fis file and running fuzzy inference system simulator respectively. Final outputs of *Pan* and *Tilt* generated by our simulation are shown in Table 3 and 4 respectively.

|  |
| --- |
| function [Pan Tilt] = CameraTracking()  Range = [100; 200; 50; 101; 200; 0; 100];  Horizontal\_Pos = [85; 150; 30; 150; 0; 170; 85];  Vertical\_Pos = [100; 20; 53; 20; 0; 170; 85];  fis1 = readfis('CamScale');  Scale = evalfis(Range,fis1);  fis2 = readfis('CamPanTilt');  [Pan Tilt] = evalfis([Scale Horizontal\_PosVertical\_Pos],fis2);  End |

**Figure 10:** MATLAB command line codes to run the simulation of camera tracking system

|  |  |
| --- | --- |
| Pan | |
| 0.0000 | 0.4596 |
| 4.8649 | -4.8649 |
| 0.0000 | 0.0000 |
| 2.6674 | -2.6674 |
| -4.8649 | -4.8649 |
| 2.6674 | 2.6674 |
| 0.0000 | 0.0000 |

**Table 3:** Final result of output variable “Pan”

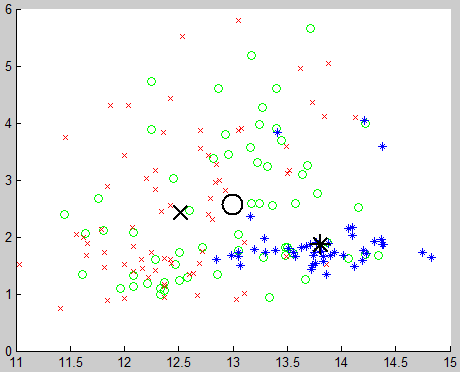
|  |  |  |
| --- | --- | --- |
| Tilt | | |
| 0 | 0 | 1 |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 0 | 0 | 1 |
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 0 | 1 |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
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| 0 | 1 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 0 |
| 0 | 1 | 0 |
| 0 | 1 | 0 |
| 0 | 1 | 1 |
| 0 | 1 | 0 |
| 0 | 1 | 0 |

**Table 4:** Final result of output variable “Tilt”

# **Problem Two: FCM for clustering analysis of the wine data**

## A) Data analysis stategy to solve clustering problem:

A 13-dimentional data set is given for clustering (Appendix –A). I have tried to analyze 13-dimension data by observing and plotted it using MATLAB. But it’s very difficult or almost impossible to make a decision from that 13-dimensional graph. It’s didn’t make any sense though clusters overlap each other and some point of one cluster was inside the range of another cluster. Later I figure out that we are seeing 2-dimnensionally but our plot is 13-dimention. Thus some points which seems to be inside a given clusteroriginal from another cluster of different dimension. Figure 11 shows the simulation of fuzzy C-means (FCM) algorithm on 13-dimensional data.



**Figure 11:** Result of running FCM on 13 dimensional data (Cluster size =3)

Then I decided to go for 2-dimensional data at a time. If we try to plot or analyze 2-dimensional data from given 13-dimensional data, then we have 78 combinations (12+11+10+9+8+7+6+5+4+3+2+1 =78) of 2-dimensional data. I have partitioned the original data in 78 pairs using a MATLAB code (Appendix-B). Then try to find out center, radius and standard deviation for all 78 combinations. Then take the average of 156 (78combinations\*2clusters) radius and standard deviation for comparison with other results. Similarly I have run the simulation for cluster 3, 4 and 5 and take the average of all cluster radius and standard deviations for future analysis. I have written a MATLAB functions to simulate fuzzy C-means algorithm (Appendix-C) for different cluster size and store the all cluster centers, radius and standard deviation into \*.txt files for analysis. It also shows a 2-dimensional graph of clustering operation on given data set. I wrote another MATLAB function to call the simulation of FCM algorithm for all 78 combinations (Appendix-D).

## B) Results of analysis of wine Data Clustering:

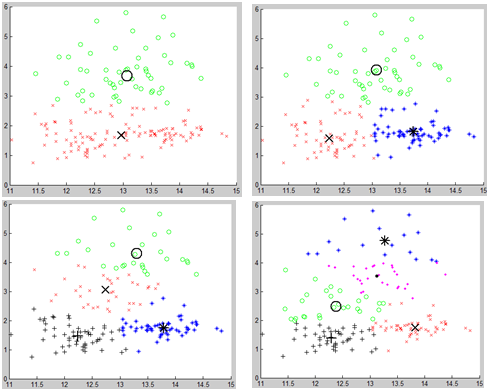
After running the simulation and collecting the results I found that average cluster radius for cluster 2, 3, 4 and 5 are 70.15, 49.11, 35.66 and 28.02 unit respectively. When we increase the number of cluster then radius of cluster become smaller which makes sense but we can’t find out any conclusion about how many cluster is good for this data using this information. Again we have standard deviations 208.87, 121.79, 78.83 and 59.25 for cluster number 2, 3, 4 and 5 respectively. This information clearly says that if I go for bigger number of cluster then standard deviation and radius will be further smaller. Thus we can’t make any decision from only standard deviation or radius. We need to find out any second order calculation to make a decision. Table 5 contains the result summary of my findings. Full results are included in Appendix-E.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No of Clusters | Average radius | Average STD | Radius\*Cluster | STD improve | Real STD improve |
| 2 | 70.15 | 208.87 | 140.31 | - | - |
| 3 | 49.11 | 121.79 | 147.33 | 71.5 % | 21.5 % |
| 4 | 35.66 | 78.83 | 142.63 | 54.5 % | 21.17 % |
| 5 | 28.02 | 59.25 | 140.08 | 33.04 % | 8.04 % |

**Table 5:** Summary of wine data clustering result

## C) Final decision of selecting number of cluster and Dicision

If we observe in the Table 5 carefully, especially second order calculations (last 3 columns), then we can see radius\*cluster is bigger (147.33 which is clearly bigger than other chosen number of clusters) for cluster 3. From my observation if we have close cluster centers then radius of clusters will be smaller. Those close clustering are unnecessary clustering and could be merged, and really useful cluster centers are far away from each other. Figure 11 illustrate the above discussion for same data pair.

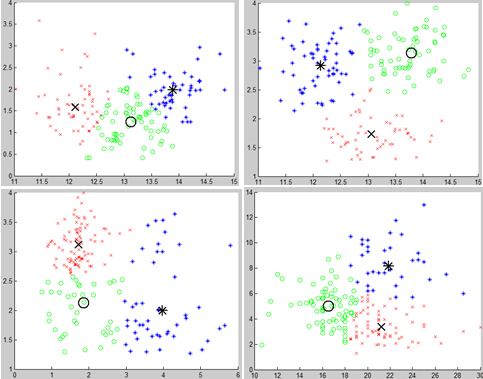


**Figure 11:** Cluster same pair of data using cluster number 2, 3, 4 and 5.

Again, if we consider the standard deviation for every cluster number, then we can see 71.5% improvement from cluster 2 to cluster 3 which is the biggest improvement from comparing other cluster number. But it’s normal if we increase the number of cluster then standard deviation will decrease i.e. improvement may be bias with choosing greater number of cluster. Thus I deduced the ratio of the number of clusters to find real improvement in last column of Table 5. Formula I have used to find real improvement of standard deviation for choosing new number of clusters over pervious number of clusters is given below:

((STD of previous cluster)/(STD of chosen cluster) – (# of chosen cluster)/(# of previous cluster))\*100%

For example, if we choose cluster size 3 instead of 2 then our real standard deviation improvement will be ((208.87/121.79)-(3/2))\*100% = 21.5 %. In this way, I have calculated all real improvement of standard deviation and found that cluster number 3 is the best among other chosen cluster number. Considering above discussion I think ***three clusters*** would be appropriate for given wind data set. Figure 12 shows sample simulation of cluster number three for some pair of data from 78 pairs. Centers, radii, standard deviations and graphical representation of cluster number 2, 3, 4 and 5 for all 78 pairs are given in Appendix-E and F.



**Figure 12:** Sample simulation on 4 pair among 78 pairs of data set for cluster number 3.

To find the cluster members of each cluster, I have written a MATLAB function which is attached in Appendix – G. The first cluster contains 46 members, second cluster contains 71 members and third cluster contains 61 members. All members from each cluster are given below:

***Cluster 1members:***

1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17,18,19,23,24,27,28,30,31,32,33,34,35,38,39,42,43,46,47,48,49,50,51,52,53,54,55,56,58,59,74.

Total members = 46.

***Cluster 2 members:***

60,62,64,65,67,68,72,73,76,77,78,80,81,84,85,86,87,88,91,92,93,94,95,98,100,102,103,104,106,107,108,109,111,112,114,115,116,117,118,119,120,122,123,124,125,126,127,128,129,130,132,133,134,138,139,140,141,143,144,147,150,151,152,153,157,161,163,166,171,172,178.

Total members = 71.

***Cluster 3 members:***

5,20,21,22,25,26,29,36,37,40,41,44,45,57,61,63,66,69,70,71,75,79,82,83,89,90,96,97,99,101,105,110,113,121,131,135,136,137,142,145,146,148,149,154,155,156,158,159,160,162,164,165,167,168,169,170,173,174,175,176,177.

Total members = 61.

# Appendix–A : Given Wine data set

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Alcohol | Malic acid | Ash | Alcalinity of ash | Magnesium | Total phenols | Flavanoids | Nonflavanoid phenols | Proanthocyanins | Color intensity | Hue | OD280/OD315 of diluted wines | Proline |
| 14.23 | 1.71 | 2.43 | 15.6 | 127 | 2.8 | 3.06 | 0.28 | 2.29 | 5.64 | 1.04 | 3.92 | 1065 |
| 13.2 | 1.78 | 2.14 | 11.2 | 100 | 2.65 | 2.76 | 0.26 | 1.28 | 4.38 | 1.05 | 3.4 | 1050 |
| 13.16 | 2.36 | 2.67 | 18.6 | 101 | 2.8 | 3.24 | 0.3 | 2.81 | 5.68 | 1.03 | 3.17 | 1185 |
| 14.37 | 1.95 | 2.5 | 16.8 | 113 | 3.85 | 3.49 | 0.24 | 2.18 | 7.8 | 0.86 | 3.45 | 1480 |
| 13.24 | 2.59 | 2.87 | 21 | 118 | 2.8 | 2.69 | 0.39 | 1.82 | 4.32 | 1.04 | 2.93 | 735 |
| 14.2 | 1.76 | 2.45 | 15.2 | 112 | 3.27 | 3.39 | 0.34 | 1.97 | 6.75 | 1.05 | 2.85 | 1450 |
| 14.39 | 1.87 | 2.45 | 14.6 | 96 | 2.5 | 2.52 | 0.3 | 1.98 | 5.25 | 1.02 | 3.58 | 1290 |
| 14.06 | 2.15 | 2.61 | 17.6 | 121 | 2.6 | 2.51 | 0.31 | 1.25 | 5.05 | 1.06 | 3.58 | 1295 |
| 14.83 | 1.64 | 2.17 | 14 | 97 | 2.8 | 2.98 | 0.29 | 1.98 | 5.2 | 1.08 | 2.85 | 1045 |
| 13.86 | 1.35 | 2.27 | 16 | 98 | 2.98 | 3.15 | 0.22 | 1.85 | 7.22 | 1.01 | 3.55 | 1045 |
| 14.1 | 2.16 | 2.3 | 18 | 105 | 2.95 | 3.32 | 0.22 | 2.38 | 5.75 | 1.25 | 3.17 | 1510 |
| 14.12 | 1.48 | 2.32 | 16.8 | 95 | 2.2 | 2.43 | 0.26 | 1.57 | 5 | 1.17 | 2.82 | 1280 |
| 13.75 | 1.73 | 2.41 | 16 | 89 | 2.6 | 2.76 | 0.29 | 1.81 | 5.6 | 1.15 | 2.9 | 1320 |
| 14.75 | 1.73 | 2.39 | 11.4 | 91 | 3.1 | 3.69 | 0.43 | 2.81 | 5.4 | 1.25 | 2.73 | 1150 |
| 14.38 | 1.87 | 2.38 | 12 | 102 | 3.3 | 3.64 | 0.29 | 2.96 | 7.5 | 1.2 | 3 | 1547 |
| 13.63 | 1.81 | 2.7 | 17.2 | 112 | 2.85 | 2.91 | 0.3 | 1.46 | 7.3 | 1.28 | 2.88 | 1310 |
| 14.3 | 1.92 | 2.72 | 20 | 120 | 2.8 | 3.14 | 0.33 | 1.97 | 6.2 | 1.07 | 2.65 | 1280 |
| 13.83 | 1.57 | 2.62 | 20 | 115 | 2.95 | 3.4 | 0.4 | 1.72 | 6.6 | 1.13 | 2.57 | 1130 |
| 14.19 | 1.59 | 2.48 | 16.5 | 108 | 3.3 | 3.93 | 0.32 | 1.86 | 8.7 | 1.23 | 2.82 | 1680 |
| 13.64 | 3.1 | 2.56 | 15.2 | 116 | 2.7 | 3.03 | 0.17 | 1.66 | 5.1 | 0.96 | 3.36 | 845 |
| 14.06 | 1.63 | 2.28 | 16 | 126 | 3 | 3.17 | 0.24 | 2.1 | 5.65 | 1.09 | 3.71 | 780 |
| 12.93 | 3.8 | 2.65 | 18.6 | 102 | 2.41 | 2.41 | 0.25 | 1.98 | 4.5 | 1.03 | 3.52 | 770 |
| 13.71 | 1.86 | 2.36 | 16.6 | 101 | 2.61 | 2.88 | 0.27 | 1.69 | 3.8 | 1.11 | 4 | 1035 |
| 12.85 | 1.6 | 2.52 | 17.8 | 95 | 2.48 | 2.37 | 0.26 | 1.46 | 3.93 | 1.09 | 3.63 | 1015 |
| 13.5 | 1.81 | 2.61 | 20 | 96 | 2.53 | 2.61 | 0.28 | 1.66 | 3.52 | 1.12 | 3.82 | 845 |
| 13.05 | 2.05 | 3.22 | 25 | 124 | 2.63 | 2.68 | 0.47 | 1.92 | 3.58 | 1.13 | 3.2 | 830 |
| 13.39 | 1.77 | 2.62 | 16.1 | 93 | 2.85 | 2.94 | 0.34 | 1.45 | 4.8 | 0.92 | 3.22 | 1195 |
| 13.3 | 1.72 | 2.14 | 17 | 94 | 2.4 | 2.19 | 0.27 | 1.35 | 3.95 | 1.02 | 2.77 | 1285 |
| 13.87 | 1.9 | 2.8 | 19.4 | 107 | 2.95 | 2.97 | 0.37 | 1.76 | 4.5 | 1.25 | 3.4 | 915 |
| 14.02 | 1.68 | 2.21 | 16 | 96 | 2.65 | 2.33 | 0.26 | 1.98 | 4.7 | 1.04 | 3.59 | 1035 |
| 13.73 | 1.5 | 2.7 | 22.5 | 101 | 3 | 3.25 | 0.29 | 2.38 | 5.7 | 1.19 | 2.71 | 1285 |
| 13.58 | 1.66 | 2.36 | 19.1 | 106 | 2.86 | 3.19 | 0.22 | 1.95 | 6.9 | 1.09 | 2.88 | 1515 |
| 13.68 | 1.83 | 2.36 | 17.2 | 104 | 2.42 | 2.69 | 0.42 | 1.97 | 3.84 | 1.23 | 2.87 | 990 |
| 13.76 | 1.53 | 2.7 | 19.5 | 132 | 2.95 | 2.74 | 0.5 | 1.35 | 5.4 | 1.25 | 3 | 1235 |
| 13.51 | 1.8 | 2.65 | 19 | 110 | 2.35 | 2.53 | 0.29 | 1.54 | 4.2 | 1.1 | 2.87 | 1095 |
| 13.48 | 1.81 | 2.41 | 20.5 | 100 | 2.7 | 2.98 | 0.26 | 1.86 | 5.1 | 1.04 | 3.47 | 920 |
| 13.28 | 1.64 | 2.84 | 15.5 | 110 | 2.6 | 2.68 | 0.34 | 1.36 | 4.6 | 1.09 | 2.78 | 880 |
| 13.05 | 1.65 | 2.55 | 18 | 98 | 2.45 | 2.43 | 0.29 | 1.44 | 4.25 | 1.12 | 2.51 | 1105 |
| 13.07 | 1.5 | 2.1 | 15.5 | 98 | 2.4 | 2.64 | 0.28 | 1.37 | 3.7 | 1.18 | 2.69 | 1020 |
| 14.22 | 3.99 | 2.51 | 13.2 | 128 | 3 | 3.04 | 0.2 | 2.08 | 5.1 | 0.89 | 3.53 | 760 |
| 13.56 | 1.71 | 2.31 | 16.2 | 117 | 3.15 | 3.29 | 0.34 | 2.34 | 6.13 | 0.95 | 3.38 | 795 |
| 13.41 | 3.84 | 2.12 | 18.8 | 90 | 2.45 | 2.68 | 0.27 | 1.48 | 4.28 | 0.91 | 3 | 1035 |
| 13.88 | 1.89 | 2.59 | 15 | 101 | 3.25 | 3.56 | 0.17 | 1.7 | 5.43 | 0.88 | 3.56 | 1095 |
| 13.24 | 3.98 | 2.29 | 17.5 | 103 | 2.64 | 2.63 | 0.32 | 1.66 | 4.36 | 0.82 | 3 | 680 |
| 13.05 | 1.77 | 2.1 | 17 | 107 | 3 | 3 | 0.28 | 2.03 | 5.04 | 0.88 | 3.35 | 885 |
| 14.21 | 4.04 | 2.44 | 18.9 | 111 | 2.85 | 2.65 | 0.3 | 1.25 | 5.24 | 0.87 | 3.33 | 1080 |
| 14.38 | 3.59 | 2.28 | 16 | 102 | 3.25 | 3.17 | 0.27 | 2.19 | 4.9 | 1.04 | 3.44 | 1065 |
| 13.9 | 1.68 | 2.12 | 16 | 101 | 3.1 | 3.39 | 0.21 | 2.14 | 6.1 | 0.91 | 3.33 | 985 |
| 14.1 | 2.02 | 2.4 | 18.8 | 103 | 2.75 | 2.92 | 0.32 | 2.38 | 6.2 | 1.07 | 2.75 | 1060 |
| 13.94 | 1.73 | 2.27 | 17.4 | 108 | 2.88 | 3.54 | 0.32 | 2.08 | 8.9 | 1.12 | 3.1 | 1260 |
| 13.05 | 1.73 | 2.04 | 12.4 | 92 | 2.72 | 3.27 | 0.17 | 2.91 | 7.2 | 1.12 | 2.91 | 1150 |
| 13.83 | 1.65 | 2.6 | 17.2 | 94 | 2.45 | 2.99 | 0.22 | 2.29 | 5.6 | 1.24 | 3.37 | 1265 |
| 13.82 | 1.75 | 2.42 | 14 | 111 | 3.88 | 3.74 | 0.32 | 1.87 | 7.05 | 1.01 | 3.26 | 1190 |
| 13.77 | 1.9 | 2.68 | 17.1 | 115 | 3 | 2.79 | 0.39 | 1.68 | 6.3 | 1.13 | 2.93 | 1375 |
| 13.74 | 1.67 | 2.25 | 16.4 | 118 | 2.6 | 2.9 | 0.21 | 1.62 | 5.85 | 0.92 | 3.2 | 1060 |
| 13.56 | 1.73 | 2.46 | 20.5 | 116 | 2.96 | 2.78 | 0.2 | 2.45 | 6.25 | 0.98 | 3.03 | 1120 |
| 14.22 | 1.7 | 2.3 | 16.3 | 118 | 3.2 | 3 | 0.26 | 2.03 | 6.38 | 0.94 | 3.31 | 970 |
| 13.29 | 1.97 | 2.68 | 16.8 | 102 | 3 | 3.23 | 0.31 | 1.66 | 6 | 1.07 | 2.84 | 1270 |
| 13.72 | 1.43 | 2.5 | 16.7 | 108 | 3.4 | 3.67 | 0.19 | 2.04 | 6.8 | 0.89 | 2.87 | 1285 |
| 12.37 | 0.94 | 1.36 | 10.6 | 88 | 1.98 | 0.57 | 0.28 | 0.42 | 1.95 | 1.05 | 1.82 | 520 |
| 12.33 | 1.1 | 2.28 | 16 | 101 | 2.05 | 1.09 | 0.63 | 0.41 | 3.27 | 1.25 | 1.67 | 680 |
| 12.64 | 1.36 | 2.02 | 16.8 | 100 | 2.02 | 1.41 | 0.53 | 0.62 | 5.75 | 0.98 | 1.59 | 450 |
| 13.67 | 1.25 | 1.92 | 18 | 94 | 2.1 | 1.79 | 0.32 | 0.73 | 3.8 | 1.23 | 2.46 | 630 |
| 12.37 | 1.13 | 2.16 | 19 | 87 | 3.5 | 3.1 | 0.19 | 1.87 | 4.45 | 1.22 | 2.87 | 420 |
| 12.17 | 1.45 | 2.53 | 19 | 104 | 1.89 | 1.75 | 0.45 | 1.03 | 2.95 | 1.45 | 2.23 | 355 |
| 12.37 | 1.21 | 2.56 | 18.1 | 98 | 2.42 | 2.65 | 0.37 | 2.08 | 4.6 | 1.19 | 2.3 | 678 |
| 13.11 | 1.01 | 1.7 | 15 | 78 | 2.98 | 3.18 | 0.26 | 2.28 | 5.3 | 1.12 | 3.18 | 502 |
| 12.37 | 1.17 | 1.92 | 19.6 | 78 | 2.11 | 2 | 0.27 | 1.04 | 4.68 | 1.12 | 3.48 | 510 |
| 13.34 | 0.94 | 2.36 | 17 | 110 | 2.53 | 1.3 | 0.55 | 0.42 | 3.17 | 1.02 | 1.93 | 750 |
| 12.21 | 1.19 | 1.75 | 16.8 | 151 | 1.85 | 1.28 | 0.14 | 2.5 | 2.85 | 1.28 | 3.07 | 718 |
| 12.29 | 1.61 | 2.21 | 20.4 | 103 | 1.1 | 1.02 | 0.37 | 1.46 | 3.05 | 0.906 | 1.82 | 870 |
| 13.86 | 1.51 | 2.67 | 25 | 86 | 2.95 | 2.86 | 0.21 | 1.87 | 3.38 | 1.36 | 3.16 | 410 |
| 13.49 | 1.66 | 2.24 | 24 | 87 | 1.88 | 1.84 | 0.27 | 1.03 | 3.74 | 0.98 | 2.78 | 472 |
| 12.99 | 1.67 | 2.6 | 30 | 139 | 3.3 | 2.89 | 0.21 | 1.96 | 3.35 | 1.31 | 3.5 | 985 |
| 11.96 | 1.09 | 2.3 | 21 | 101 | 3.38 | 2.14 | 0.13 | 1.65 | 3.21 | 0.99 | 3.13 | 886 |
| 11.66 | 1.88 | 1.92 | 16 | 97 | 1.61 | 1.57 | 0.34 | 1.15 | 3.8 | 1.23 | 2.14 | 428 |
| 13.03 | 0.9 | 1.71 | 16 | 86 | 1.95 | 2.03 | 0.24 | 1.46 | 4.6 | 1.19 | 2.48 | 392 |
| 11.84 | 2.89 | 2.23 | 18 | 112 | 1.72 | 1.32 | 0.43 | 0.95 | 2.65 | 0.96 | 2.52 | 500 |
| 12.33 | 0.99 | 1.95 | 14.8 | 136 | 1.9 | 1.85 | 0.35 | 2.76 | 3.4 | 1.06 | 2.31 | 750 |
| 12.7 | 3.87 | 2.4 | 23 | 101 | 2.83 | 2.55 | 0.43 | 1.95 | 2.57 | 1.19 | 3.13 | 463 |
| 12 | 0.92 | 2 | 19 | 86 | 2.42 | 2.26 | 0.3 | 1.43 | 2.5 | 1.38 | 3.12 | 278 |
| 12.72 | 1.81 | 2.2 | 18.8 | 86 | 2.2 | 2.53 | 0.26 | 1.77 | 3.9 | 1.16 | 3.14 | 714 |
| 12.08 | 1.13 | 2.51 | 24 | 78 | 2 | 1.58 | 0.4 | 1.4 | 2.2 | 1.31 | 2.72 | 630 |
| 13.05 | 3.86 | 2.32 | 22.5 | 85 | 1.65 | 1.59 | 0.61 | 1.62 | 4.8 | 0.84 | 2.01 | 515 |
| 11.84 | 0.89 | 2.58 | 18 | 94 | 2.2 | 2.21 | 0.22 | 2.35 | 3.05 | 0.79 | 3.08 | 520 |
| 12.67 | 0.98 | 2.24 | 18 | 99 | 2.2 | 1.94 | 0.3 | 1.46 | 2.62 | 1.23 | 3.16 | 450 |
| 12.16 | 1.61 | 2.31 | 22.8 | 90 | 1.78 | 1.69 | 0.43 | 1.56 | 2.45 | 1.33 | 2.26 | 495 |
| 11.65 | 1.67 | 2.62 | 26 | 88 | 1.92 | 1.61 | 0.4 | 1.34 | 2.6 | 1.36 | 3.21 | 562 |
| 11.64 | 2.06 | 2.46 | 21.6 | 84 | 1.95 | 1.69 | 0.48 | 1.35 | 2.8 | 1 | 2.75 | 680 |
| 12.08 | 1.33 | 2.3 | 23.6 | 70 | 2.2 | 1.59 | 0.42 | 1.38 | 1.74 | 1.07 | 3.21 | 625 |
| 12.08 | 1.83 | 2.32 | 18.5 | 81 | 1.6 | 1.5 | 0.52 | 1.64 | 2.4 | 1.08 | 2.27 | 480 |
| 12 | 1.51 | 2.42 | 22 | 86 | 1.45 | 1.25 | 0.5 | 1.63 | 3.6 | 1.05 | 2.65 | 450 |
| 12.69 | 1.53 | 2.26 | 20.7 | 80 | 1.38 | 1.46 | 0.58 | 1.62 | 3.05 | 0.96 | 2.06 | 495 |
| 12.29 | 2.83 | 2.22 | 18 | 88 | 2.45 | 2.25 | 0.25 | 1.99 | 2.15 | 1.15 | 3.3 | 290 |
| 11.62 | 1.99 | 2.28 | 18 | 98 | 3.02 | 2.26 | 0.17 | 1.35 | 3.25 | 1.16 | 2.96 | 345 |
| 12.47 | 1.52 | 2.2 | 19 | 162 | 2.5 | 2.27 | 0.32 | 3.28 | 2.6 | 1.16 | 2.63 | 937 |
| 11.81 | 2.12 | 2.74 | 21.5 | 134 | 1.6 | 0.99 | 0.14 | 1.56 | 2.5 | 0.95 | 2.26 | 625 |
| 12.29 | 1.41 | 1.98 | 16 | 85 | 2.55 | 2.5 | 0.29 | 1.77 | 2.9 | 1.23 | 2.74 | 428 |
| 12.37 | 1.07 | 2.1 | 18.5 | 88 | 3.52 | 3.75 | 0.24 | 1.95 | 4.5 | 1.04 | 2.77 | 660 |
| 12.29 | 3.17 | 2.21 | 18 | 88 | 2.85 | 2.99 | 0.45 | 2.81 | 2.3 | 1.42 | 2.83 | 406 |
| 12.08 | 2.08 | 1.7 | 17.5 | 97 | 2.23 | 2.17 | 0.26 | 1.4 | 3.3 | 1.27 | 2.96 | 710 |
| 12.6 | 1.34 | 1.9 | 18.5 | 88 | 1.45 | 1.36 | 0.29 | 1.35 | 2.45 | 1.04 | 2.77 | 562 |
| 12.34 | 2.45 | 2.46 | 21 | 98 | 2.56 | 2.11 | 0.34 | 1.31 | 2.8 | 0.8 | 3.38 | 438 |
| 11.82 | 1.72 | 1.88 | 19.5 | 86 | 2.5 | 1.64 | 0.37 | 1.42 | 2.06 | 0.94 | 2.44 | 415 |
| 12.51 | 1.73 | 1.98 | 20.5 | 85 | 2.2 | 1.92 | 0.32 | 1.48 | 2.94 | 1.04 | 3.57 | 672 |
| 12.42 | 2.55 | 2.27 | 22 | 90 | 1.68 | 1.84 | 0.66 | 1.42 | 2.7 | 0.86 | 3.3 | 315 |
| 12.25 | 1.73 | 2.12 | 19 | 80 | 1.65 | 2.03 | 0.37 | 1.63 | 3.4 | 1 | 3.17 | 510 |
| 12.72 | 1.75 | 2.28 | 22.5 | 84 | 1.38 | 1.76 | 0.48 | 1.63 | 3.3 | 0.88 | 2.42 | 488 |
| 12.22 | 1.29 | 1.94 | 19 | 92 | 2.36 | 2.04 | 0.39 | 2.08 | 2.7 | 0.86 | 3.02 | 312 |
| 11.61 | 1.35 | 2.7 | 20 | 94 | 2.74 | 2.92 | 0.29 | 2.49 | 2.65 | 0.96 | 3.26 | 680 |
| 11.46 | 3.74 | 1.82 | 19.5 | 107 | 3.18 | 2.58 | 0.24 | 3.58 | 2.9 | 0.75 | 2.81 | 562 |
| 12.52 | 2.43 | 2.17 | 21 | 88 | 2.55 | 2.27 | 0.26 | 1.22 | 2 | 0.9 | 2.78 | 325 |
| 11.76 | 2.68 | 2.92 | 20 | 103 | 1.75 | 2.03 | 0.6 | 1.05 | 3.8 | 1.23 | 2.5 | 607 |
| 11.41 | 0.74 | 2.5 | 21 | 88 | 2.48 | 2.01 | 0.42 | 1.44 | 3.08 | 1.1 | 2.31 | 434 |
| 12.08 | 1.39 | 2.5 | 22.5 | 84 | 2.56 | 2.29 | 0.43 | 1.04 | 2.9 | 0.93 | 3.19 | 385 |
| 11.03 | 1.51 | 2.2 | 21.5 | 85 | 2.46 | 2.17 | 0.52 | 2.01 | 1.9 | 1.71 | 2.87 | 407 |
| 11.82 | 1.47 | 1.99 | 20.8 | 86 | 1.98 | 1.6 | 0.3 | 1.53 | 1.95 | 0.95 | 3.33 | 495 |
| 12.42 | 1.61 | 2.19 | 22.5 | 108 | 2 | 2.09 | 0.34 | 1.61 | 2.06 | 1.06 | 2.96 | 345 |
| 12.77 | 3.43 | 1.98 | 16 | 80 | 1.63 | 1.25 | 0.43 | 0.83 | 3.4 | 0.7 | 2.12 | 372 |
| 12 | 3.43 | 2 | 19 | 87 | 2 | 1.64 | 0.37 | 1.87 | 1.28 | 0.93 | 3.05 | 564 |
| 11.45 | 2.4 | 2.42 | 20 | 96 | 2.9 | 2.79 | 0.32 | 1.83 | 3.25 | 0.8 | 3.39 | 625 |
| 11.56 | 2.05 | 3.23 | 28.5 | 119 | 3.18 | 5.08 | 0.47 | 1.87 | 6 | 0.93 | 3.69 | 465 |
| 12.42 | 4.43 | 2.73 | 26.5 | 102 | 2.2 | 2.13 | 0.43 | 1.71 | 2.08 | 0.92 | 3.12 | 365 |
| 13.05 | 5.8 | 2.13 | 21.5 | 86 | 2.62 | 2.65 | 0.3 | 2.01 | 2.6 | 0.73 | 3.1 | 380 |
| 11.87 | 4.31 | 2.39 | 21 | 82 | 2.86 | 3.03 | 0.21 | 2.91 | 2.8 | 0.75 | 3.64 | 380 |
| 12.07 | 2.16 | 2.17 | 21 | 85 | 2.6 | 2.65 | 0.37 | 1.35 | 2.76 | 0.86 | 3.28 | 378 |
| 12.43 | 1.53 | 2.29 | 21.5 | 86 | 2.74 | 3.15 | 0.39 | 1.77 | 3.94 | 0.69 | 2.84 | 352 |
| 11.79 | 2.13 | 2.78 | 28.5 | 92 | 2.13 | 2.24 | 0.58 | 1.76 | 3 | 0.97 | 2.44 | 466 |
| 12.37 | 1.63 | 2.3 | 24.5 | 88 | 2.22 | 2.45 | 0.4 | 1.9 | 2.12 | 0.89 | 2.78 | 342 |
| 12.04 | 4.3 | 2.38 | 22 | 80 | 2.1 | 1.75 | 0.42 | 1.35 | 2.6 | 0.79 | 2.57 | 580 |
| 12.86 | 1.35 | 2.32 | 18 | 122 | 1.51 | 1.25 | 0.21 | 0.94 | 4.1 | 0.76 | 1.29 | 630 |
| 12.88 | 2.99 | 2.4 | 20 | 104 | 1.3 | 1.22 | 0.24 | 0.83 | 5.4 | 0.74 | 1.42 | 530 |
| 12.81 | 2.31 | 2.4 | 24 | 98 | 1.15 | 1.09 | 0.27 | 0.83 | 5.7 | 0.66 | 1.36 | 560 |
| 12.7 | 3.55 | 2.36 | 21.5 | 106 | 1.7 | 1.2 | 0.17 | 0.84 | 5 | 0.78 | 1.29 | 600 |
| 12.51 | 1.24 | 2.25 | 17.5 | 85 | 2 | 0.58 | 0.6 | 1.25 | 5.45 | 0.75 | 1.51 | 650 |
| 12.6 | 2.46 | 2.2 | 18.5 | 94 | 1.62 | 0.66 | 0.63 | 0.94 | 7.1 | 0.73 | 1.58 | 695 |
| 12.25 | 4.72 | 2.54 | 21 | 89 | 1.38 | 0.47 | 0.53 | 0.8 | 3.85 | 0.75 | 1.27 | 720 |
| 12.53 | 5.51 | 2.64 | 25 | 96 | 1.79 | 0.6 | 0.63 | 1.1 | 5 | 0.82 | 1.69 | 515 |
| 13.49 | 3.59 | 2.19 | 19.5 | 88 | 1.62 | 0.48 | 0.58 | 0.88 | 5.7 | 0.81 | 1.82 | 580 |
| 12.84 | 2.96 | 2.61 | 24 | 101 | 2.32 | 0.6 | 0.53 | 0.81 | 4.92 | 0.89 | 2.15 | 590 |
| 12.93 | 2.81 | 2.7 | 21 | 96 | 1.54 | 0.5 | 0.53 | 0.75 | 4.6 | 0.77 | 2.31 | 600 |
| 13.36 | 2.56 | 2.35 | 20 | 89 | 1.4 | 0.5 | 0.37 | 0.64 | 5.6 | 0.7 | 2.47 | 780 |
| 13.52 | 3.17 | 2.72 | 23.5 | 97 | 1.55 | 0.52 | 0.5 | 0.55 | 4.35 | 0.89 | 2.06 | 520 |
| 13.62 | 4.95 | 2.35 | 20 | 92 | 2 | 0.8 | 0.47 | 1.02 | 4.4 | 0.91 | 2.05 | 550 |
| 12.25 | 3.88 | 2.2 | 18.5 | 112 | 1.38 | 0.78 | 0.29 | 1.14 | 8.21 | 0.65 | 2 | 855 |
| 13.16 | 3.57 | 2.15 | 21 | 102 | 1.5 | 0.55 | 0.43 | 1.3 | 4 | 0.6 | 1.68 | 830 |
| 13.88 | 5.04 | 2.23 | 20 | 80 | 0.98 | 0.34 | 0.4 | 0.68 | 4.9 | 0.58 | 1.33 | 415 |
| 12.87 | 4.61 | 2.48 | 21.5 | 86 | 1.7 | 0.65 | 0.47 | 0.86 | 7.65 | 0.54 | 1.86 | 625 |
| 13.32 | 3.24 | 2.38 | 21.5 | 92 | 1.93 | 0.76 | 0.45 | 1.25 | 8.42 | 0.55 | 1.62 | 650 |
| 13.08 | 3.9 | 2.36 | 21.5 | 113 | 1.41 | 1.39 | 0.34 | 1.14 | 9.4 | 0.57 | 1.33 | 550 |
| 13.5 | 3.12 | 2.62 | 24 | 123 | 1.4 | 1.57 | 0.22 | 1.25 | 8.6 | 0.59 | 1.3 | 500 |
| 12.79 | 2.67 | 2.48 | 22 | 112 | 1.48 | 1.36 | 0.24 | 1.26 | 10.8 | 0.48 | 1.47 | 480 |
| 13.11 | 1.9 | 2.75 | 25.5 | 116 | 2.2 | 1.28 | 0.26 | 1.56 | 7.1 | 0.61 | 1.33 | 425 |
| 13.23 | 3.3 | 2.28 | 18.5 | 98 | 1.8 | 0.83 | 0.61 | 1.87 | 10.52 | 0.56 | 1.51 | 675 |
| 12.58 | 1.29 | 2.1 | 20 | 103 | 1.48 | 0.58 | 0.53 | 1.4 | 7.6 | 0.58 | 1.55 | 640 |
| 13.17 | 5.19 | 2.32 | 22 | 93 | 1.74 | 0.63 | 0.61 | 1.55 | 7.9 | 0.6 | 1.48 | 725 |
| 13.84 | 4.12 | 2.38 | 19.5 | 89 | 1.8 | 0.83 | 0.48 | 1.56 | 9.01 | 0.57 | 1.64 | 480 |
| 12.45 | 3.03 | 2.64 | 27 | 97 | 1.9 | 0.58 | 0.63 | 1.14 | 7.5 | 0.67 | 1.73 | 880 |
| 14.34 | 1.68 | 2.7 | 25 | 98 | 2.8 | 1.31 | 0.53 | 2.7 | 13 | 0.57 | 1.96 | 660 |
| 13.48 | 1.67 | 2.64 | 22.5 | 89 | 2.6 | 1.1 | 0.52 | 2.29 | 11.75 | 0.57 | 1.78 | 620 |
| 12.36 | 3.83 | 2.38 | 21 | 88 | 2.3 | 0.92 | 0.5 | 1.04 | 7.65 | 0.56 | 1.58 | 520 |
| 13.69 | 3.26 | 2.54 | 20 | 107 | 1.83 | 0.56 | 0.5 | 0.8 | 5.88 | 0.96 | 1.82 | 680 |
| 12.85 | 3.27 | 2.58 | 22 | 106 | 1.65 | 0.6 | 0.6 | 0.96 | 5.58 | 0.87 | 2.11 | 570 |
| 12.96 | 3.45 | 2.35 | 18.5 | 106 | 1.39 | 0.7 | 0.4 | 0.94 | 5.28 | 0.68 | 1.75 | 675 |
| 13.78 | 2.76 | 2.3 | 22 | 90 | 1.35 | 0.68 | 0.41 | 1.03 | 9.58 | 0.7 | 1.68 | 615 |
| 13.73 | 4.36 | 2.26 | 22.5 | 88 | 1.28 | 0.47 | 0.52 | 1.15 | 6.62 | 0.78 | 1.75 | 520 |
| 13.45 | 3.7 | 2.6 | 23 | 111 | 1.7 | 0.92 | 0.43 | 1.46 | 10.68 | 0.85 | 1.56 | 695 |
| 12.82 | 3.37 | 2.3 | 19.5 | 88 | 1.48 | 0.66 | 0.4 | 0.97 | 10.26 | 0.72 | 1.75 | 685 |
| 13.58 | 2.58 | 2.69 | 24.5 | 105 | 1.55 | 0.84 | 0.39 | 1.54 | 8.66 | 0.74 | 1.8 | 750 |
| 13.4 | 4.6 | 2.86 | 25 | 112 | 1.98 | 0.96 | 0.27 | 1.11 | 8.5 | 0.67 | 1.92 | 630 |
| 12.2 | 3.03 | 2.32 | 19 | 96 | 1.25 | 0.49 | 0.4 | 0.73 | 5.5 | 0.66 | 1.83 | 510 |
| 12.77 | 2.39 | 2.28 | 19.5 | 86 | 1.39 | 0.51 | 0.48 | 0.64 | 9.899999 | 0.57 | 1.63 | 470 |
| 14.16 | 2.51 | 2.48 | 20 | 91 | 1.68 | 0.7 | 0.44 | 1.24 | 9.7 | 0.62 | 1.71 | 660 |
| 13.71 | 5.65 | 2.45 | 20.5 | 95 | 1.68 | 0.61 | 0.52 | 1.06 | 7.7 | 0.64 | 1.74 | 740 |
| 13.4 | 3.91 | 2.48 | 23 | 102 | 1.8 | 0.75 | 0.43 | 1.41 | 7.3 | 0.7 | 1.56 | 750 |
| 13.27 | 4.28 | 2.26 | 20 | 120 | 1.59 | 0.69 | 0.43 | 1.35 | 10.2 | 0.59 | 1.56 | 835 |
| 13.17 | 2.59 | 2.37 | 20 | 120 | 1.65 | 0.68 | 0.53 | 1.46 | 9.3 | 0.6 | 1.62 | 840 |
| 14.13 | 4.1 | 2.74 | 24.5 | 96 | 2.05 | 0.76 | 0.56 | 1.35 | 9.2 | 0.61 | 1.6 | 560 |

# Appendix–B: patitioning 13-dimentional data into 78 2-dimentional data using matlab code

functionWine\_Data( )

clearall;

fcmdata = xlsread('Wine\_Data.xls'); % Read Wine\_Data.xls file

data1\_2 = [fcmdata(:, 1) fcmdata(:, 2)];

data1\_3 = [fcmdata(:, 1) fcmdata(:, 3)];

data1\_4 = [fcmdata(:, 1) fcmdata(:, 4)];

data1\_5 = [fcmdata(:, 1) fcmdata(:, 5)];

data1\_6 = [fcmdata(:, 1) fcmdata(:, 6)];

data1\_7 = [fcmdata(:, 1) fcmdata(:, 7)];

data1\_8 = [fcmdata(:, 1) fcmdata(:, 8)];

data1\_9 = [fcmdata(:, 1) fcmdata(:, 9)];

data1\_10 = [fcmdata(:, 1) fcmdata(:, 10)];

data1\_11 = [fcmdata(:, 1) fcmdata(:, 11)];

data1\_12 = [fcmdata(:, 1) fcmdata(:, 12)];

data1\_13 = [fcmdata(:, 1) fcmdata(:, 13)];

data2\_3 = [fcmdata(:, 2) fcmdata(:, 3)];

data2\_4 = [fcmdata(:, 2) fcmdata(:, 4)];

data2\_5 = [fcmdata(:, 2) fcmdata(:, 5)];

data2\_6 = [fcmdata(:, 2) fcmdata(:, 6)];

data2\_7 = [fcmdata(:, 2) fcmdata(:, 7)];

data2\_8 = [fcmdata(:, 2) fcmdata(:, 8)];

data2\_9 = [fcmdata(:, 2) fcmdata(:, 9)];

data2\_10 = [fcmdata(:, 2) fcmdata(:, 10)];

data2\_11 = [fcmdata(:, 2) fcmdata(:, 11)];

data2\_12 = [fcmdata(:, 2) fcmdata(:, 12)];

data2\_13 = [fcmdata(:, 2) fcmdata(:, 13)];

data3\_4 = [fcmdata(:, 3) fcmdata(:, 4)];

data3\_5 = [fcmdata(:, 3) fcmdata(:, 5)];

data3\_6 = [fcmdata(:, 3) fcmdata(:, 6)];

data3\_7 = [fcmdata(:, 3) fcmdata(:, 7)];

data3\_8 = [fcmdata(:, 3) fcmdata(:, 8)];

data3\_9 = [fcmdata(:, 3) fcmdata(:, 9)];

data3\_10 = [fcmdata(:, 3) fcmdata(:, 10)];

data3\_11 = [fcmdata(:, 3) fcmdata(:, 11)];

data3\_12 = [fcmdata(:, 3) fcmdata(:, 12)];

data3\_13 = [fcmdata(:, 3) fcmdata(:, 13)];

data4\_5 = [fcmdata(:, 4) fcmdata(:, 5)];

data4\_6 = [fcmdata(:, 4) fcmdata(:, 6)];

data4\_7 = [fcmdata(:, 4) fcmdata(:, 7)];

data4\_8 = [fcmdata(:, 4) fcmdata(:, 8)];

data4\_9 = [fcmdata(:, 4) fcmdata(:, 9)];

data4\_10 = [fcmdata(:, 4) fcmdata(:, 10)];

data4\_11 = [fcmdata(:, 4) fcmdata(:, 11)];

data4\_12 = [fcmdata(:, 4) fcmdata(:, 12)];

data4\_13 = [fcmdata(:, 4) fcmdata(:, 13)];

data5\_6 = [fcmdata(:, 5) fcmdata(:, 6)];

data5\_7 = [fcmdata(:, 5) fcmdata(:, 7)];

data5\_8 = [fcmdata(:, 5) fcmdata(:, 8)];

data5\_9 = [fcmdata(:, 5) fcmdata(:, 9)];

data5\_10 = [fcmdata(:, 5) fcmdata(:, 10)];

data5\_11 = [fcmdata(:, 5) fcmdata(:, 11)];

data5\_12 = [fcmdata(:, 5) fcmdata(:, 12)];

data5\_13 = [fcmdata(:, 5) fcmdata(:, 13)];

data6\_7 = [fcmdata(:, 6) fcmdata(:, 7)];

data6\_8 = [fcmdata(:, 6) fcmdata(:, 8)];

data6\_9 = [fcmdata(:, 6) fcmdata(:, 9)];

data6\_10 = [fcmdata(:, 6) fcmdata(:, 10)];

data6\_11 = [fcmdata(:, 6) fcmdata(:, 11)];

data6\_12 = [fcmdata(:, 6) fcmdata(:, 12)];

data6\_13 = [fcmdata(:, 6) fcmdata(:, 13)];

data7\_8 = [fcmdata(:, 7) fcmdata(:, 8)];

data7\_9 = [fcmdata(:, 7) fcmdata(:, 9)];

data7\_10 = [fcmdata(:, 7) fcmdata(:, 10)];

data7\_11 = [fcmdata(:, 7) fcmdata(:, 11)];

data7\_12 = [fcmdata(:, 7) fcmdata(:, 12)];

data7\_13 = [fcmdata(:, 7) fcmdata(:, 13)];

data8\_9 = [fcmdata(:, 8) fcmdata(:, 9)];

data8\_10 = [fcmdata(:, 8) fcmdata(:, 10)];

data8\_11 = [fcmdata(:, 8) fcmdata(:, 11)];

data8\_12 = [fcmdata(:, 8) fcmdata(:, 12)];

data8\_13 = [fcmdata(:, 8) fcmdata(:, 13)];

data9\_10 = [fcmdata(:, 9) fcmdata(:, 10)];

data9\_11 = [fcmdata(:, 9) fcmdata(:, 11)];

data9\_12 = [fcmdata(:, 9) fcmdata(:, 12)];

data9\_13 = [fcmdata(:, 9) fcmdata(:, 13)];

data10\_11 = [fcmdata(:, 10) fcmdata(:, 11)];

data10\_12 = [fcmdata(:, 10) fcmdata(:, 12)];

data10\_13 = [fcmdata(:, 10) fcmdata(:, 13)];

data11\_12 = [fcmdata(:, 11) fcmdata(:, 12)];

data11\_13 = [fcmdata(:, 11) fcmdata(:, 13)];

data12\_13 = [fcmdata(:, 12) fcmdata(:, 13)];

end

# Appendix-C: implementatoin of fuzzy c-means (FCM) algorithm in matlab for Wine clustering

function [result] = Wine\_Clustering(data,nOfc )

[center,U,objFcn] = fcm(data,nOfc);

maxU = max(U);

index1 = find(U(1, :) == maxU);

index2 = find(U(2, :) == maxU);

ifnOfc>=3

index3 = find(U(3, :) == maxU);

end

ifnOfc>=4

index4 = find(U(4, :) == maxU);

end

ifnOfc>=5

index5 = find(U(5, :) == maxU);

end

figure

line(data(index1,1),data(index1,2),'linestyle','none','marker', 'o','color','g');

line(data(index2,1),data(index2,2),'linestyle','none','marker', 'x','color','r');

ifnOfc>=3

line(data(index3,1),data(index3,2),'linestyle','none','marker', '\*','color','b');

end

ifnOfc>=4

line(data(index4,1),data(index4,2),'linestyle','none','marker', '+','color','k');

end

ifnOfc>=5

line(data(index5,1),data(index5,2),'linestyle','none','marker', '.','color','m');

end

holdon

plot(center(1,1),center(1,2),'ko','markersize',15,'LineWidth',2)

plot(center(2,1),center(2,2),'kx','markersize',15,'LineWidth',2)

ifnOfc>=3

plot(center(3,1),center(3,2),'k\*','markersize',15,'LineWidth',2)

end

ifnOfc>=4

plot(center(4,1),center(4,2),'k+','markersize',15,'LineWidth',2)

end

ifnOfc>=5

plot(center(5,1),center(5,2),'k.','markersize',15,'LineWidth',2)

end

[m1 n1]=size(index1);

[m2 n2]=size(index2);

ifnOfc>=3

[m3 n3]=size(index3);

end

ifnOfc>=4

[m4 n4]=size(index4);

end

ifnOfc>=5

[m5 n5]=size(index5);

end

std1=0;

r1=0;

std2=0;

r2=0;

ifnOfc>=3

std3=0;

r3=0;

end

ifnOfc>=4

std4=0;

r4=0;

end

ifnOfc>=5

std5=0;

r5=0;

end

fori=1:n1

temp=sqrt((data(index1(1, i), 1)-center(1, 1))^2+(data(index1(1, i), 2)-center(1, 2))^2);

if(r1<temp)

r1=temp;

end

std1=std1+temp;

end

fori=1:n2

temp=sqrt((data(index2(1, i), 1)-center(2, 1))^2+(data(index2(1, i), 2)-center(2, 2))^2);

if(r2<temp)

r2=temp;

end

std2=std2+temp;

end

ifnOfc>=3

fori=1:n3

temp=sqrt((data(index3(1, i), 1)-center(3, 1))^2+(data(index3(1, i), 2)-center(3, 2))^2);

if(r3<temp)

r3=temp;

end

std3=std3+temp;

end

end

ifnOfc>=4

fori=1:n4

temp=sqrt((data(index4(1, i), 1)-center(4, 1))^2+(data(index4(1, i), 2)-center(4, 2))^2);

if(r4<temp)

r4=temp;

end

std4=std4+temp;

end

end

ifnOfc>=5

fori=1:n5

temp=sqrt((data(index5(1, i), 1)-center(5, 1))^2+(data(index5(1, i), 2)-center(5, 2))^2);

if(r5<temp)

r5=temp;

end

std5=std5+temp;

end

end

x1=center(1,1);

y1=center(1,2);

std1=std1/sqrt(n1);

x2=center(2,1);

y2=center(2,2);

std2=std2/sqrt(n2);

ifnOfc>=3

x3=center(3,1);

y3=center(3,2);

std3=std3/sqrt(n3);

end

ifnOfc>=4

x4=center(4,1);

y4=center(4,2);

std4=std4/sqrt(n4);

end

ifnOfc>=5

x5=center(5,1);

y5=center(5,2);

std5=std5/sqrt(n5);

end

result = [x1 y1 r1 std1; x2 y2 r2 std2];

ifnOfc>=3

result = [x1 y1 r1 std1; x2 y2 r2 std2; x3 y3 r3 std3];

end

ifnOfc>=4

result = [x1 y1 r1 std1; x2 y2 r2 std2; x3 y3 r3 std3; x4 y4 r4 std4];

end

ifnOfc>=5

result = [x1 y1 r1 std1; x2 y2 r2 std2; x3 y3 r3 std3; x4 y4 r4 std4; x5 y5 r5 std5];

end

ifnOfc==2

fileID=fopen('clus2\_c1.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x1,y1);

fclose(fileID);

fileID=fopen('clus2\_c2.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x2,y2);

fclose(fileID);

fileID=fopen('clus2\_r1.txt','a');

fprintf(fileID,'%4.4f\n',r1);

fclose(fileID);

fileID=fopen('clus2\_r2.txt','a');

fprintf(fileID,'%4.4f\n',r2);

fclose(fileID);

fileID=fopen('clus2\_std1.txt','a');

fprintf(fileID,'%4.4f\n',std1);

fclose(fileID);

fileID=fopen('clus2\_std2.txt','a');

fprintf(fileID,'%4.4f\n',std2);

fclose(fileID);

end

ifnOfc==3

fileID=fopen('clus3\_c1.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x1,y1);

fclose(fileID);

fileID=fopen('clus3\_c2.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x2,y2);

fclose(fileID);

fileID=fopen('clus3\_c3.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x3,y3);

fclose(fileID);

fileID=fopen('clus3\_r1.txt','a');

fprintf(fileID,'%4.4f\n',r1);

fclose(fileID);

fileID=fopen('clus3\_r2.txt','a');

fprintf(fileID,'%4.4f\n',r2);

fclose(fileID);

fileID=fopen('clus3\_r3.txt','a');

fprintf(fileID,'%4.4f\n',r3);

fclose(fileID);

fileID=fopen('clus3\_std1.txt','a');

fprintf(fileID,'%4.4f\n',std1);

fclose(fileID);

fileID=fopen('clus3\_std2.txt','a');

fprintf(fileID,'%4.4f\n',std2);

fclose(fileID);

fileID=fopen('clus3\_std3.txt','a');

fprintf(fileID,'%4.4f\n',std3);

fclose(fileID);

end

ifnOfc==4

fileID=fopen('clus4\_c1.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x1,y1);

fclose(fileID);

fileID=fopen('clus4\_c2.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x2,y2);

fclose(fileID);

fileID=fopen('clus4\_c3.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x3,y3);

fclose(fileID);

fileID=fopen('clus4\_c4.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x4,y4);

fclose(fileID);

fileID=fopen('clus4\_r1.txt','a');

fprintf(fileID,'%4.4f\n',r1);

fclose(fileID);

fileID=fopen('clus4\_r2.txt','a');

fprintf(fileID,'%4.4f\n',r2);

fclose(fileID);

fileID=fopen('clus4\_r3.txt','a');

fprintf(fileID,'%4.4f\n',r3);

fclose(fileID);

fileID=fopen('clus4\_r4.txt','a');

fprintf(fileID,'%4.4f\n',r4);

fclose(fileID);

fileID=fopen('clus4\_std1.txt','a');

fprintf(fileID,'%4.4f\n',std1);

fclose(fileID);

fileID=fopen('clus4\_std2.txt','a');

fprintf(fileID,'%4.4f\n',std2);

fclose(fileID);

fileID=fopen('clus4\_std3.txt','a');

fprintf(fileID,'%4.4f\n',std3);

fclose(fileID);

fileID=fopen('clus4\_std4.txt','a');

fprintf(fileID,'%4.4f\n',std4);

fclose(fileID);

end

ifnOfc==5

fileID=fopen('clus5\_c1.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x1,y1);

fclose(fileID);

fileID=fopen('clus5\_c2.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x2,y2);

fclose(fileID);

fileID=fopen('clus5\_c3.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x3,y3);

fclose(fileID);

fileID=fopen('clus5\_c4.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x4,y4);

fclose(fileID);

fileID=fopen('clus5\_c5.txt','a');

fprintf(fileID,'[%4.2f,%4.2f]\n',x5,y5);

fclose(fileID);

fileID=fopen('clus5\_r1.txt','a');

fprintf(fileID,'%4.4f\n',r1);

fclose(fileID);

fileID=fopen('clus5\_r2.txt','a');

fprintf(fileID,'%4.4f\n',r2);

fclose(fileID);

fileID=fopen('clus5\_r3.txt','a');

fprintf(fileID,'%4.4f\n',r3);

fclose(fileID);

fileID=fopen('clus5\_r4.txt','a');

fprintf(fileID,'%4.4f\n',r4);

fclose(fileID);

fileID=fopen('clus5\_r5.txt','a');

fprintf(fileID,'%4.4f\n',r5);

fclose(fileID);

fileID=fopen('clus5\_std1.txt','a');

fprintf(fileID,'%4.4f\n',std1);

fclose(fileID);

fileID=fopen('clus5\_std2.txt','a');

fprintf(fileID,'%4.4f\n',std2);

fclose(fileID);

fileID=fopen('clus5\_std3.txt','a');

fprintf(fileID,'%4.4f\n',std3);

fclose(fileID);

fileID=fopen('clus5\_std4.txt','a');

fprintf(fileID,'%4.4f\n',std4);

fclose(fileID);

fileID=fopen('clus5\_std5.txt','a');

fprintf(fileID,'%4.4f\n',std5);

fclose(fileID);

end

end

# Appendix-D: matlab Code for running fcm simulation for 78 combinations within a given range of cluster number

functionRunWineCluster( )

% Wine\_Data

fori=2:5

Wine\_Clustering(data1\_2,i)

Wine\_Clustering(data1\_3,i)

Wine\_Clustering(data1\_4,i)

Wine\_Clustering(data1\_5,i)

Wine\_Clustering(data1\_6,i)

Wine\_Clustering(data1\_7,i)

Wine\_Clustering(data1\_8,i)

Wine\_Clustering(data1\_9,i)

Wine\_Clustering(data1\_10,i)

Wine\_Clustering(data1\_11,i)

Wine\_Clustering(data1\_12,i)

Wine\_Clustering(data1\_13,i)

Wine\_Clustering(data2\_3,i)

Wine\_Clustering(data2\_4,i)

Wine\_Clustering(data2\_5,i)

Wine\_Clustering(data2\_6,i)

Wine\_Clustering(data2\_7,i)

Wine\_Clustering(data2\_8,i)

Wine\_Clustering(data2\_9,i)

Wine\_Clustering(data2\_10,i)

Wine\_Clustering(data2\_11,i)

Wine\_Clustering(data2\_12,i)

Wine\_Clustering(data2\_13,i)

Wine\_Clustering(data3\_4,i)

Wine\_Clustering(data3\_5,i)

Wine\_Clustering(data3\_6,i)

Wine\_Clustering(data3\_7,i)

Wine\_Clustering(data3\_8,i)

Wine\_Clustering(data3\_9,i)

Wine\_Clustering(data3\_10,i)

Wine\_Clustering(data3\_11,i)

Wine\_Clustering(data3\_12,i)

Wine\_Clustering(data3\_13,i)

Wine\_Clustering(data4\_5,i)

Wine\_Clustering(data4\_6,i)

Wine\_Clustering(data4\_7,i)

Wine\_Clustering(data4\_8,i)

Wine\_Clustering(data4\_9,i)

Wine\_Clustering(data4\_10,i)

Wine\_Clustering(data4\_11,i)

Wine\_Clustering(data4\_12,i)

Wine\_Clustering(data4\_13,i)

Wine\_Clustering(data5\_6,i)

Wine\_Clustering(data5\_7,i)

Wine\_Clustering(data5\_8,i)

Wine\_Clustering(data5\_9,i)

Wine\_Clustering(data5\_10,i)

Wine\_Clustering(data5\_11,i)

Wine\_Clustering(data5\_12,i)

Wine\_Clustering(data5\_13,i)

Wine\_Clustering(data6\_7,i)

Wine\_Clustering(data6\_8,i)

Wine\_Clustering(data6\_9,i)

Wine\_Clustering(data6\_10,i)

Wine\_Clustering(data6\_11,i)

Wine\_Clustering(data6\_12,i)

Wine\_Clustering(data6\_13,i)

Wine\_Clustering(data7\_8,i)

Wine\_Clustering(data7\_9,i)

Wine\_Clustering(data7\_10,i)

Wine\_Clustering(data7\_11,i)

Wine\_Clustering(data7\_12,i)

Wine\_Clustering(data7\_13,i)

Wine\_Clustering(data8\_9,i)

Wine\_Clustering(data8\_10,i)

Wine\_Clustering(data8\_11,i)

Wine\_Clustering(data8\_12,i)

Wine\_Clustering(data8\_13,i)

Wine\_Clustering(data9\_10,i)

Wine\_Clustering(data9\_11,i)

Wine\_Clustering(data9\_12,i)

Wine\_Clustering(data9\_13,i)

Wine\_Clustering(data10\_11,i)

Wine\_Clustering(data10\_12,i)

Wine\_Clustering(data10\_13,i)

Wine\_Clustering(data11\_12,i)

Wine\_Clustering(data11\_13,i)

Wine\_Clustering(data12\_13,i)

end

end

# Appendix-E: collected data from fcm simulation for cluster number 2, 3, 4 and 5

**Number of Cluster = 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Pair | center 1 | radius 1 | Std 1 | center 2 | radius 2 | std 2 | avg radius | avgstd |
| 1 | [1 2] | [12.97,1.67] | 1.9482 | 9.7999 | [13.07,3.67] | 2.1293 | 6.4399 | 2.03875 | 8.1199 |
| 2 | [1 3] | [12.78,2.28] | 1.2509 | 4.1712 | [13.7,2.45] | 1.1637 | 4.0834 | 1.2073 | 4.1273 |
| 3 | [1 4] | [13.22,17.04] | 6.4995 | 17.5045 | [12.79,7.72] | 7.7223 | 17 | 7.1109 | 17.4349 |
| 4 | [1 5] | [13.33,115.04] | 21.0907 | 68.7442 | [12.83,91.08] | 46.9713 | 61.5752 | 34.031 | 65.1597 |
| 5 | [1 6] | [13.7,2.68] | 1.525 | 6.3753 | [12.4,2] | 1.7134 | 5.629 | 1.6192 | 6.00215 |
| 6 | [1 7] | [13.53,2.91] | 1.9115 | 8.8451 | [12.64,1.3] | 2.9321 | 5.9392 | 2.4218 | 7.39215 |
| 7 | [1 8] | [12.26,0.38] | 1.1346 | 3.6831 | [13.7,0.34] | 1.2412 | 3.4699 | 1.1879 | 3.5765 |
| 8 | [1 9] | [12.32,1.46] | 2.2862 | 5.7704 | [13.67,1.73] | 1.5299 | 5.7787 | 1.90805 | 5.77455 |
| 9 | [1 10] | [13.51,7.59] | 2.468 | 12.6321 | [12.62,3.53] | 5.4772 | 13.2429 | 3.9726 | 12.9375 |
| 10 | [1 11] | [12.27,0.98] | 1.435 | 3.9456 | [13.69,0.95] | 1.1425 | 4.1259 | 1.28875 | 4.03575 |
| 11 | [1 12] | [12.39,2.43] | 1.5851 | 6.1772 | [13.66,2.9] | 1.5777 | 7.7413 | 1.5814 | 6.95925 |
| 12 | [1 13] | [13.7,1150.9] | 293.779 | 1329.7 | [12.7,551.2] | 529.0703 | 1187.18 | 411.42465 | 1258.442 |
| 13 | [2 3] | [1.68,2.35] | 1.2339 | 5 | [3.86,2.39] | 1.9561 | 4.5173 | 1.595 | 4.722 |
| 14 | [2 4] | [1.93,17.06] | 7.7793 | 20.4451 | [2.73,22.29] | 6.5376 | 16.6546 | 7.15845 | 18.54985 |
| 15 | [2 5] | [2.33,115.04] | 21.1068 | 69.5646 | [2.35,91.08] | 46.9695 | 61.9081 | 34.03815 | 65.73635 |
| 16 | [2 6] | [1.66,2.51] | 1.5053 | 6.5659 | [3.74,1.9] | 2.1814 | 6.5878 | 1.84335 | 6.57685 |
| 17 | [2 7] | [13.53,2.91] | 2.7394 | 7.6814 | [12.64,1.3] | 2.5682 | 8.7039 | 2.6538 | 8.19265 |
| 18 | [2 8] | [1.68,0.34] | 1.0836 | 3.9641 | [3.87,0.41] | 1.9298 | 4.3441 | 1.5067 | 4.1541 |
| 19 | [2 9] | [3.81,1.33] | 2.2465 | 6.0074 | [1.68,1.71] | 1.5778 | 6.332 | 1.91215 | 6.1697 |
| 20 | [2 10] | [2.74,7.71] | 5.4004 | 13.9221 | [2.04,3.63] | 3.9011 | 15.5499 | 4.65075 | 14.736 |
| 21 | [2 11] | [3.87,0.77] | 1.9355 | 4.5748 | [1.68,1.04] | 1.1432 | 4.2817 | 1.53935 | 4.42825 |
| 22 | [2 12] | [1.68,2.9] | 2.3368 | 7.4153 | [3.72,2.03] | 1.6399 | 6.3237 | 1.98835 | 6.8695 |
| 23 | [2 13] | [2.5,551.2] | 529.0709 | 1187.1 | [1.9,1150.9] | 293.7784 | 1329.93 | 411.42465 | 1258.516 |
| 24 | [3 4] | [2.46, 22.3] | 7.6949 | 15.799 | [2.29,17.06] | 6.5263 | 15.5077 | 7.1106 | 15.65335 |
| 25 | [3 5] | [2.49,115.05] | 46.9511 | 61.2006 | [2.3,91.09] | 21.0853 | 67.7932 | 34.0182 | 64.4969 |
| 26 | [3 6] | [2.41,2.81] | 1.0655 | 3.5945 | [2.33,1.72] | 1.0083 | 3.3668 | 1.0369 | 3.48065 |
| 27 | [3 7] | [2.35,1.04] | 1.0989 | 4.378 | [2.4,2.85] | 2.3845 | 5.0005 | 1.7417 | 4.68925 |
| 28 | [3 8] | [2.58,0.37] | 0.6598 | 1.703 | [2.17,0.34] | 0.8086 | 1.8199 | 0.7342 | 1.76145 |
| 29 | [3 9] | [2.37,2.07] | 1.2629 | 3.6868 | [2.36,1.19] | 1.6045 | 3.5859 | 1.4337 | 3.63635 |
| 30 | [3 10] | [2.32,3.66] | 5.1044 | 9.8574 | [2.44,7.9] | 2.4039 | 12.2806 | 3.75415 | 11.069 |
| 31 | [3 11] | [2.55,0.92] | 0.7037 | 2.482 | [2.18,1] | 0.8239 | 2.2524 | 0.7638 | 2.3672 |
| 32 | [3 12] | [2.39,1.79] | 1.045 | 4.2364 | [2.36,3.12] | 1.0263 | 2.9214 | 1.03565 | 3.5789 |
| 33 | [3 13] | [2.4,1150.9] | 293.7774 | 1329.63 | [2.3,551.2] | 529.0702 | 1187.09 | 411.4238 | 1258.36 |
| 34 | [4 5] | [19.72,90.92] | 21.2759 | 73.7124 | [19.15,114,61] | 47.3879 | 72.1415 | 34.3319 | 72.92695 |
| 35 | [4 6] | [17.04,2.52] | 7.8152 | 16.7776 | [22.29,2.05] | 6.4618 | 16.5011 | 7.1385 | 16.63935 |
| 36 | [4 7] | [22.24,1.57] | 7.8725 | 18.692 | [17.02,2.47] | 6.6986 | 16.98 | 7.28555 | 17.836 |
| 37 | [4 8] | [22.31,0.41] | 7.6962 | 15.6908 | [17.06,0.32] | 6.4576 | 15.2063 | 7.0769 | 15.44855 |
| 38 | [4 9] | [22.29,1.46] | 7.731 | 16.3626 | [17.04,1.71] | 6.5707 | 16.5085 | 7.15085 | 16.43555 |
| 39 | [4 10] | [17.21,5.09] | 8.6816 | 28.006 | [22.14,4.8] | 7.3137 | 23.2185 | 7.99765 | 25.61225 |
| 40 | [4 11] | [22.3,0.87] | 7.7095 | 15.8526 | [17.05,1.04] | 6.4542 | 15.318 | 7.08185 | 15.5853 |
| 41 | [4 12] | [17.06,2.85] | 6.5417 | 16.5805 | [22.31,2.35] | 7.779 | 17.3583 | 7.16035 | 16.9694 |
| 42 | [4 13] | [17.3,1150.9] | 293.8239 | 1330.5 | [20.5,551.2] | 529.0654 | 1188.56 | 411.44465 | 1259.534 |
| 43 | [5 6] | [115.05,2.48] | 21.086 | 68.1803 | [91.09,2.19] | 46.9475 | 61.6326 | 34.01675 | 64.90645 |
| 44 | [5 7] | [115.05,2.34] | 21.0835 | 69.0635 | [91.08,1.85] | 46.9528 | 62.1752 | 34.01815 | 65.61935 |
| 45 | [5 8] | [91.09,0.38] | 46.9489 | 61.14 | [115.05,0.33] | 21.0858 | 67.7155 | 34.01735 | 64.42775 |
| 46 | [5 9] | [91.09,1.53] | 21.0856 | 68.2196 | [115.05,1.67] | 46.9762 | 61.3446 | 34.0309 | 64.7821 |
| 47 | [5 10] | [115.01,5.97] | 47.11 | 66.2093 | [91.08,4.6] | 21.2729 | 72.2372 | 34.19145 | 69.22325 |
| 48 | [5 11] | [91.09,0.95] | 46.9494 | 61.196 | [115.05,0.95] | 21.0862 | 67.8081 | 34.0178 | 64.50205 |
| 49 | [5 12] | [91.08,2.58] | 46.9608 | 61.6479 | [115.04,2.65] | 21.0893 | 68.3745 | 34.02505 | 65.0112 |
| 50 | [5 13] | [95.7,551.1] | 529.2345 | 1195.14 | [106.2,1150.8] | 294.6086 | 1342.44 | 411.92155 | 1268.79 |
| 51 | [6 7] | [1.73,1.07] | 1.0926 | 5.2502 | [2.79,2.86] | 2.251 | 4.9679 | 1.6718 | 5.10905 |
| 52 | [6 8] | [2.82,0.31] | 0.733 | 2.7214 | [1.7126,0.43] | 1.0607 | 2.781 | 0.89685 | 2.7512 |
| 53 | [6 9] | [1.77,1.2] | 1.6244 | 4.8423 | [2.83,1.99] | 1.0887 | 4.2303 | 1.35655 | 4.5363 |
| 54 | [6 10] | [2.29,3.66] | 2.3972 | 13.5267 | [2.23,7.9] | 5.1324 | 11.4589 | 3.7648 | 12.4928 |
| 55 | [6 11] | [2.81,1.05] | 1.0739 | 3.187 | [1.7,0.84] | 0.7659 | 3.1782 | 0.9199 | 3.1826 |
| 56 | [6 12] | [1.7,1.86] | 1.1756 | 5.0748 | [2.72,3.12] | 1.1087 | 3.9383 | 1.14215 | 4.50655 |
| 57 | [6 13] | [2.1,551.2] | 293.7779 | 1329.66 | [2.8,1150.9] | 529.0703 | 1187.09 | 411.4241 | 1258.377 |
| 58 | [7 8] | [1.03,0.43] | 2.2456 | 4.2992 | [2.84,0.3] | 0.8968 | 3.8904 | 1.5712 | 4.0948 |
| 59 | [7 9] | [2.85,1.93] | 2.2342 | 5.9274 | [1.06,1.18] | 1.5379 | 5.3124 | 1.88605 | 5.6199 |
| 60 | [7 10] | [1.62,7.98] | 3.7357 | 15.2216 | [2.14,3.7] | 5.0286 | 13.3882 | 4.38215 | 14.3049 |
| 61 | [7 11] | [2.83,1.06] | 2.2562 | 4.6534 | [1.01,0.8] | 0.9828 | 4.1082 | 1.6195 | 4.3808 |
| 62 | [7 12] | [2.76,3.11] | 1.2739 | 4.4202 | [0.95,1.84] | 2.3954 | 6.1128 | 1.83465 | 5.2665 |
| 63 | [7 13] | [2.9,1150.9] | 293.7805 | 1329.7 | [1.6,551.2] | 529.071 | 1187.14 | 411.42575 | 1258.42 |
| 64 | [8 9] | [0.4,1.19] | 0.8156 | 3.0462 | [0.31,2.09] | 1.4873 | 2.8445 | 1.15145 | 2.94535 |
| 65 | [8 10] | [0.35,3.67] | 5.0885 | 9.7972 | [0.39,7.91] | 2.3854 | 11.7787 | 3.73695 | 10.78795 |
| 66 | [8 11] | [0.32,1.12] | 0.3119 | 1.4205 | [0.42,0.73] | 0.6278 | 1.4984 | 0.46985 | 1.45945 |
| 67 | [8 12] | [0.45,1.78] | 0.8856 | 3.2473 | [0.31,3.12] | 0.6753 | 2.4238 | 0.78045 | 2.83555 |
| 68 | [8 13] | [0.4,551.2] | 529.0701 | 1187.08 | [0.3,1150.9] | 293.7773 | 1329.62 | 411.4237 | 1258.352 |
| 69 | [9 10] | [1.58,7.87] | 5.2463 | 10.6121 | [1.57,3.66] | 2.3978 | 13.4077 | 3.82205 | 12.0099 |
| 70 | [9 11] | [2.06,1.04] | 0.8529 | 3.4771 | [1.17,0.87] | 1.5483 | 3.3096 | 1.2006 | 3.39335 |
| 71 | [9 12] | [1.86,3.11] | 1.1514 | 3.7191 | [1.14,1.82] | 1.7418 | 5.5218 | 1.4466 | 4.62045 |
| 72 | [9 13] | [1.9,1150.9] | 529.0702 | 1187.2 | [1.4,551.2] | 293.7774 | 1329.67 | 411.4238 | 1258.433 |
| 73 | [10 11] | [3.67,1.03] | 2.3903 | 11.9537 | [7.92,0.8] | 5.0863 | 9.9388 | 3.7383 | 10.94625 |
| 74 | [10 12] | [7.93,2.15] | 2.4048 | 13.6113 | [3.67,2.8] | 5.07 | 11.6265 | 3.7374 | 12.6189 |
| 75 | [10 13] | [5.6,1150.9] | 529.0831 | 1187.25 | [4.8,551.2] | 293.7829 | 1330.5 | 411.433 | 1258.878 |
| 76 | [11 12] | [1.06,3.1] | 0.8977 | 3.6547 | [0.76,1.76] | 0.8392 | 2.6759 | 0.86845 | 3.1653 |
| 77 | [11 13] | [1.1,1150.9] | 293.7773 | 1329.63 | [0.9,551.2] | 529.0701 | 1187.08 | 411.4237 | 1258.356 |
| 78 | [12 13] | [2.4,551.2] | 293.7808 | 1329.7 | [3.1,1150.9] | 529.0703 | 1187.1 | 411.42555 | 1258.399 |

**Number of Cluster = 3**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Pair | center 1 | radius 1 | Std 1 | center 2 | radius 2 | std 2 | center 3 | radius 3 | std 3 | avg radius | avgstd |
| 1 | [1 2] | [13.08,3.92] | 1.1042 | 3.8054 | [12.23,1.59] | 1.3544 | 4.815 | [13.08,3.92] | 1.8799 | 6.1251 | 1.446167 | 4.915167 |
| 2 | [1 3] | [12.97,2.36] | 1.0757 | 3.0775 | [12.97,2.36] | 0.8686 | 2.4648 | [13.90,2.45] | 0.9717 | 2.6925 | 0.972 | 2.744933 |
| 3 | [1 4] | [13.51,15.94] | 2.4705 | 11.7407 | [13.51,15.94] | 5.4627 | 10 | [12.92,24.10] | 6 | 11 | 4.610467 | 11.06003 |
| 4 | [1 5] | [13.14,102.16] | 39.5325 | 41.8616 | [13.14,102.16] | 9.9236 | 39.1304 | [12.67,86.96] | 16.9712 | 30.1243 | 22.14243 | 37.03877 |
| 5 | [1 6] | [12.14,2.25] | 1.1291 | 3.909 | [12.14,2.25] | 1.286 | 4.3342 | [13.08,1.68] | 1.0793 | 3.5011 | 1.1648 | 3.914767 |
| 6 | [1 7] | [12.17,2.08] | 1.3259 | 4.5381 | [12.17,2.08] | 1.1449 | 4.2079 | [13.75,3.02] | 3.0083 | 4.6297 | 1.826367 | 4.458567 |
| 7 | [1 8] | [12.07,0.37] | 0.5063 | 2.0437 | [12.07,0.37] | 1.0491 | 2.4209 | [13.94,0.33] | 0.8932 | 2.1901 | 0.8162 | 2.218233 |
| 8 | [1 9] | [13.12,1.25] | 1.2559 | 3.4133 | [12.11,1.58] | 2.1013 | 4.3253 | [13.12,1.25] | 1.1531 | 4.0558 | 1.503433 | 3.931467 |
| 9 | [1 10] | [13.43,9.06] | 2.04 | 8.7787 | [12.26,2.89] | 1.6756 | 5.864 | [13.43,9.06] | 4.0437 | 7.1971 | 2.586433 | 7.279933 |
| 10 | [1 11] | [12.06,1.03] | 0.9054 | 2.536 | [12.06,1.03] | 1.2369 | 2.7416 | [13.02,0.85] | 0.5504 | 2.5692 | 0.897567 | 2.6156 |
| 11 | [1 12] | [13.79,3.14] | 1.2977 | 4.296 | [13.06,1.73] | 1.0974 | 3.9596 | [12.14,2.92] | 1.112 | 3.7809 | 1.169033 | 4.012167 |
| 12 | [1 13] | [13.8,1220.89] | 227.7952 | 647.0609 | [13.80,1220.89] | 459.1122 | 966.8322 | [12.52,459.37] | 181.3754 | 582.7196 | 289.4276 | 732.2042 |
| 13 | [2 3] | [1.57,2.32] | 1.5739 | 3 | [2.76,2.45] | 0.8181 | 2.4984 | [1.57,2.32] | 1.1491 | 3.8945 | 1.180367 | 3.159267 |
| 14 | [2 4] | [1.76,16.1] | 6.0179 | 12.3596 | [1.76,16.10] | 5.5579 | 10.7728 | [2.46,19.85] | 3.7262 | 12.9692 | 5.100667 | 12.03387 |
| 15 | [2 5] | [2.35,102.15] | 10.1009 | 39.9837 | [2.34,86.97] | 16.9969 | 31.8473 | [2.21,122.47] | 39.5386 | 42.0468 | 22.21213 | 37.95927 |
| 16 | [2 6] | [3.95,1.9] | 1.152 | 3.6583 | [1.71,1.90] | 1.181 | 4.1795 | [3.95,1.90] | 1.9856 | 5.768 | 1.439533 | 4.535267 |
| 17 | [2 7] | [3.83,1.01] | 2.564 | 6.9864 | [1.80,2.98] | 2.1197 | 4.3316 | [1.65,1.60] | 1.3221 | 4.7445 | 2.001933 | 5.354167 |
| 18 | [2 8] | [4.32,0.41] | 1.4883 | 2.6565 | [1.58,0.33] | 0.8466 | 2.9964 | [2.89,0.42] | 0.7199 | 2.4218 | 1.018267 | 2.691567 |
| 19 | [2 9] | [1.6,1.79] | 1.5173 | 5.3278 | [2.61,1.22] | 1.6828 | 3.2374 | [4.17,1.40] | 2.2252 | 4.2016 | 1.808433 | 4.2556 |
| 20 | [2 10] | [3.19,9.1] | 4.1828 | 8.0497 | [2.22,5.56] | 3.338 | 10.3869 | [1.89,3.06] | 3.9406 | 8.648 | 3.820467 | 9.0282 |
| 21 | [2 11] | [4.31,0.75] | 1.4947 | 2.7834 | [2.86,0.81] | 0.7615 | 2.5237 | [1.58,1.07] | 0.8412 | 3.3561 | 1.032467 | 2.887733 |
| 22 | [2 12] | [1.87,2.13] | 1.1407 | 4.2731 | [3.97,1.99] | 2.1348 | 6.3223 | [1.72,3.12] | 1.4027 | 4.2417 | 1.5594 | 4.9457 |
| 23 | [2 13] | [1.87,1220.89] | 181.3803 | 582.8323 | [1.87,1220.89] | 459.1121 | 966.8331 | [2.56,742.21] | 227.7942 | 647.3596 | 289.4289 | 732.3417 |
| 24 | [3 4] | [2.28,15.97] | 5.7345 | 8.3472 | [2.34,19.87] | 2.1474 | 10.5984 | [2.28,15.97] | 5.452 | 8.8696 | 4.444633 | 9.271733 |
| 25 | [3 5] | [2.53,122.49] | 9.8494 | 38.1604 | [2.53,122.49] | 39.5118 | 41.6356 | [2.25,86.97] | 16.9654 | 29.1691 | 22.10887 | 36.3217 |
| 26 | [3 6] | [2.32,2.41] | 0.726 | 2.3829 | [2.32,2.41] | 1.0506 | 2.4622 | [2.45,3.01] | 0.8656 | 2.3909 | 0.880733 | 2.412 |
| 27 | [3 7] | [2.43,3.08] | 1.0584 | 2.5826 | [2.43,3.08] | 2.1507 | 3.2557 | [2.26,2.03] | 0.7022 | 2.9385 | 1.303767 | 2.9256 |
| 28 | [3 8] | [2.66,0.37] | 0.5781 | 1.2294 | [2.34,0.38] | 0.2898 | 1.3154 | [2.00,0.31] | 0.6441 | 0.9269 | 0.504 | 1.157233 |
| 29 | [3 9] | [2.37,2.37] | 1.1396 | 2.1435 | [2.37,2.37] | 1.3341 | 2.3872 | [2.39,1.63] | 0.8816 | 2.9912 | 1.118433 | 2.5073 |
| 30 | [3 10] | [2.44,9.12] | 1.7683 | 6.2777 | [2.28,2.94] | 1.6848 | 5.3132 | [2.44,9.12] | 3.8871 | 6.4226 | 2.446733 | 6.0045 |
| 31 | [3 11] | [2.6,1.07] | 0.3969 | 1.2694 | [2.60,1.07] | 0.6442 | 1.5714 | [2.12,1.08] | 0.7642 | 1.7385 | 0.601767 | 1.526433 |
| 32 | [3 12] | [2.4,3.35] | 0.6693 | 2.6268 | [2.40,3.35] | 0.8966 | 2.2716 | [2.39,1.68] | 1.0367 | 2.2337 | 0.867533 | 2.377367 |
| 33 | [3 13] | [2.46,1220.89] | 459.1123 | 966.8266 | [2.30,459.37] | 181.3747 | 582.6831 | [2.39,742.21] | 227.7929 | 647.015 | 289.4266 | 732.1749 |
| 34 | [4 5] | [19.31,122.37] | 11.4255 | 48.6884 | [19.31,122.37] | 39.6342 | 47.8703 | [20.17,87.04] | 17.3848 | 38.3807 | 22.81483 | 44.9798 |
| 35 | [4 6] | [15.98,2.69] | 5.4286 | 9.8577 | [19.85,2.14] | 2.2916 | 12.0475 | [24.21,2.06] | 5.9168 | 8.8715 | 4.545667 | 10.2589 |
| 36 | [4 7] | [24.04,1.54] | 6.1115 | 11.1455 | [19.78,1.77] | 2.5738 | 12.7302 | [15.99,2.74] | 5.8115 | 10.6476 | 4.832267 | 11.50777 |
| 37 | [4 8] | [24.26,0.42] | 5.7453 | 8.2206 | [15.97,0.30] | 5.3721 | 8.5145 | [19.86,0.38] | 2.1594 | 10.2919 | 4.4256 | 9.009 |
| 38 | [4 9] | [19.87,1.48] | 5.5664 | 9.8493 | [24.24,1.47] | 5.7846 | 8.8028 | [19.87,1.48] | 2.1899 | 11.65 | 4.513633 | 10.1007 |
| 39 | [4 10] | [16.53,5.01] | 6.6689 | 17.4791 | [21.88,8.18] | 6.9648 | 15.7186 | [21.20,3.39] | 8.7951 | 17.7294 | 7.476267 | 16.9757 |
| 40 | [4 11] | [24.26,0.9] | 5.3781 | 8.6027 | [24.26,0.90] | 5.7558 | 8.3784 | [19.87,0.91] | 2.1767 | 10.595 | 4.436867 | 9.192033 |
| 41 | [4 12] | [24.13,2.3] | 5.994 | 10.9758 | [19.79,2.51] | 2.1644 | 11.3887 | [15.96,2.99] | 5.4906 | 9.9611 | 4.549667 | 10.7752 |
| 42 | [4 13] | [20.78,459.37] | 227.8202 | 647.9809 | [16.97,1220.89] | 459.1098 | 967.107 | [20.78,459.37] | 181.3814 | 584.3848 | 289.4371 | 733.1576 |
| 43 | [5 6] | [86.97,2.12] | 9.891 | 38.9304 | [122.49,2.50] | 39.5115 | 41.975 | [86.97,2.12] | 16.9678 | 29.7511 | 22.12343 | 36.8855 |
| 44 | [5 7] | [102.16,2.12] | 39.4981 | 42.3592 | [102.16,2.12] | 9.932 | 39.967 | [86.96,1.79] | 16.9644 | 30.6494 | 22.1315 | 37.65853 |
| 45 | [5 8] | [102.16,0.35] | 16.9657 | 29.0539 | [102.16,0.35] | 9.8391 | 38.0446 | [122.49,0.31] | 39.5094 | 41.5759 | 22.10473 | 36.2248 |
| 46 | [5 9] | [102.15,1.16] | 39.5518 | 41.7587 | [102.15,1.60] | 9.8678 | 38.7356 | [86.96,1.51] | 16.9628 | 29.6483 | 22.12747 | 36.7142 |
| 47 | [5 10] | [86.85,4.17] | 10.5712 | 39.2493 | [122.15,5.89] | 39.9842 | 48.1849 | [86.85,4.17] | 17.029 | 36.3337 | 22.52813 | 41.25597 |
| 48 | [5 11] | [102.16,0.97] | 9.8507 | 38.133 | [122.49,0.94] | 39.5101 | 41.6126 | [86.97,0.95] | 16.9662 | 29.1684 | 22.109 | 36.30467 |
| 49 | [5 12] | [122.51,2.75] | 9.8882 | 39.156 | [122.51,2.75] | 39.489 | 42.3046 | [86.97,2.56] | 16.9848 | 29.8463 | 22.12067 | 37.1023 |
| 50 | [5 13] | [92.42,459.58] | 181.6942 | 594.3945 | [104.03,742.69] | 227.7341 | 667.7653 | [105.35,1221.03] | 458.9766 | 972.8622 | 289.4683 | 745.0073 |
| 51 | [6 7] | [2.27,2.12] | 1.9919 | 3.2465 | [1.65,0.84] | 0.9897 | 3.255 | [2.27,2.12] | 0.9695 | 3.1559 | 1.317033 | 3.219133 |
| 52 | [6 8] | [2.4,0.34] | 0.4583 | 1.5593 | [3.05,0.29] | 0.8354 | 1.653 | [1.60,0.44] | 0.6166 | 1.9962 | 0.636767 | 1.736167 |
| 53 | [6 9] | [2.97,2.17] | 1.4226 | 3.4647 | [1.63,1.11] | 0.8211 | 3.0687 | [2.43,1.55] | 1.1333 | 2.7967 | 1.125667 | 3.110033 |
| 54 | [6 10] | [2.56,5.5] | 2.1308 | 8.4264 | [2.22,2.97] | 1.7019 | 6.45 | [1.88,9.15] | 3.9624 | 6.7615 | 2.598367 | 7.212633 |
| 55 | [6 11] | [2.36,1.05] | 0.8596 | 1.9828 | [2.35,1.05] | 0.6656 | 2.2639 | [1.58,0.77] | 0.6246 | 1.9997 | 0.7166 | 2.082133 |
| 56 | [6 12] | [1.65,1.73] | 0.9555 | 3.0464 | [2.93,3.21] | 0.9492 | 3.3186 | [2.26,2.87] | 1.0622 | 2.8428 | 0.988967 | 3.069267 |
| 57 | [6 13] | [2.08,459.37] | 181.3741 | 582.7155 | [2.14,742.21] | 227.7974 | 647.0374 | [2.87,1220.89] | 459.1141 | 966.8292 | 289.4285 | 732.194 |
| 58 | [7 8] | [0.77,0.46] | 2.0016 | 2.5564 | [0.77,0.46] | 0.6292 | 2.149 | [2.02,0.35] | 0.6362 | 2.3579 | 1.089 | 2.354433 |
| 59 | [7 9] | [3.1,2.08] | 1.9896 | 3.7938 | [0.80,1.08] | 1.2452 | 3.1796 | [2.10,1.53] | 1.41 | 3.8288 | 1.548267 | 3.600733 |
| 60 | [7 10] | [2.75,5.55] | 4.0137 | 7.7291 | [1.95,3.04] | 2.457 | 7.8006 | [2.75,5.55] | 2.3714 | 9.5362 | 2.947367 | 8.3553 |
| 61 | [7 11] | [2.04,1.06] | 1.9914 | 2.8352 | [2.04,1.06] | 0.6672 | 2.5808 | [0.78,0.73] | 0.7459 | 2.3129 | 1.134833 | 2.5763 |
| 62 | [7 12] | [0.83,1.73] | 0.8565 | 2.9183 | [3.07,3.17] | 2.0733 | 3.6377 | [2.08,2.90] | 0.8688 | 3.6146 | 1.2662 | 3.3902 |
| 63 | [7 13] | [1.63,742.21] | 181.3739 | 582.8325 | [1.63,742.20] | 227.8001 | 647.1095 | [3.03,1220.89] | 459.1158 | 966.8296 | 289.4299 | 732.2572 |
| 64 | [8 9] | [0.35,1.64] | 0.5775 | 1.7223 | [0.29,2.46] | 1.1259 | 1.7895 | [0.35,1.64] | 0.4068 | 2.2618 | 0.7034 | 1.924533 |
| 65 | [8 10] | [0.36,2.94] | 3.8737 | 5.8875 | [0.36,2.94] | 1.6625 | 4.8684 | [0.34,5.48] | 1.8244 | 6.2077 | 2.453533 | 5.654533 |
| 66 | [8 11] | [0.45,0.67] | 0.547 | 0.9456 | [0.45,0.67] | 0.2839 | 0.9673 | [0.32,0.97] | 0.261 | 1.0795 | 0.363967 | 0.997467 |
| 67 | [8 12] | [0.34,2.74] | 0.4834 | 1.737 | [0.34,2.74] | 0.5247 | 1.7317 | [0.29,3.37] | 0.6282 | 1.5157 | 0.545433 | 1.661467 |
| 68 | [8 13] | [0.29,1220.89] | 459.1123 | 966.8254 | [0.39,742.21] | 227.7927 | 647.0083 | [0.39,459.37] | 181.3746 | 582.6675 | 289.4265 | 732.1671 |
| 69 | [9 10] | [1.44,9.08] | 2.1723 | 7.9157 | [1.44,9.08] | 4.1187 | 6.8161 | [1.60,2.95] | 1.984 | 6.5268 | 2.758333 | 7.0862 |
| 70 | [9 11] | [2.42,1.04] | 0.774 | 2.5328 | [0.98,0.79] | 0.7313 | 2.1727 | [2.42,1.04] | 1.1929 | 2.0229 | 0.8994 | 2.2428 |
| 71 | [9 12] | [1.09,1.72] | 0.821 | 3.0528 | [2.15,3.21] | 1.482 | 3.5052 | [1.09,1.72] | 1.1979 | 3.1374 | 1.166967 | 3.2318 |
| 72 | [9 13] | [1.53,742.21] | 227.7947 | 647.0512 | [1.92,1220.89] | 459.1132 | 966.8336 | [1.45,459.37] | 181.3738 | 582.6993 | 289.4272 | 732.1947 |
| 73 | [10 11] | [2.94,1.05] | 1.8468 | 6.1951 | [9.13,0.69] | 3.8692 | 6.2197 | [2.94,1.05] | 1.6685 | 5.1143 | 2.4615 | 5.843033 |
| 74 | [10 12] | [5.5,2.8] | 1.9042 | 6.6138 | [5.50,2.80] | 2.0175 | 8.4568 | [9.11,1.80] | 3.8967 | 7.0453 | 2.606133 | 7.371967 |
| 75 | [10 13] | [4.14,459.38] | 227.7757 | 647.6956 | [5.82,1220.89] | 459.1164 | 966.8852 | [4.14,459.38] | 181.3849 | 583.3462 | 289.4257 | 732.6423 |
| 76 | [11 12] | [1.09,2.73] | 0.633 | 2.0924 | [1.01,3.36] | 0.6449 | 1.8211 | [0.71,1.67] | 0.5414 | 1.8475 | 0.606433 | 1.920333 |
| 77 | [11 13] | [0.89,742.21] | 181.3751 | 582.6729 | [1.08,1220.89] | 459.1123 | 966.8256 | [0.89,742.21] | 227.7926 | 647.0122 | 289.4267 | 732.1702 |
| 78 | [12 13] | [3.07,1220.89] | 227.7955 | 647.0694 | [3.07,1220.89] | 459.1131 | 966.8281 | [2.49,459.37] | 181.3752 | 582.7317 | 289.4279 | 732.2097 |

**Number of Cluster = 4**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Pair | center 1 | | radius 1 | Std 1 | center 2 | | radius 2 | | std 2 | |
| 1 | [1 2] | [13.79,1.75] | | 1.0445 | 3.3289 | [13.30,4.31] | | 1.5119 | | 4.2511 | |
| 2 | [1 3] | [12.51,2.22] | | 0.8725 | 2.2221 | [11.87,2.38] | | 0.9055 | | 1.9697 | |
| 3 | [1 4] | [12.96,25.05] | | 4.9515 | 7.1105 | [12.68,21.31] | | 1.8578 | | 8 | |
| 4 | [1 5] | [12.62,86.27] | | 16.2795 | 25.1821 | [12.88,137.04] | | 24.9588 | | 26.9338 | |
| 5 | [1 6] | [13.88,2.91] | | 1.0615 | 3.7742 | [12.36,1.80] | | 0.7928 | | 2.927 | |
| 6 | [1 7] | [13.01,2.67] | | 2.8173 | 3.1184 | [12.09,1.89] | | 1.1641 | | 3.7667 | |
| 7 | [1 8] | [14.05,0.32] | | 0.7808 | 1.7449 | [11.79,0.36] | | 0.7792 | | 1.3432 | |
| 8 | [1 9] | [12.62,1.06] | | 0.9622 | 2.4321 | [13.39,1.44] | | 0.9068 | | 3.0843 | |
| 9 | [1 10] | [13.66,6.36] | | 2.1305 | 6.3329 | [12.15,2.72] | | 1.445 | | 4.664 | |
| 10 | [1 11] | [13.36,0.88] | | 0.5653 | 2.0647 | [14.07,1.03] | | 0.7661 | | 1.988 | |
| 11 | [1 12] | [13.81,3.19] | | 1.0724 | 3.9824 | [13.50,1.79] | | 0.8626 | | 2.0767 | |
| 12 | [1 13] | [13.88,1334.24] | | 345.7636 | 486.912 | [12.88,680.03] | | 164.9686 | | 496.7567 | |
| 13 | [2 3] | [1.34,2.16] | | 0.8974 | 2 | [4.51,2.43] | | 1.3209 | | 2.547 | |
| 14 | [2 4] | [2.90,21.26] | | 2.9097 | 10.8088 | [1.73,15.67] | | 5.1271 | | 8.9525 | |
| 15 | [2 5] | [2.32,99.48] | | 7.0908 | 27.8558 | [2.32,86.29] | | 16.3153 | | 26.9612 | |
| 16 | [2 6] | [1.75,2.88] | | 0.9957 | 3.145 | [1.45,2.03] | | 0.9387 | | 3.0924 | |
| 17 | [2 7] | [4.43,1.07] | | 2.092 | 5.4534 | [1.52,1.73] | | 1.2948 | | 3.8879 | |
| 18 | [2 8] | [4.97,0.47] | | 0.8438 | 1.4069 | [2.41,0.39] | | 0.6617 | | 1.8268 | |
| 19 | [2 9] | [1.68,2.11] | | 1.6443 | 3.0789 | [1.60,1.44] | | 1.2109 | | 3.0031 | |
| 20 | [2 10] | [1.83,5.88] | | 1.9233 | 6.0141 | [1.68,3.00] | | 2.4577 | | 6.5114 | |
| 21 | [2 11] | [3.27,0.80] | | 0.778 | 2.9121 | [4.57,0.73] | | 1.2311 | | 2.1185 | |
| 22 | [2 12] | [4.49,1.99] | | 1.7172 | 4.6313 | [1.79,3.26] | | 1.3134 | | 3.2786 | |
| 23 | [2 13] | [2.00,1025.10] | | 170.1096 | 409.4348 | [1.78,1334.24] | | 345.765 | | 486.9069 | |
| 24 | [3 4] | [2.30,18.55] | | 1.4981 | 4.8516 | [2.26,15.48] | | 4.9648 | | 8.2375 | |
| 25 | [3 5] | [2.23,86.28] | | 16.2783 | 24.24 | [2.52,114.21] | | 9.8198 | | 26.961 | |
| 26 | [3 6] | [2.35,1.53] | | 0.6112 | 1.7808 | [2.44,2.60] | | 0.781 | | 1.8434 | |
| 27 | [3 7] | [2.40,0.70] | | 1.0514 | 1.6973 | [2.24,1.64] | | 0.7583 | | 2.3262 | |
| 28 | [3 8] | [2.37,0.28] | | 0.2274 | 0.7668 | [1.95,0.31] | | 0.5924 | | 0.8213 | |
| 29 | [3 9] | [2.38,1.45] | | 0.6859 | 2.1295 | [2.37,1.94] | | 0.864 | | 1.961 | |
| 30 | [3 10] | [2.43,9.96] | | 3.055 | 3.8848 | [2.40,5.01] | | 1.2869 | | 4.6357 | |
| 31 | [3 11] | [2.67,1.04] | | 0.5726 | 1.2783 | [2.33,1.08] | | 0.6447 | | 1.1389 | |
| 32 | [3 12] | [2.24,2.90] | | 0.6829 | 2.0789 | [2.47,2.34] | | 0.5905 | | 1.7234 | |
| 33 | [3 13] | [2.36,1025.10] | | 170.1028 | 409.3806 | [2.38,680.03] | | 164.9677 | | 496.2743 | |
| 34 | [4 5] | [18.96,113.37] | | 12.2277 | 33.3096 | [19.28,135.28] | | 26.7217 | | 30.9196 | |
| 35 | [4 6] | [25.10,2.15] | | 5.0331 | 6.525 | [18.51,2.29] | | 1.5758 | | 6.5067 | |
| 36 | [4 7] | [18.50,2.18] | | 1.9509 | 8.8135 | [21.21,1.47] | | 2.2007 | | 8.796 | |
| 37 | [4 8] | [25.13,0.41] | | 4.8731 | 5.9511 | [21.35,0.40] | | 1.6529 | | 6.5887 | |
| 38 | [4 9] | [15.47,1.83] | | 5.0744 | 8.5545 | [25.11,1.50] | | 4.914 | | 6.5239 | |
| 39 | [4 10] | [19.02,3.90] | | 2.9983 | 11.9977 | [15.84,5.40] | | 6.2711 | | 12.8542 | |
| 40 | [4 11] | [25.12,0.89] | | 4.8968 | 6.1244 | [21.33,0.85] | | 1.7089 | | 6.782 | |
| 41 | [4 12] | [18.55,2.71] | | 1.8201 | 6.9377 | [21.33,2.35] | | 1.8492 | | 8.2912 | |
| 42 | [4 13] | [17.15,1334.23] | | 345.7682 | 487.0375 | [17.55,1025.11] | | 170.1145 | | 410.1978 | |
| 43 | [5 6] | [99.46,2.34] | | 6.6092 | 26.7551 | [114.20,2.53] | | 9.7957 | | 27.4363 | |
| 44 | [5 7] | [99.45,2.05] | | 6.7122 | 27.6888 | [136.88,2.18] | | 25.1164 | | 26.7498 | |
| 45 | [5 8] | [114.21,0.33] | | 9.7934 | 26.9159 | [86.28,0.39] | | 16.2788 | | 24.0774 | |
| 46 | [5 9] | [114.20,1.61] | | 9.8023 | 27.1357 | [86.27,1.50] | | 16.2747 | | 24.6299 | |
| 47 | [5 10] | [86.13,4.00] | | 16.2899 | 31.2041 | [136.85,3.83] | | 25.1754 | | 26.9107 | |
| 48 | [5 11] | [114.21,0.91] | | 9.7949 | 26.9571 | [99.47,0.97] | | 6.5369 | | 26.2822 | |
| 49 | [5 12] | [114.17,2.61] | | 9.8479 | 27.4159 | [99.46,2.64] | | 6.6751 | | 27.1863 | |
| 50 | [5 13] | [106.63,1025.37] | | 170.4532 | 421.6457 | [100.27,679.88] | | 165.8637 | | 517.2137 | |
| 51 | [6 7] | [1.63,0.70] | | 0.7458 | 2.062 | [3.04,3.23] | | 1.8551 | | 2.5262 | |
| 52 | [6 8] | [2.58,0.32] | | 0.3363 | 1.1633 | [1.49,0.43] | | 0.5071 | | 1.2894 | |
| 53 | [6 9] | [2.87,1.83] | | 1.0129 | 2.4614 | [1.57,1.03] | | 0.7821 | | 2.5584 | |
| 54 | [6 10] | [2.22,2.74] | | 1.4784 | 5.1731 | [2.75,6.54] | | 1.6888 | | 5.4693 | |
| 55 | [6 11] | [3.12,1.05] | | 0.7596 | 1.5964 | [2.02,1.04] | | 0.5528 | | 1.5329 | |
| 56 | [6 12] | [2.44,3.08] | | 0.7954 | 2.6433 | [3.01,3.19] | | 0.9082 | | 2.6829 | |
| 57 | [6 13] | [2.12,440.99] | | 162.9929 | 482.6148 | [2.04,680.03] | | 164.969 | | 496.4133 | |
| 58 | [7 8] | [0.68,0.48] | | 0.4624 | 1.2331 | [1.60,0.39] | | 0.476 | | 1.6794 | |
| 59 | [7 9] | [3.24,2.21] | | 1.8745 | 3.1117 | [0.71,1.04] | | 0.8574 | | 2.6113 | |
| 60 | [7 10] | [2.04,2.89] | | 1.7462 | 6.5407 | [3.06,5.70] | | 2.1401 | | 6.4513 | |
| 61 | [7 11] | [2.55,1.07] | | 0.7457 | 1.8306 | [0.70,0.71] | | 0.4274 | | 1.2848 | |
| 62 | [7 12] | [0.76,1.70] | | 0.8991 | 2.537 | [3.21,3.17] | | 1.9401 | | 2.9511 | |
| 63 | [7 13] | [1.88,440.99] | | 162.9916 | 482.6549 | [3.05,1334.24] | | 345.765 | | 486.9144 | |
| 64 | [8 9] | [0.31,1.96] | | 0.4002 | 1.2523 | [0.31,2.79] | | 0.7923 | | 1.1507 | |
| 65 | [8 10] | [0.36,2.81] | | 1.5339 | 4.2702 | [0.44,9.97] | | 3.0319 | | 3.6079 | |
| 66 | [8 11] | [0.44,0.90] | | 0.2476 | 0.7022 | [0.28,1.03] | | 0.2778 | | 0.6736 | |
| 67 | [8 12] | [0.32,2.88] | | 0.3086 | 1.1085 | [0.45,1.60] | | 0.4233 | | 1.3049 | |
| 68 | [8 13] | [0.28,1025.10] | | 170.103 | 409.3772 | [0.41,680.03] | | 164.9675 | | 496.2492 | |
| 69 | [9 10] | [1.41,9.66] | | 3.5852 | 4.7084 | [1.62,2.75] | | 1.9659 | | 5.332 | |
| 70 | [9 11] | [2.75,1.07] | | 0.8919 | 1.3573 | [1.46,1.00] | | 0.6216 | | 1.9153 | |
| 71 | [9 12] | [1.07,1.68] | | 0.8142 | 2.8361 | [1.79,3.32] | | 0.7838 | | 2.6712 | |
| 72 | [9 13] | [1.44,680.03] | | 164.968 | 496.5995 | [1.90,1334.24] | | 345.7638 | | 486.9131 | |
| 73 | [10 11] | [2.82,1.05] | | 1.5408 | 4.5453 | [9.97,0.65] | | 3.0318 | | 3.8866 | |
| 74 | [10 12] | [6.54,2.64] | | 1.5327 | 5.7868 | [9.62,1.70] | | 3.3921 | | 4.8544 | |
| 75 | [10 13] | [4.00,440.99] | | 162.9944 | 483.0574 | [5.04,1025.10] | | 170.1339 | | 409.5078 | |
| 76 | [11 12] | [1.00,3.42] | | 0.5917 | 1.4599 | [0.67,1.60] | | 0.5831 | | 1.4528 | |
| 77 | [11 13] | [1.11,1334.24] | | 345.7636 | 486.9083 | [0.96,440.99] | | 162.9935 | | 482.583 | |
| 78 | [12 13] | [2.54,440.99] | | 162.993 | 482.6377 | [2.27,680.03] | | 164.9761 | | 496.6422 | |
| No. | Pair | center 3 | radius 3 | | std 3 | | center 4 | | radius 4 | | std 4 | | avg radius | avgstd |
| 1 | [1 2] | [12.74,3.07] | 1.4441 | | 3.8281 | | [12.24,1.46] | | 1.2262 | | 3.7848 | | 1.306675 | 3.798225 |
| 2 | [1 3] | [13.34,2.44] | 0.8299 | | 2.3005 | | [14.06,2.44] | | 0.8189 | | 1.9203 | | 0.8567 | 2.10315 |
| 3 | [1 4] | [13.62,15.56] | 5 | | 10 | | [12.80,18.56] | | 2 | | 7 | | 3.500075 | 8.010125 |
| 4 | [1 5] | [13.42,114.22] | 9.7861 | | 27.363 | | [13.09,99.48] | | 6.5392 | | 27.1601 | | 14.3909 | 26.65975 |
| 5 | [1 6] | [12.15,2.57] | 1.1225 | | 2.7809 | | [13.36,1.76] | | 0.939 | | 2.7167 | | 0.97895 | 3.0497 |
| 6 | [1 7] | [13.14,0.79] | 1.3053 | | 4.0457 | | [13.95,3.11] | | 0.9899 | | 2.8525 | | 1.56915 | 3.445825 |
| 7 | [1 8] | [13.30,0.36] | 0.4352 | | 1.6504 | | [12.47,0.39] | | 0.4297 | | 1.7066 | | 0.606225 | 1.611275 |
| 8 | [1 9] | [13.99,2.07] | 1.2574 | | 2.7324 | | [12.05,1.71] | | 1.9583 | | 3.6628 | | 1.271175 | 2.9779 |
| 9 | [1 10] | [13.21,4.53] | 1.3977 | | 5.1363 | | [13.44,9.57] | | 3.5473 | | 4.9663 | | 2.130125 | 5.274875 |
| 10 | [1 11] | [12.55,0.92] | 0.5655 | | 2.0919 | | [11.86,1.03] | | 1.07 | | 1.6883 | | 0.741725 | 1.958225 |
| 11 | [1 12] | [12.56,1.85] | 0.942 | | 2.6489 | | [12.15,3.02] | | 1.1268 | | 3.3766 | | 1.00095 | 3.02115 |
| 12 | [1 13] | [12.48,440.99] | 162.9936 | | 482.6274 | | [13.60,1025.10] | | 170.109 | | 409.4083 | | 210.9587 | 468.9261 |
| 13 | [2 3] | [1.83,2.48] | 0.8168 | | 2.6606 | | [3.22,2.39] | | 0.795 | | 2.6101 | | 0.957525 | 2.5008 |
| 14 | [2 4] | [2.47,24.92] | 5.14 | | 8.2861 | | [2.04,18.70] | | 2.282 | | 8.3152 | | 3.8647 | 9.09065 |
| 15 | [2 5] | [1.73,137.02] | 24.9775 | | 26.8766 | | [2.39,114.24] | | 9.7691 | | 27.7898 | | 14.53818 | 27.37085 |
| 16 | [2 6] | [4.41,2.00] | 1.5179 | | 4.1427 | | [3.08,1.70] | | 1.1563 | | 2.8722 | | 1.15215 | 3.313075 |
| 17 | [2 7] | [1.77,3.02] | 2.0785 | | 4.1879 | | [3.05,0.91] | | 1.1809 | | 3.0293 | | 1.66155 | 4.139625 |
| 18 | [2 8] | [3.67,0.39] | 0.6661 | | 1.9845 | | [1.53,0.33] | | 0.7973 | | 2.6538 | | 0.742225 | 1.968 |
| 19 | [2 9] | [4.30,1.39] | 2.2569 | | 3.8548 | | [2.99,1.10] | | 0.9063 | | 2.969 | | 1.5046 | 3.22645 |
| 20 | [2 10] | [3.70,4.60] | 2.9037 | | 6.5045 | | [3.17,9.40] | | 3.8978 | | 7.9241 | | 2.795625 | 6.738525 |
| 21 | [2 11] | [1.27,1.08] | 0.6698 | | 1.7465 | | [1.84,1.04] | | 0.7206 | | 2.1531 | | 0.849875 | 2.23255 |
| 22 | [2 12] | [3.13,1.90] | 1.6126 | | 3.4465 | | [1.53,2.53] | | 1.2575 | | 3.6914 | | 1.475175 | 3.76195 |
| 23 | [2 13] | [2.35,440.99] | 162.997 | | 482.736 | | [2.60,680.03] | | 164.9735 | | 497.0243 | | 210.9613 | 469.0255 |
| 24 | [3 4] | [2.39,21.35] | 1.6677 | | 6.7073 | | [2.67,25.14] | | 4.8619 | | 6.0495 | | 3.248125 | 6.461475 |
| 25 | [3 5] | [2.39,136.97] | 25.0322 | | 26.6863 | | [2.40,99.47] | | 6.5325 | | 26.3044 | | 14.4157 | 26.04793 |
| 26 | [3 6] | [2.41,3.12] | 0.827 | | 1.9337 | | [2.24,2.08] | | 0.8829 | | 2.0037 | | 0.775525 | 1.8904 |
| 27 | [3 7] | [2.41,3.26] | 1.9976 | | 2.336 | | [2.40,2.54] | | 0.8357 | | 2.2888 | | 1.16075 | 2.162075 |
| 28 | [3 8] | [2.69,0.37] | 0.551 | | 1.1429 | | [2.32,0.47] | | 0.2279 | | 0.7943 | | 0.399675 | 0.881325 |
| 29 | [3 9] | [2.35,0.91] | 1.0993 | | 1.8385 | | [2.33,2.74] | | 0.9835 | | 1.6134 | | 0.908175 | 1.8856 |
| 30 | [3 10] | [2.27,2.81] | 1.5565 | | 4.853 | | [2.43,7.21] | | 1.3624 | | 3.2418 | | 1.8152 | 4.153825 |
| 31 | [3 11] | [2.36,0.69] | 0.3934 | | 1.1583 | | [1.97,1.07] | | 0.6151 | | 1.089 | | 0.55645 | 1.166125 |
| 32 | [3 12] | [2.37,1.61] | 1.0333 | | 1.6299 | | [2.44,3.41] | | 0.8401 | | 1.9656 | | 0.7867 | 1.84945 |
| 33 | [3 13] | [2.50,1334.24] | 345.7637 | | 486.9087 | | [2.29,440.99] | | 162.9931 | | 482.586 | | 210.9568 | 468.7874 |
| 34 | [4 5] | [20.30,86.26] | 16.5946 | | 32.4985 | | [18.87,99.18] | | 9.6647 | | 38.0528 | | 16.30218 | 33.69513 |
| 35 | [4 6] | [21.31,2.01] | 1.8796 | | 8.0521 | | [15.46,2.75] | | 4.924 | | 8.5887 | | 3.353125 | 7.418125 |
| 36 | [4 7] | [15.50,2.85] | 5.4016 | | 8.7179 | | [24.94,1.58] | | 5.2289 | | 7.4435 | | 3.695525 | 8.442725 |
| 37 | [4 8] | [15.49,0.29] | 4.886 | | 7.9013 | | [18.56,0.35] | | 1.4611 | | 4.5706 | | 3.218275 | 6.252925 |
| 38 | [4 9] | [18.50,1.59] | 2.2241 | | 6.5663 | | [21.29,1.43] | | 1.7885 | | 7.4601 | | 3.50025 | 7.2762 |
| 39 | [4 10] | [21.55,8.76] | 5.5944 | | 13.221 | | [23.03,3.40] | | 6.9693 | | 13.2637 | | 5.458275 | 12.83415 |
| 40 | [4 11] | [15.48,1.05] | 4.8803 | | 7.955 | | [18.54,1.00] | | 1.4487 | | 4.8184 | | 3.233675 | 6.41995 |
| 41 | [4 12] | [15.48,3.04] | 5.0293 | | 8.8383 | | [25.08,2.34] | | 5.0528 | | 7.1339 | | 3.43785 | 7.800275 |
| 42 | [4 13] | [20.74,440.98] | 162.9883 | | 483.7945 | | [20.04,680.02] | | 165.0507 | | 497.8378 | | 210.9804 | 469.7169 |
| 43 | [5 6] | [86.28,2.12] | 16.2754 | | 24.8418 | | [136.96,2.43] | | 25.0442 | | 26.7921 | | 14.43113 | 26.45633 |
| 44 | [5 7] | [114.16,2.40] | 9.8436 | | 27.9313 | | [86.26,1.79] | | 16.2657 | | 25.7663 | | 14.48448 | 27.03405 |
| 45 | [5 8] | [99.47,0.36] | 6.5344 | | 26.2364 | | [136.98,0.27] | | 25.0249 | | 26.6462 | | 14.40788 | 25.96898 |
| 46 | [5 9] | [99.46,1.58] | 6.5806 | | 26.7718 | | [136.96,2.11] | | 25.0629 | | 26.7469 | | 14.43013 | 26.32108 |
| 47 | [5 10] | [114.22,6.57] | 10.2272 | | 29.3793 | | [99.38,5.02] | | 8.0952 | | 31.4595 | | 14.94693 | 29.7384 |
| 48 | [5 11] | [136.97,1.12] | 25.0261 | | 26.6478 | | [86.28,0.96] | | 16.2786 | | 24.2711 | | 14.40913 | 26.03955 |
| 49 | [5 12] | [86.28,2.56] | 16.2909 | | 24.9622 | | [136.90,2.92] | | 25.0984 | | 26.717 | | 14.47808 | 26.57035 |
| 50 | [5 13] | [91.98,440.92] | 163.0274 | | 493.2241 | | [105.88,1334.45] | | 345.5569 | | 492.2419 | | 211.2253 | 481.0814 |
| 51 | [6 7] | [2.54,2.51] | 0.9167 | | 2.129 | | [1.89,1.64] | | 0.9701 | | 2.4229 | | 1.121925 | 2.285025 |
| 52 | [6 8] | [3.13,0.28] | 0.7513 | | 1.3225 | | [2.00,0.41] | | 0.3179 | | 1.1858 | | 0.47815 | 1.24025 |
| 53 | [6 9] | [2.88,2.52] | 1.1057 | | 2.2961 | | [2.15,1.45] | | 1.0956 | | 2.4215 | | 0.999075 | 2.43435 |
| 54 | [6 10] | [2.36,4.71] | 1.5594 | | 6.0926 | | [1.76,9.61] | | 3.5449 | | 4.837 | | 2.067875 | 5.393 |
| 55 | [6 11] | [1.52,0.73] | 0.5563 | | 1.5225 | | [2.59,1.04] | | 0.6863 | | 1.5112 | | 0.63875 | 1.54075 |
| 56 | [6 12] | [1.85,2.38] | 1.0374 | | 2.1635 | | [1.62,1.63] | | 0.7108 | | 2.1717 | | 0.86295 | 2.41535 |
| 57 | [6 13] | [2.89,1334.24] | 345.7638 | | 486.913 | | [2.73,1025.10] | | 170.1085 | | 409.3867 | | 210.9586 | 468.832 |
| 58 | [7 8] | [3.27,0.28] | 1.8217 | | 1.8423 | | [2.53,0.32] | | 0.44 | | 1.5362 | | 0.800025 | 1.57275 |
| 59 | [7 9] | [1.70,1.42] | 1.3341 | | 2.4955 | | [2.62,1.72] | | 1.294 | | 2.5337 | | 1.34 | 2.68805 |
| 60 | [7 10] | [0.96,5.26] | 2.0466 | | 4.6661 | | [0.95,9.40] | | 3.6154 | | 6.836 | | 2.387075 | 6.123525 |
| 61 | [7 11] | [3.28,1.05] | 1.8073 | | 1.9692 | | [1.65,1.01] | | 0.6056 | | 2.2616 | | 0.8965 | 1.83655 |
| 62 | [7 12] | [1.69,2.49] | 0.8457 | | 2.0414 | | [2.45,3.09] | | 0.8181 | | 2.7115 | | 1.12575 | 2.56025 |
| 63 | [7 13] | [1.45,680.03] | 164.9769 | | 496.8145 | | [2.77,1025.10] | | 170.1142 | | 409.3924 | | 210.9619 | 468.9441 |
| 64 | [8 9] | [0.36,1.43] | 0.3233 | | 1.3867 | | [0.44,0.86] | | 0.4836 | | 1.3197 | | 0.49985 | 1.27735 |
| 65 | [8 10] | [0.37,7.23] | 1.3794 | | 3.3329 | | [0.34,5.02] | | 1.0912 | | 4.2605 | | 1.7591 | 3.867875 |
| 66 | [8 11] | [0.44,0.64] | 0.2582 | | 0.8378 | | [0.33,1.24] | | 0.5082 | | 0.7858 | | 0.32295 | 0.74985 |
| 67 | [8 12] | [0.44,2.26] | 0.3146 | | 1.0784 | | [0.28,3.43] | | 0.568 | | 1.3118 | | 0.403625 | 1.2009 |
| 68 | [8 13] | [0.30,1334.24] | 345.7635 | | 486.908 | | [0.38,440.99] | | 162.993 | | 482.577 | | 210.9568 | 468.7779 |
| 69 | [9 10] | [1.49,4.72] | 1.4907 | | 5.6248 | | [1.78,6.68] | | 1.4352 | | 5.1204 | | 2.11925 | 5.1964 |
| 70 | [9 11] | [0.91,0.78] | 0.6895 | | 1.6837 | | [1.95,1.04] | | 0.6732 | | 1.5269 | | 0.71905 | 1.6208 |
| 71 | [9 12] | [1.47,2.71] | 0.8693 | | 2.3035 | | [2.53,2.96] | | 1.2084 | | 2.284 | | 0.918925 | 2.5237 |
| 72 | [9 13] | [1.48,440.99] | 162.9927 | | 482.6011 | | [1.85,1025.10] | | 170.104 | | 409.3926 | | 210.9571 | 468.8766 |
| 73 | [10 11] | [7.22,0.86] | 1.2946 | | 3.3331 | | [5.01,0.98] | | 1.1122 | | 4.3833 | | 1.74485 | 4.037075 |
| 74 | [10 12] | [4.70,2.83] | 1.7779 | | 6.5612 | | [2.75,2.84] | | 1.482 | | 4.9609 | | 2.046175 | 5.540825 |
| 75 | [10 13] | [5.69,680.04] | 164.974 | | 498.6242 | | [6.20,1334.24] | | 345.7719 | | 486.9563 | | 210.9686 | 469.5364 |
| 76 | [11 12] | [1.11,2.88] | 0.6033 | | 1.547 | | [1.00,2.26] | | 0.4509 | | 1.2574 | | 0.55725 | 1.429275 |
| 77 | [11 13] | [1.04,1025.10] | 170.1034 | | 409.3781 | | [0.87,680.03] | | 164.9675 | | 496.2741 | | 210.957 | 468.7859 |
| 78 | [12 13] | [3.15,1025.10] | 170.106 | | 409.3996 | | [3.02,1334.24] | | 345.764 | | 486.9102 | | 210.9598 | 468.8974 |

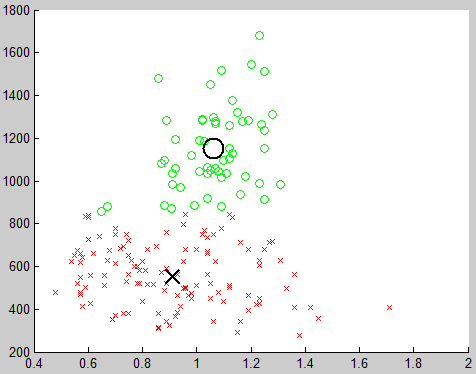
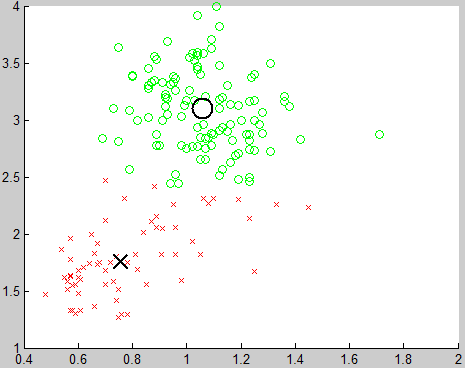
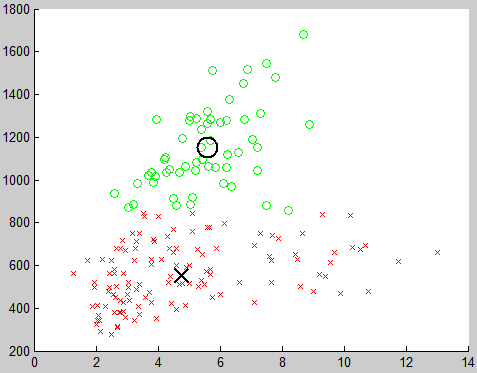
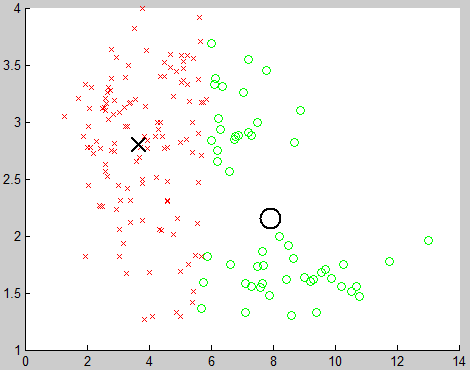
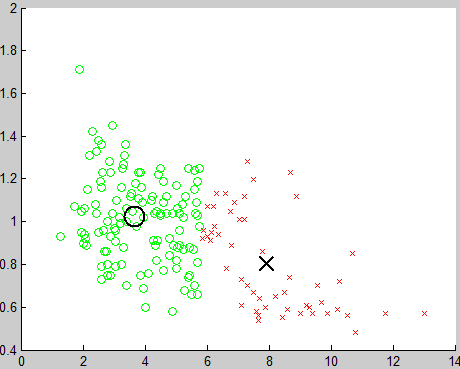
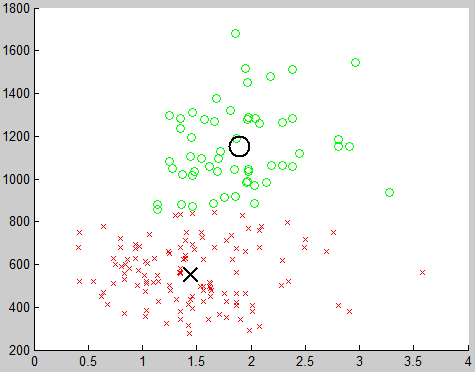
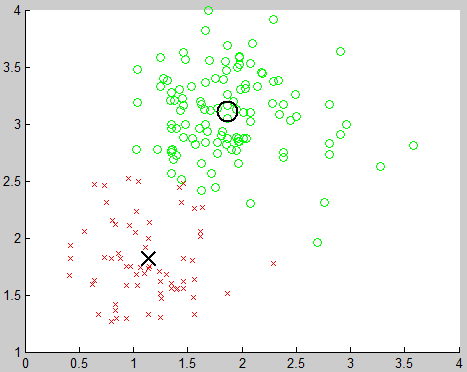
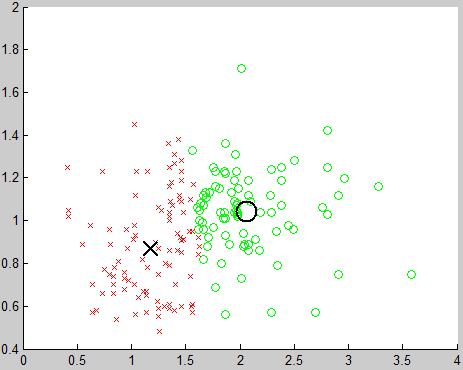
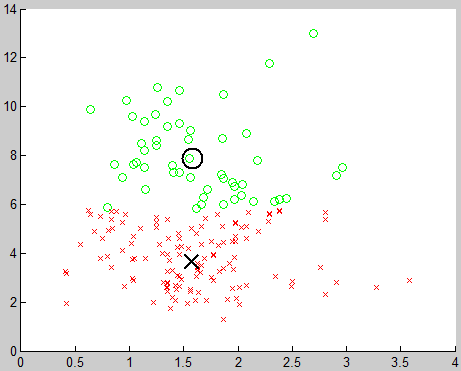
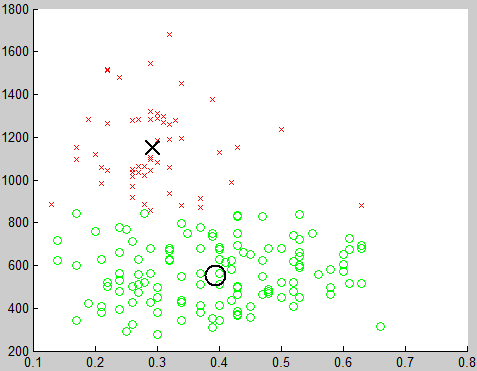
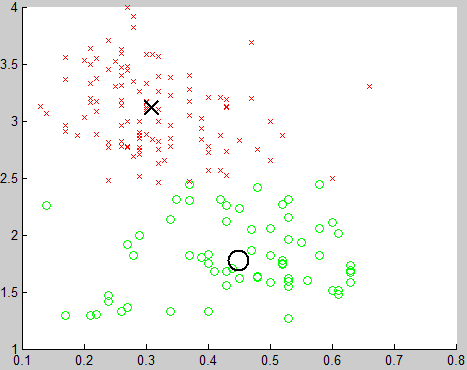
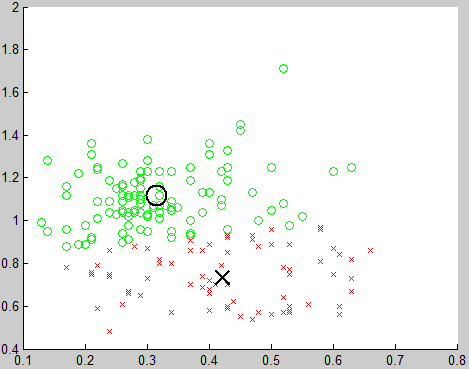
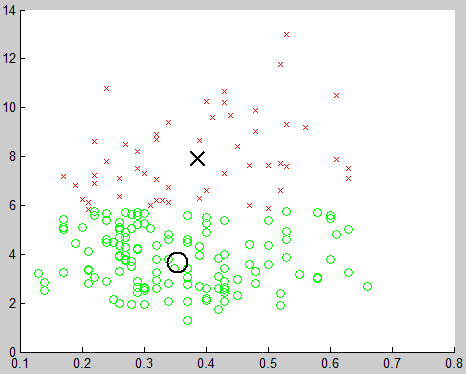
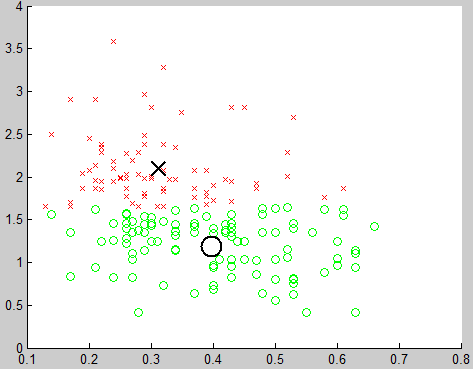
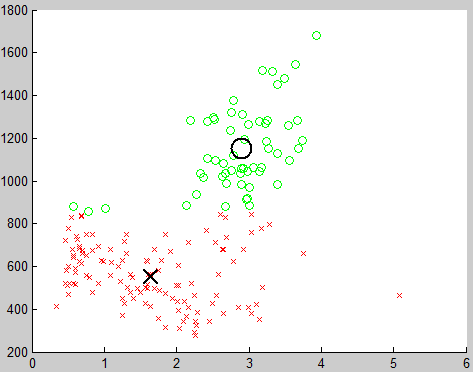
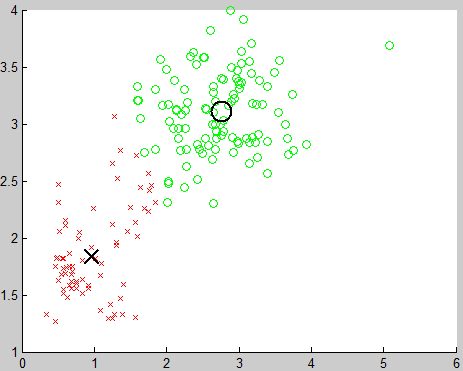
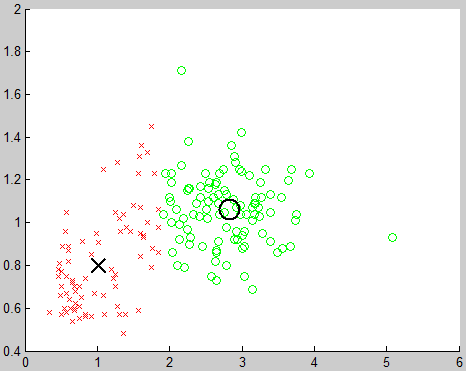
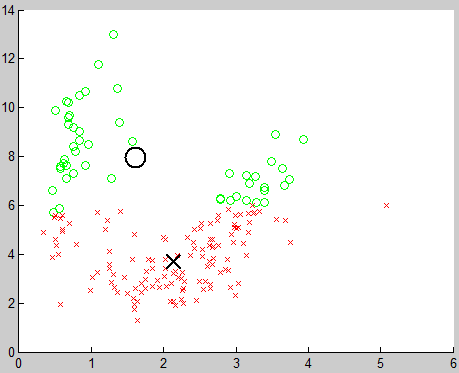
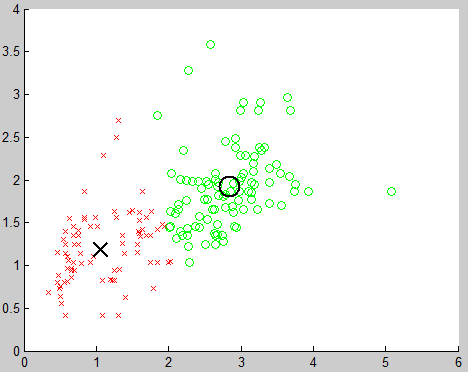
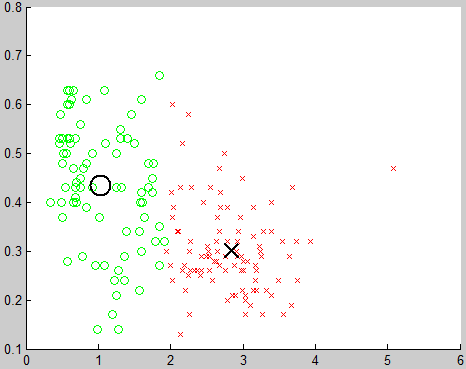
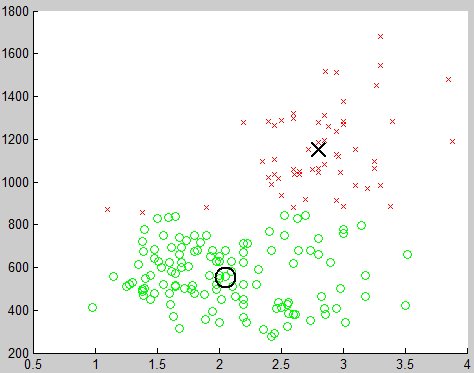
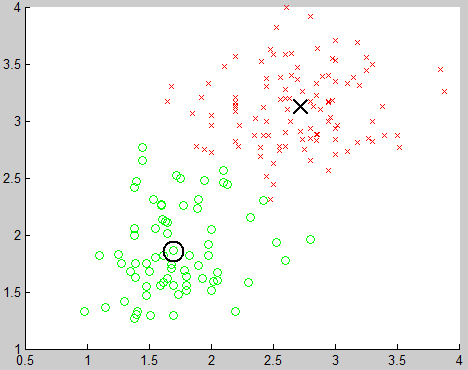
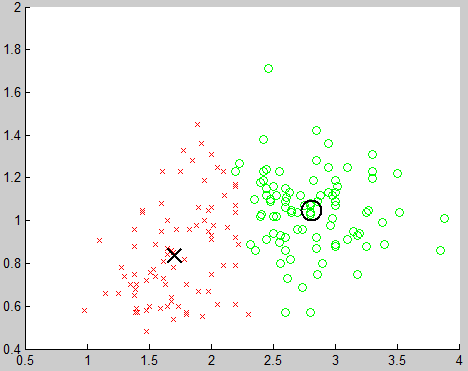
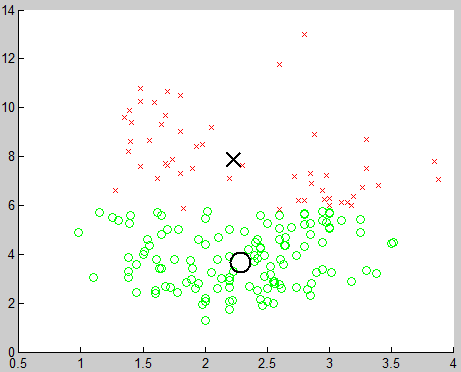
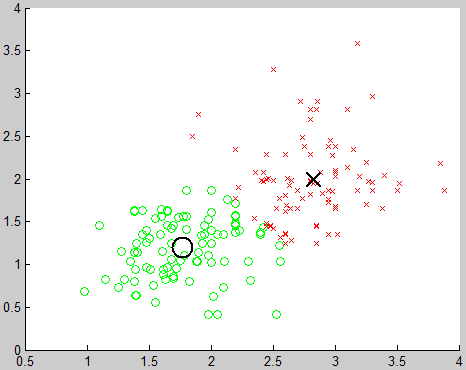
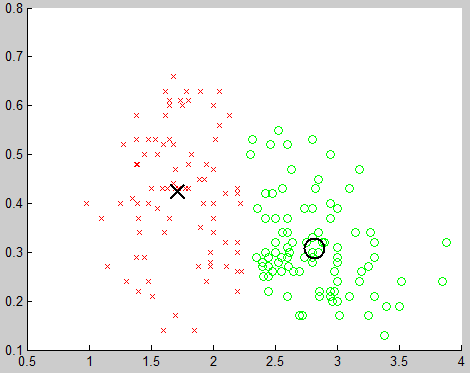
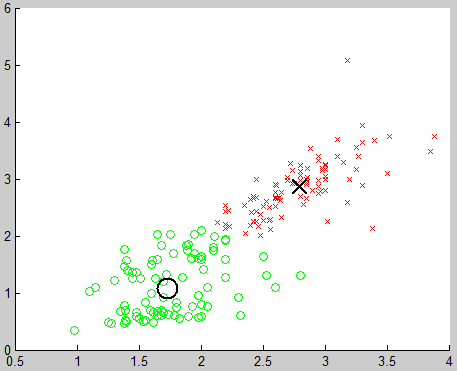
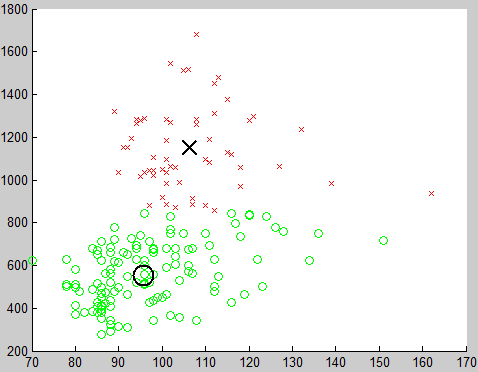
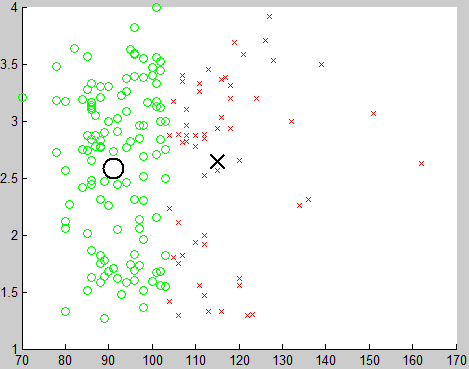
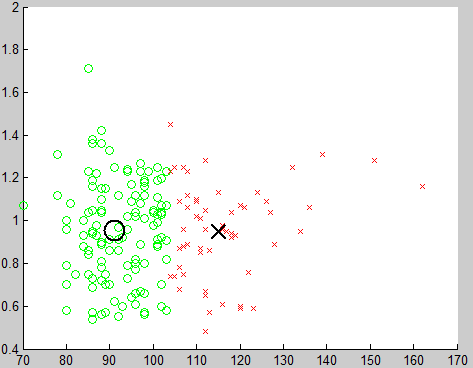
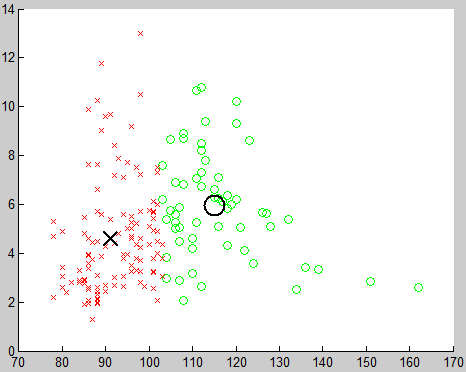
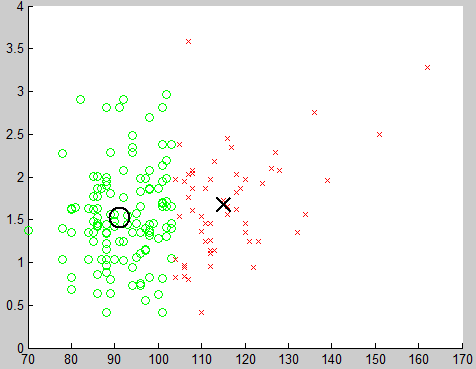
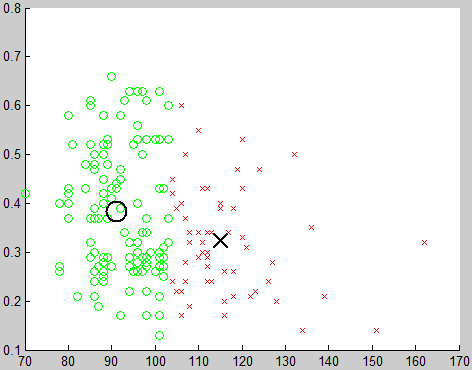
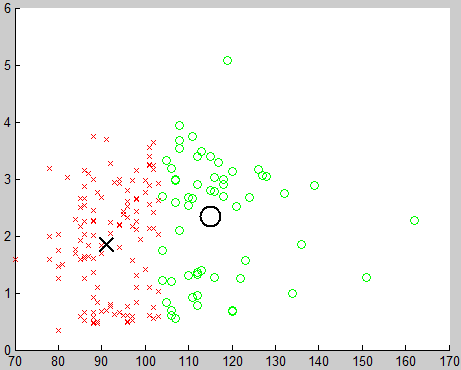
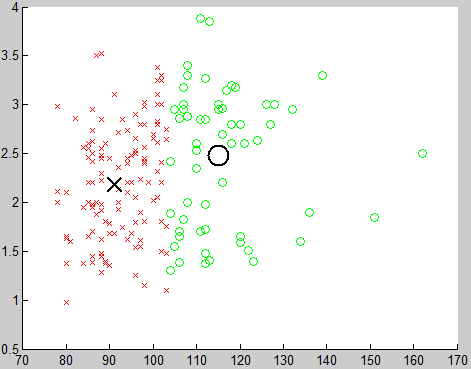
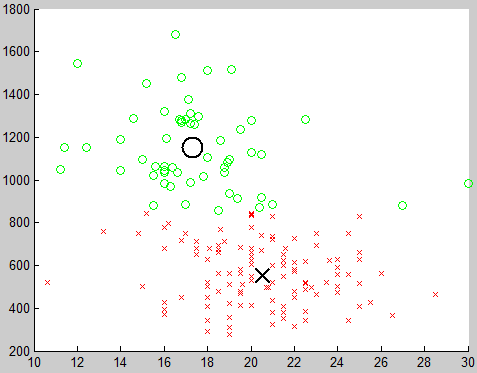
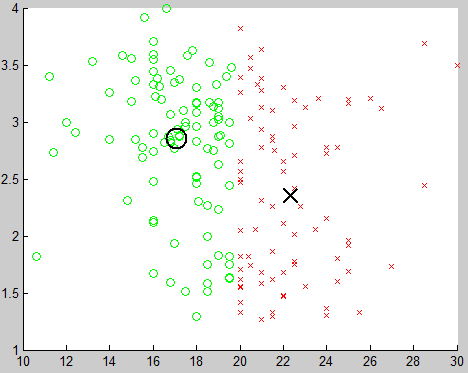
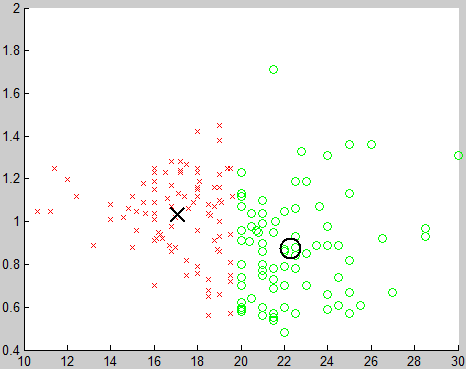
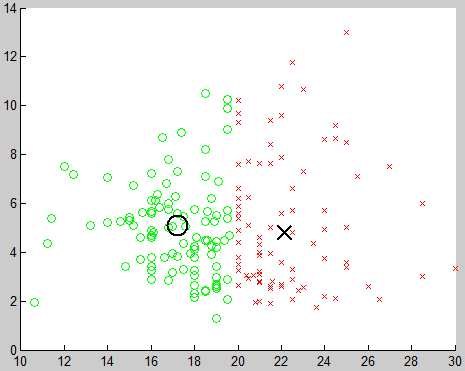
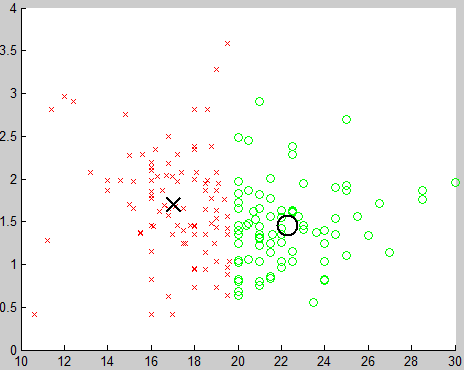
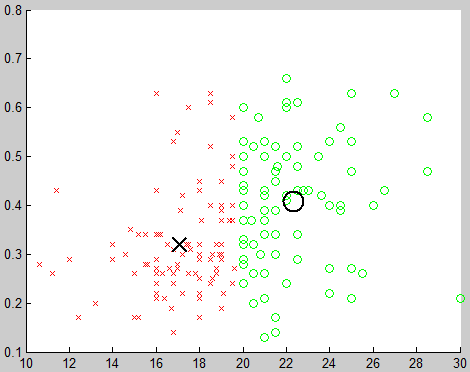
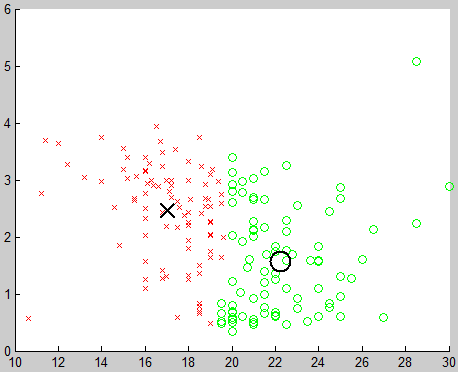
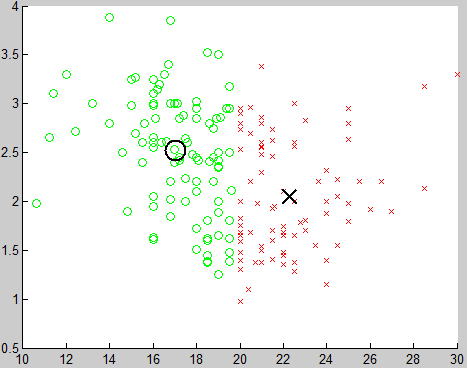
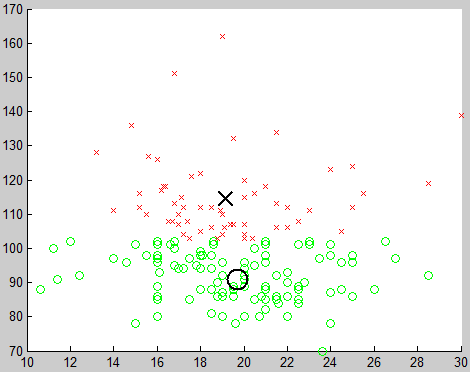
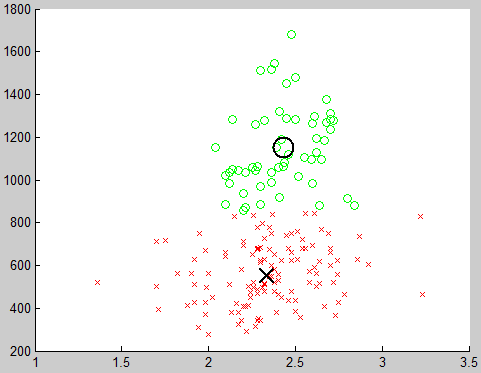
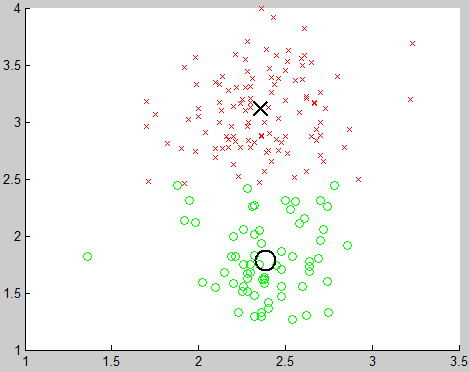
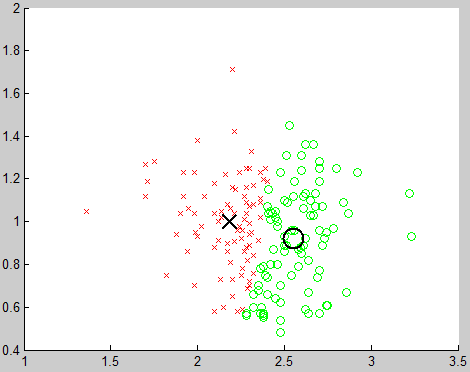
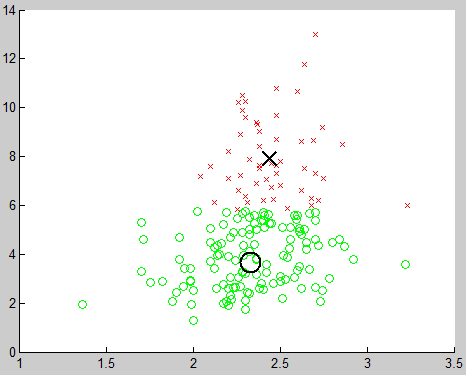
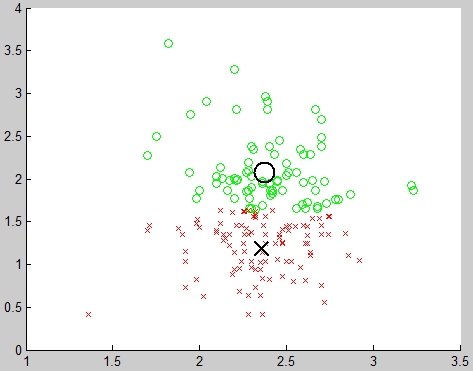
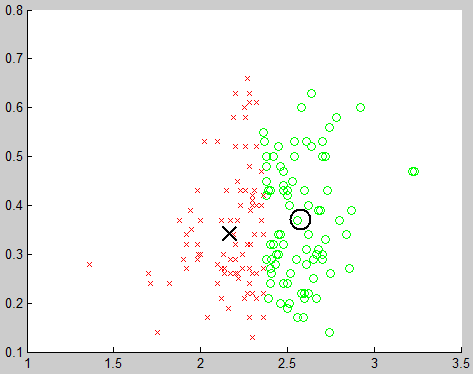
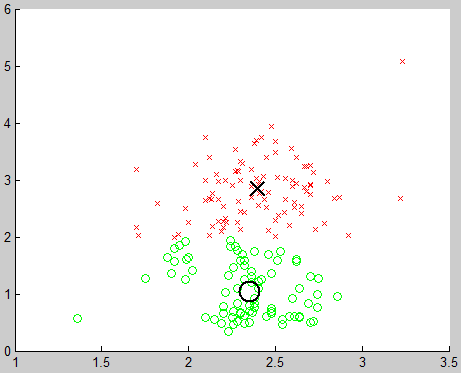
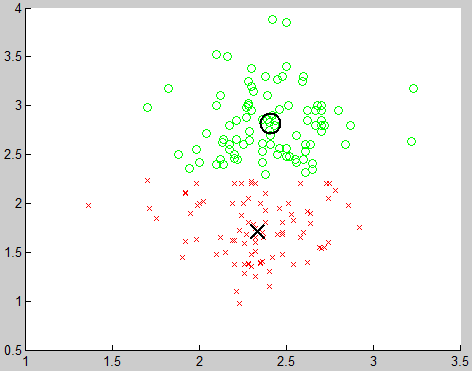
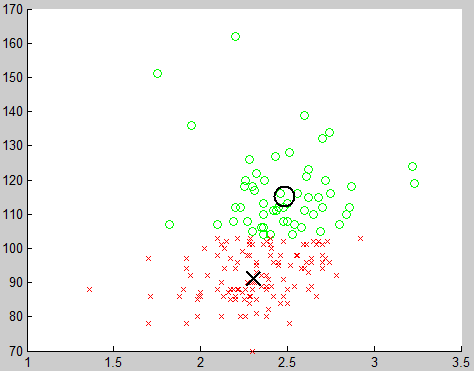
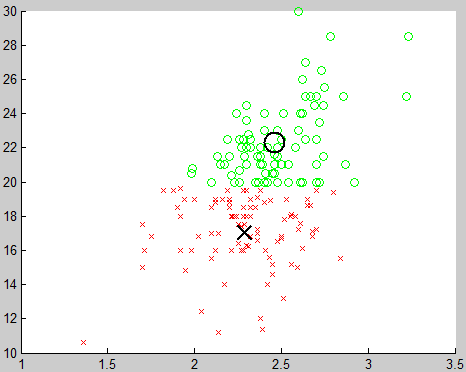
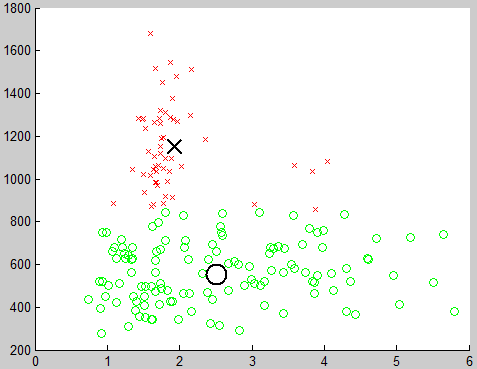
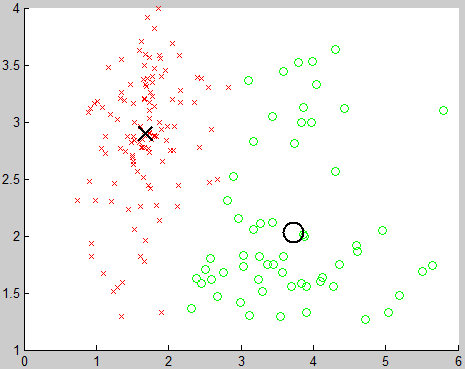
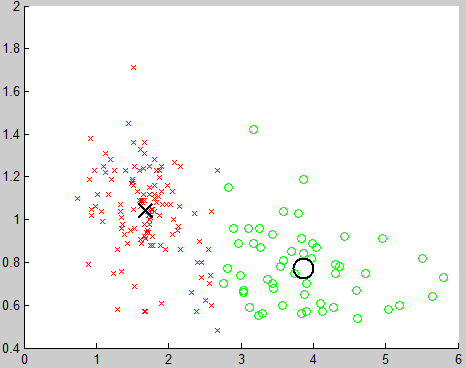
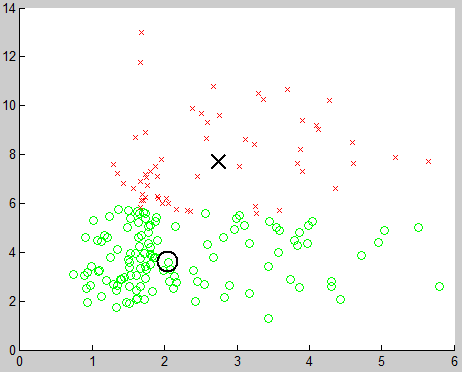
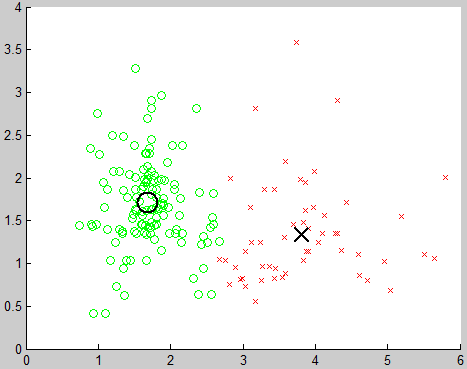
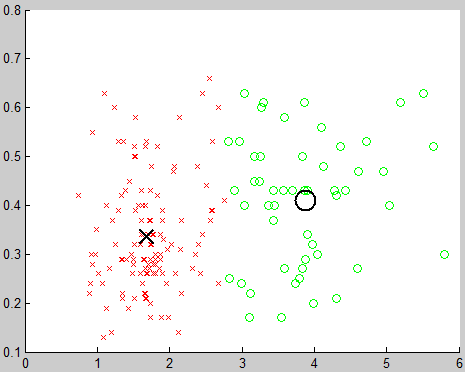
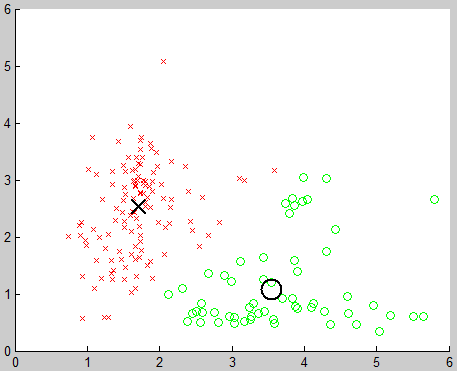
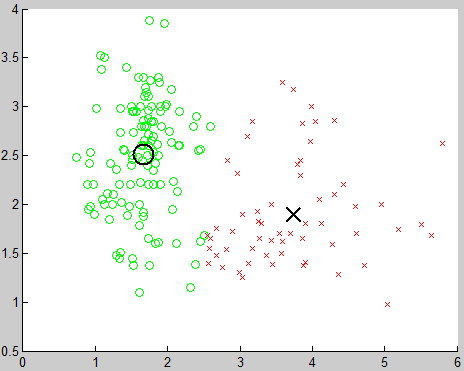
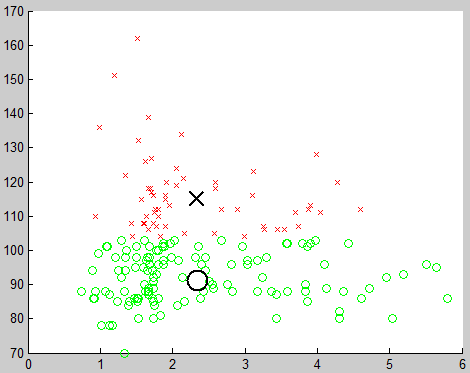
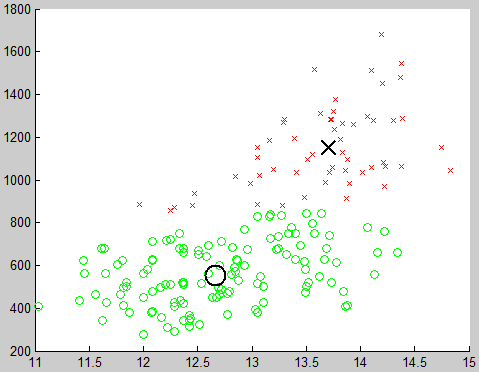
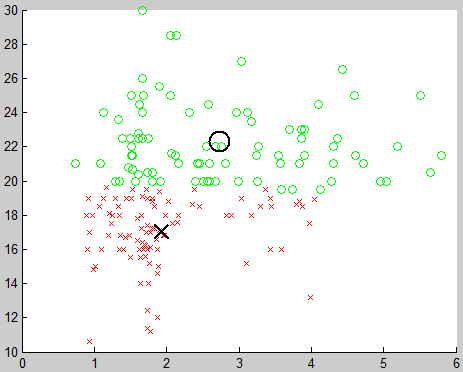
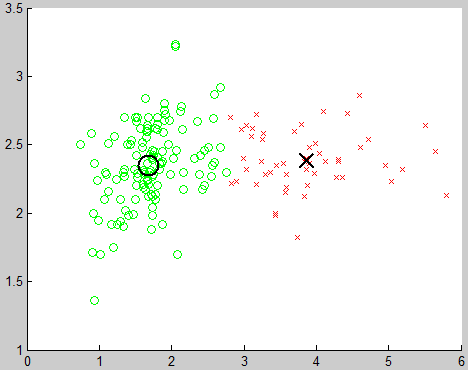
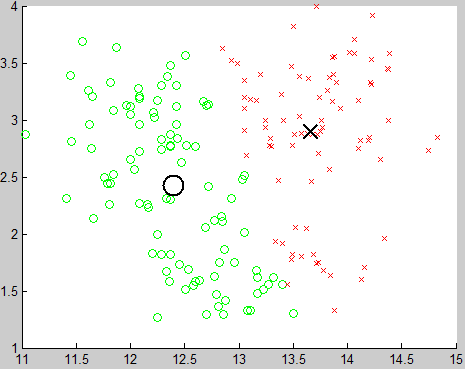
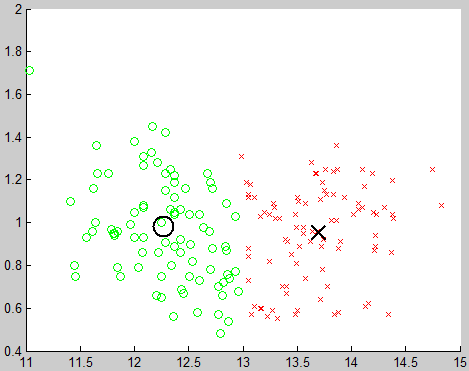
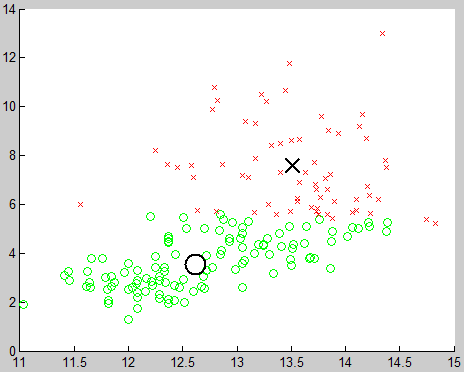
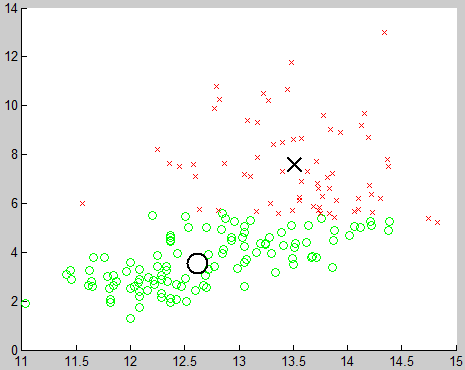
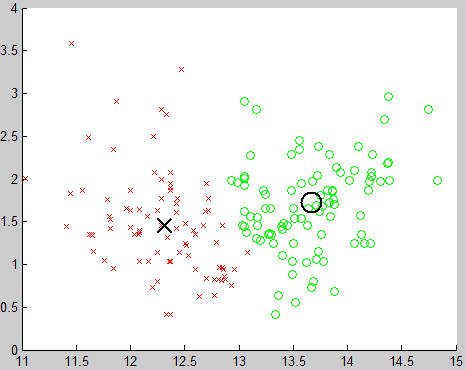
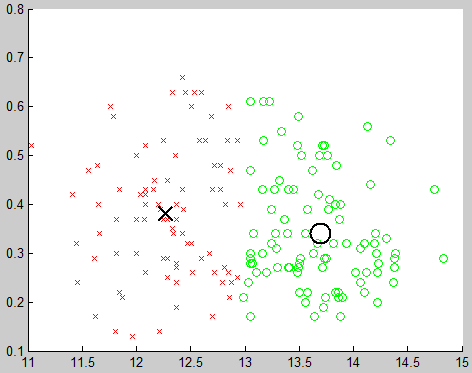
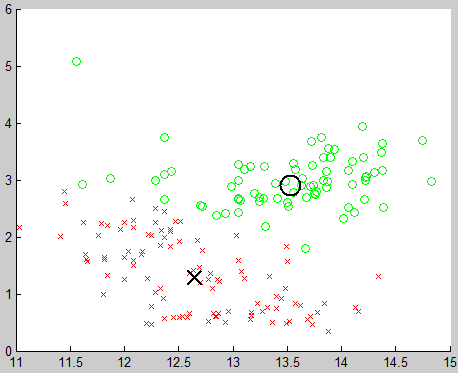
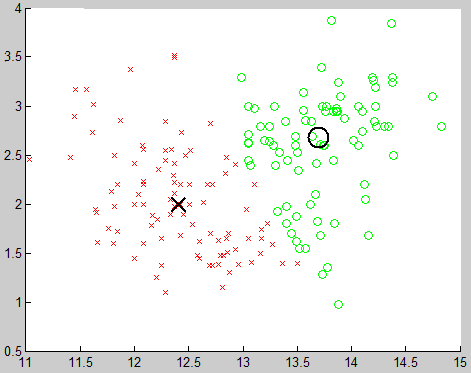
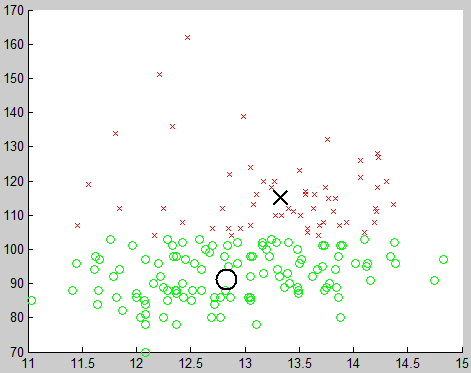
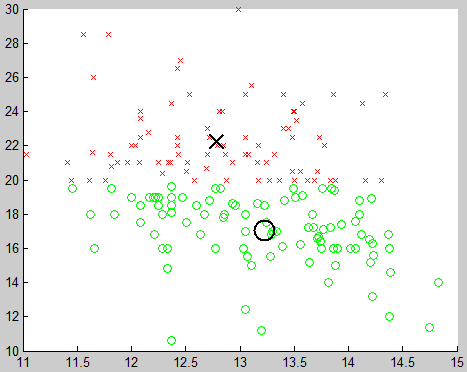
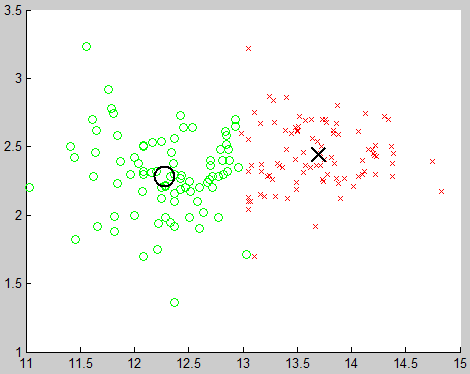
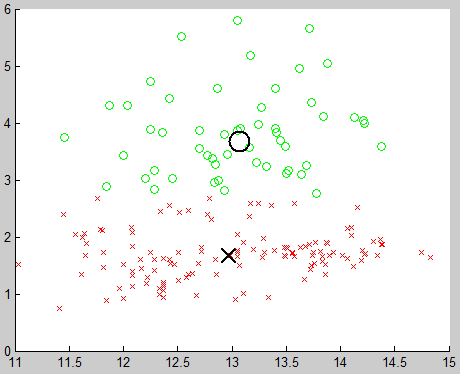
**Number of Cluster = 5**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Pair | center 1 | radius 1 | Std 1 | center 2 | radius 2 | std 2 | center 3 | radius 3 | std 3 |
| 1 | [1 2] | [13.13,3.53] | 1.2534 | 2.8097 | [13.82,1.74] | 1.0133 | 3.1787 | [12.29,1.38] | 1.2679 | 3.1064 |
| 2 | [1 3] | [12.93,2.37] | 0.862 | 1.8747 | [11.77,2.45] | 0.8083 | 1.7484 | [12.33,2.18] | 0.8231 | 1.6438 |
| 3 | [1 4] | [12.75,18.94] | 1.8747 | 7.9154 | [12.96,25.14] | 4.8585 | 7 | [12.66,21.53] | 2 | 6 |
| 4 | [1 5] | [13.06,95.86] | 5.1507 | 15.4171 | [12.65,140.24] | 21.7631 | 21.504 | [12.55,85.66] | 15.665 | 21.9328 |
| 5 | [1 6] | [14.05,2.97] | 0.9404 | 2.3284 | [12.29,1.81] | 0.7089 | 2.5656 | [13.28,2.64] | 0.7236 | 1.943 |
| 6 | [1 7] | [13.48,0.76] | 1.0431 | 2.1876 | [13.99,3.16] | 0.9254 | 2.7352 | [12.08,2.09] | 1.0575 | 3.1564 |
| 7 | [1 8] | [14.22,0.31] | 0.6147 | 0.84 | [11.71,0.36] | 0.7015 | 1.0847 | [13.62,0.34] | 0.3509 | 1.3008 |
| 8 | [1 9] | [12.39,2.03] | 1.806 | 3.1271 | [12.78,0.94] | 0.8387 | 2.0921 | [13.45,1.44] | 0.8765 | 2.6053 |
| 9 | [1 10] | [13.74,5.62] | 2.2143 | 4.3439 | [13.35,7.51] | 1.4563 | 4.0348 | [12.13,2.67] | 1.391 | 4.2486 |
| 10 | [1 11] | [11.77,1.01] | 1.0185 | 1.3111 | [12.97,0.79] | 0.5157 | 1.6723 | [13.58,0.96] | 0.4869 | 1.6544 |
| 11 | [1 12] | [12.05,2.99] | 1.0314 | 3.1201 | [13.24,3.00] | 0.7362 | 2.3388 | [13.50,1.73] | 0.874 | 1.8582 |
| 12 | [1 13] | [13.15,814.63] | 122.3743 | 318.5531 | [12.44,420.71] | 142.7103 | 444.1256 | [13.89,1342.12] | 337.8835 | 435.9695 |
| 13 | [2 3] | [3.81,2.35] | 0.5867 | 2 | [5.09,2.41] | 0.7688 | 1.4388 | [1.26,2.12] | 0.8255 | 1.7647 |
| 14 | [2 4] | [1.84,12.42] | 2.2862 | 3.6327 | [1.71,16.58] | 2.4454 | 6.636 | [2.12,19.41] | 2.1069 | 8.6675 |
| 15 | [2 5] | [2.29,118.04] | 10.0992 | 21.819 | [2.45,105.03] | 6.1756 | 20.4296 | [1.56,140.28] | 21.7158 | 21.4911 |
| 16 | [2 6] | [3.21,1.69] | 1.1563 | 3.1921 | [1.73,3.05] | 0.8327 | 2.0162 | [1.75,2.52] | 0.8865 | 2.0252 |
| 17 | [2 7] | [2.99,0.79] | 0.9601 | 2.7672 | [1.73,3.01] | 2.0951 | 3.6144 | [4.57,0.74] | 1.0906 | 2.2278 |
| 18 | [2 8] | [1.19,0.33] | 0.4562 | 1.2187 | [1.76,0.32] | 0.4524 | 1.5273 | [3.83,0.38] | 0.5971 | 1.5766 |
| 19 | [2 9] | [1.66,2.25] | 1.6076 | 2.7042 | [3.14,1.06] | 0.9776 | 2.7591 | [1.38,1.30] | 0.9809 | 2.15 |
| 20 | [2 10] | [1.79,5.99] | 1.9508 | 5.7802 | [3.44,2.82] | 2.3673 | 3.9849 | [3.47,5.17] | 2.1701 | 4.4006 |
| 21 | [2 11] | [1.76,1.06] | 0.499 | 1.7865 | [1.20,1.09] | 0.6929 | 1.5416 | [2.71,0.80] | 0.7735 | 1.8078 |
| 22 | [2 12] | [3.30,1.89] | 1.7035 | 4.1391 | [1.84,3.38] | 1.2582 | 2.3222 | [1.62,2.83] | 0.8116 | 2.5225 |
| 23 | [2 13] | [2.26,420.72] | 142.7249 | 444.3159 | [1.78,1342.12] | 337.8825 | 435.9686 | [2.62,814.65] | 122.3504 | 305.9863 |
| 24 | [3 4] | [2.29,16.33] | 1.7397 | 4.7699 | [2.68,25.26] | 4.7441 | 6.2197 | [2.31,19.05] | 1.2693 | 5.3451 |
| 25 | [3 5] | [2.42,104.86] | 6.1405 | 19.1571 | [2.22,85.68] | 15.6815 | 21.0566 | [2.33,140.18] | 21.8246 | 21.4078 |
| 26 | [3 6] | [2.30,1.46] | 0.6777 | 1.3836 | [2.58,2.76] | 0.7726 | 1.7255 | [2.18,2.46] | 0.951 | 1.5213 |
| 27 | [3 7] | [2.49,2.83] | 0.7491 | 1.795 | [2.23,2.21] | 0.7176 | 1.7654 | [2.40,0.67] | 1.0446 | 1.545 |
| 28 | [3 8] | [2.33,0.48] | 0.2373 | 0.6826 | [1.90,0.31] | 0.5458 | 0.6272 | [2.51,0.28] | 0.2697 | 0.6955 |
| 29 | [3 9] | [2.34,2.00] | 0.6996 | 1.5994 | [2.19,1.42] | 0.4902 | 1.4287 | [2.30,2.82] | 0.9004 | 1.3351 |
| 30 | [3 10] | [2.43,7.52] | 1.185 | 2.8945 | [2.42,10.10] | 2.9155 | 3.2673 | [2.42,5.51] | 0.9484 | 2.9756 |
| 31 | [3 11] | [2.32,0.68] | 0.3428 | 0.8441 | [2.61,0.85] | 0.6285 | 0.8987 | [1.94,1.09] | 0.5782 | 0.9012 |
| 32 | [3 12] | [2.36,1.58] | 1.0334 | 1.5403 | [2.52,2.86] | 0.7752 | 1.3802 | [2.45,2.14] | 0.5287 | 1.385 |
| 33 | [3 13] | [2.42,800.35] | 119.6472 | 323.108 | [2.50,1341.35] | 338.6489 | 434.9401 | [2.36,1063.32] | 131.6851 | 280.5719 |
| 34 | [4 5] | [19.71,139.54] | 22.4723 | 26.1345 | [20.41,85.70] | 16.0227 | 29.8266 | [19.22,104.61] | 7.7335 | 25.1587 |
| 35 | [4 6] | [12.24,2.86] | 2.0308 | 3.2788 | [16.38,2.68] | 1.7933 | 5.6137 | [19.08,2.19] | 1.5233 | 6.8681 |
| 36 | [4 7] | [18.97,2.05] | 2.0804 | 7.7994 | [25.05,1.58] | 5.1215 | 7.4789 | [12.53,3.04] | 3.1374 | 3.7566 |
| 37 | [4 8] | [19.07,0.36] | 1.2738 | 4.9735 | [21.65,0.41] | 1.3495 | 4.5574 | [12.14,0.28] | 1.8635 | 2.9843 |
| 38 | [4 9] | [21.63,1.43] | 1.6035 | 5.358 | [16.39,1.75] | 1.8838 | 5.5271 | [25.25,1.51] | 4.7685 | 6.6562 |
| 39 | [4 10] | [18.28,4.18] | 2.9316 | 10.2644 | [24.94,4.21] | 5.1284 | 9.4897 | [21.09,8.97] | 5.6129 | 12.32 |
| 40 | [4 11] | [21.64,0.84] | 1.4057 | 4.7725 | [19.06,0.96] | 1.2679 | 5.3161 | [12.14,1.10] | 1.8644 | 2.9966 |
| 41 | [4 12] | [19.07,2.63] | 1.7098 | 6.9348 | [25.21,2.35] | 4.925 | 7.2461 | [16.40,3.01] | 1.887 | 5.9896 |
| 42 | [4 13] | [17.17,1341.62] | 338.385 | 435.4147 | [19.31,805.38] | 114.6303 | 313.3992 | [20.82,614.84] | 95.3904 | 342.2373 |
| 43 | [5 6] | [117.97,2.55] | 10.0368 | 21.4928 | [95.91,2.24] | 4.9825 | 14.3204 | [85.67,2.12] | 15.6747 | 21.6421 |
| 44 | [5 7] | [117.92,2.50] | 10.0957 | 22.1579 | [95.91,1.87] | 5.2335 | 15.6195 | [104.87,2.18] | 6.3273 | 20.7928 |
| 45 | [5 8] | [85.68,0.39] | 15.6847 | 20.9012 | [95.91,0.38] | 4.9075 | 13.6347 | [117.95,0.32] | 10.0511 | 21.0112 |
| 46 | [5 9] | [140.20,2.21] | 21.8309 | 21.4582 | [104.86,1.63] | 6.1503 | 19.7101 | [117.94,1.69] | 10.0686 | 21.1969 |
| 47 | [5 10] | [95.17,5.11] | 8.3826 | 19.1478 | [103.87,5.21] | 6.4595 | 20.7672 | [139.26,3.50] | 22.7617 | 20.7913 |
| 48 | [5 11] | [104.98,0.98] | 6.0212 | 19.2709 | [140.31,1.16] | 21.6904 | 21.4876 | [95.95,0.94] | 4.9642 | 13.7126 |
| 49 | [5 12] | [95.92,2.60] | 4.9968 | 15.0784 | [85.68,2.59] | 15.6909 | 21.8119 | [104.91,2.55] | 6.1668 | 19.9178 |
| 50 | [5 13] | [105.20,1061.83] | 137.1466 | 293.5173 | [109.38,790.86] | 129.4769 | 334.6036 | [95.69,602.36] | 94.0429 | 403.7972 |
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| 52 | [6 8] | [1.46,0.42] | 0.4794 | 1.1699 | [2.88,0.31] | 0.2515 | 0.79 | [3.34,0.25] | 0.5484 | 0.727 |
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| 55 | [6 11] | [2.64,1.03] | 0.4877 | 1.447 | [1.74,0.80] | 0.4456 | 1.0794 | [1.41,0.70] | 0.4459 | 0.8704 |
| 56 | [6 12] | [2.85,3.43] | 1.0007 | 1.9533 | [1.62,1.60] | 0.6976 | 1.9493 | [2.25,2.97] | 0.7041 | 2.097 |
| 57 | [6 13] | [2.22,814.65] | 122.348 | 305.9322 | [2.79,1066.17] | 128.835 | 262.8755 | [2.20,420.72] | 142.7175 | 444.1772 |
| 58 | [7 8] | [3.49,0.28] | 1.5973 | 1.2654 | [1.46,0.39] | 0.4632 | 1.3936 | [2.20,0.32] | 0.3653 | 1.1298 |
| 59 | [7 9] | [2.85,1.84] | 0.8128 | 1.8156 | [3.28,2.31] | 1.8552 | 2.8294 | [0.68,1.02] | 0.864 | 2.239 |
| 60 | [7 10] | [3.17,6.38] | 2.5512 | 4.5645 | [0.76,5.45] | 2.0551 | 4.3315 | [2.62,4.44] | 1.4139 | 4.1628 |
| 61 | [7 11] | [2.80,1.06] | 0.4034 | 1.5333 | [1.45,0.94] | 0.472 | 1.5186 | [2.16,1.07] | 0.6451 | 1.3949 |
| 62 | [7 12] | [2.18,3.04] | 0.8767 | 2.2799 | [3.33,2.94] | 1.9016 | 2.0522 | [0.74,1.69] | 0.9195 | 2.3389 |
| 63 | [7 13] | [2.00,420.70] | 142.7 | 444.2286 | [1.32,621.33] | 92.6796 | 289.6404 | [2.91,1066.16] | 128.8449 | 262.8584 |
| 64 | [8 9] | [0.45,0.82] | 0.4462 | 1.2333 | [0.37,1.34] | 0.3286 | 0.9606 | [0.32,2.86] | 0.7214 | 0.8625 |
| 65 | [8 10] | [0.37,2.59] | 1.3102 | 2.8186 | [0.39,7.55] | 1.1506 | 2.832 | [0.34,5.55] | 0.8319 | 2.5593 |
| 66 | [8 11] | [0.50,0.92] | 0.174 | 0.5564 | [0.29,1.07] | 0.1779 | 0.5262 | [0.33,1.25] | 0.4927 | 0.7409 |
| 67 | [8 12] | [0.31,3.16] | 0.3748 | 0.7986 | [0.27,3.55] | 0.4523 | 0.7375 | [0.45,2.16] | 0.3677 | 0.9206 |
| 68 | [8 13] | [0.41,566.01] | 83.9923 | 307.1318 | [0.37,396.66] | 118.6624 | 297.4696 | [0.39,751.04] | 134.9569 | 413.0292 |
| 69 | [9 10] | [1.62,2.60] | 1.9796 | 4.7678 | [1.43,4.10] | 1.3187 | 3.7117 | [1.52,7.47] | 1.4428 | 3.8208 |
| 70 | [9 11] | [1.52,1.09] | 0.6065 | 1.4039 | [1.31,0.71] | 0.3086 | 0.9928 | [0.82,0.81] | 0.6072 | 1.2947 |
| 71 | [9 12] | [2.61,2.94] | 0.9845 | 1.8719 | [1.54,2.87] | 0.7887 | 2.8535 | [0.85,1.87] | 0.6542 | 1.9953 |
| 72 | [9 13] | [1.89,1342.12] | 337.8816 | 435.9732 | [1.88,1066.17] | 128.8333 | 262.8932 | [1.61,814.67] | 122.3447 | 305.9159 |
| 73 | [10 11] | [7.57,0.80] | 1.2115 | 3.0547 | [2.60,1.05] | 1.3206 | 3.1442 | [10.13,0.64] | 2.8738 | 3.2438 |
| 74 | [10 12] | [10.10,1.65] | 2.9129 | 3.0306 | [7.61,1.93] | 1.739 | 3.9003 | [4.20,2.63] | 1.5644 | 4.8165 |
| 75 | [10 13] | [3.77,420.46] | 142.4668 | 444.8939 | [5.17,1066.02] | 128.9836 | 262.8283 | [5.52,620.82] | 93.1891 | 292.4178 |
| 76 | [11 12] | [1.11,2.78] | 0.6037 | 1.299 | [1.02,3.16] | 0.3615 | 1.0249 | [0.95,2.14] | 0.5572 | 1.3128 |
| 77 | [11 13] | [1.05,1066.15] | 128.8505 | 262.8393 | [0.85,621.31] | 92.6896 | 289.5742 | [1.11,1342.11] | 337.8866 | 435.9623 |
| 78 | [12 13] | [2.61,420.71] | 142.7131 | 444.1175 | [3.01,1342.12] | 337.8828 | 435.9696 | [2.60,814.64] | 122.3622 | 318.5791 |

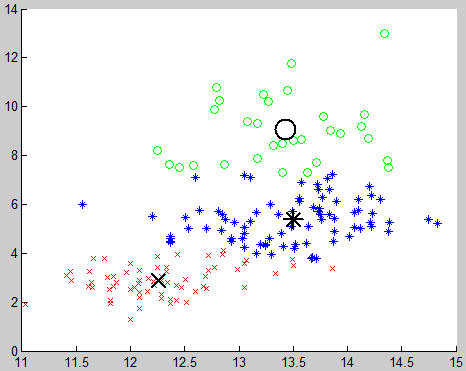
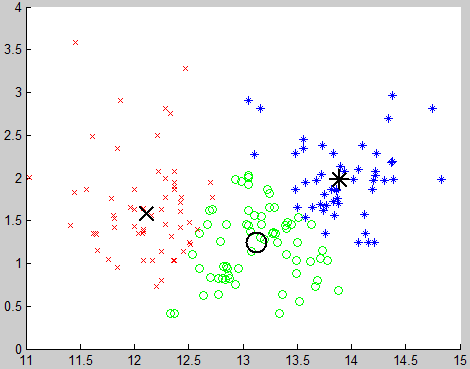
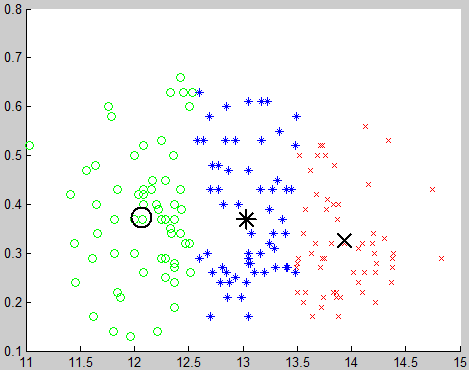
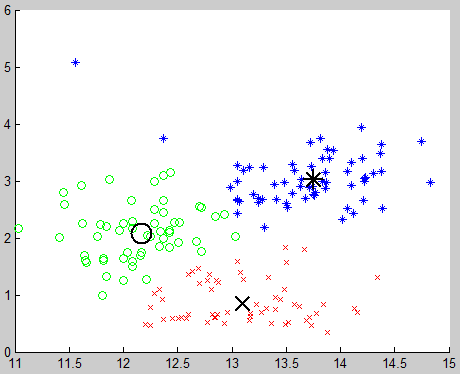
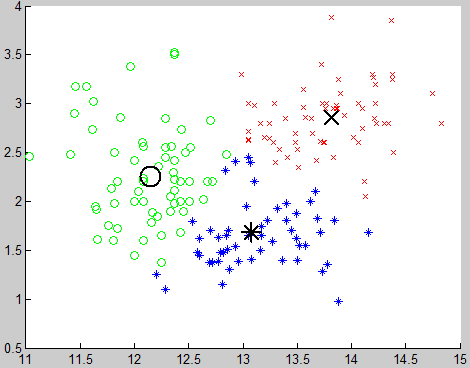
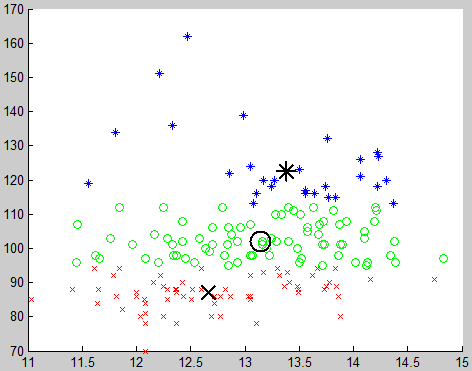
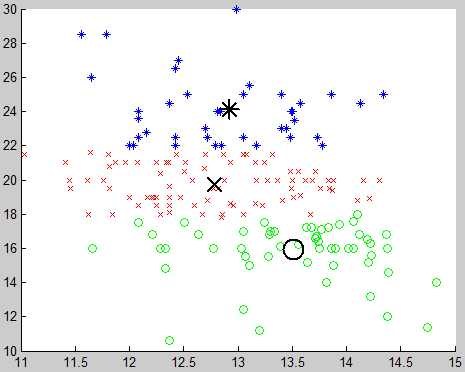
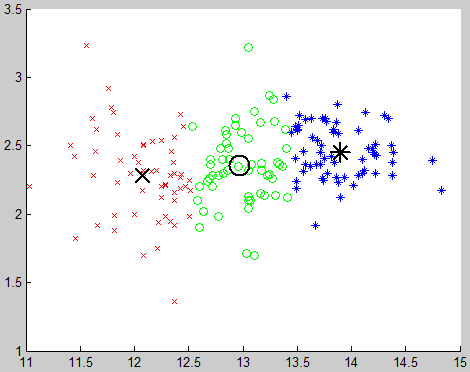
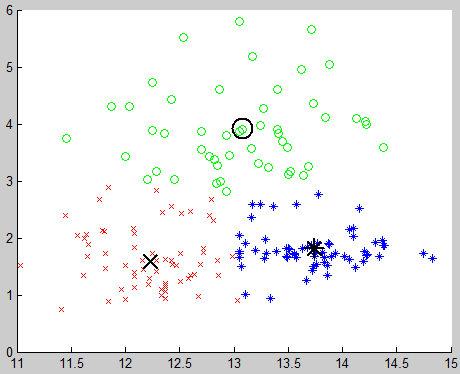
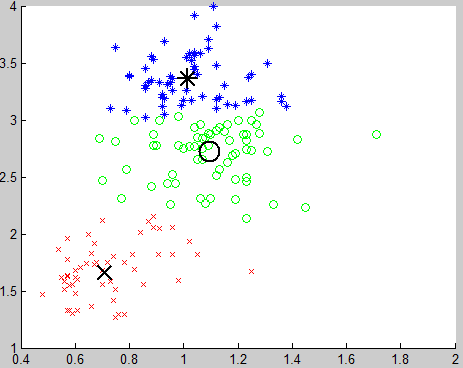
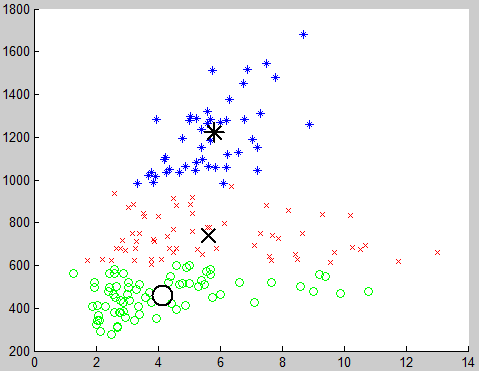
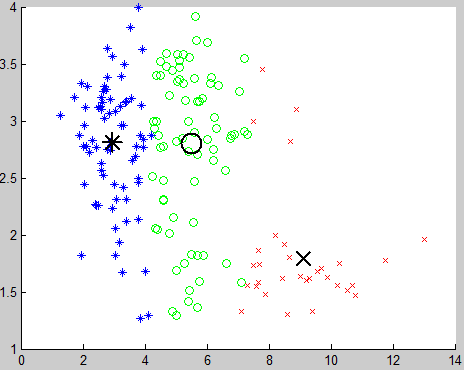
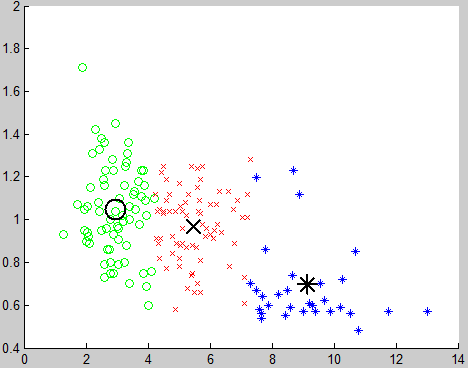
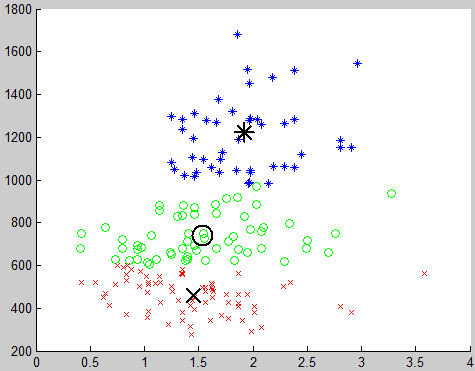
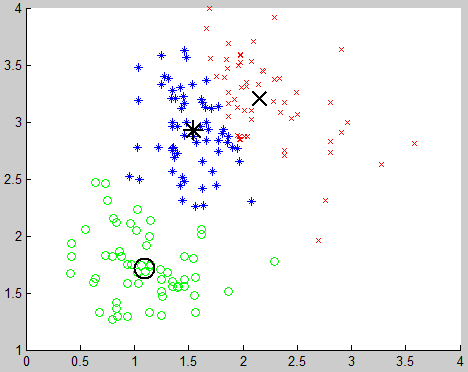
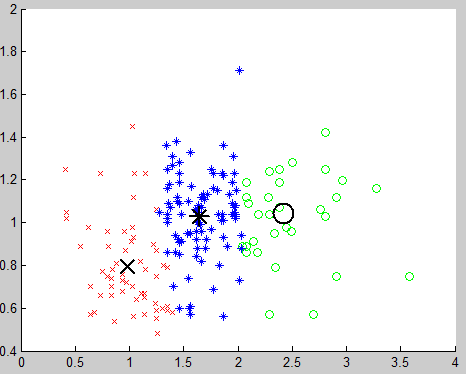
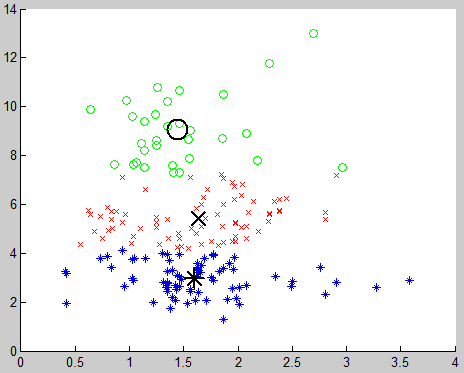
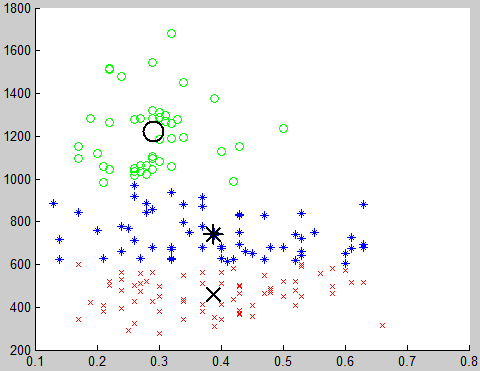
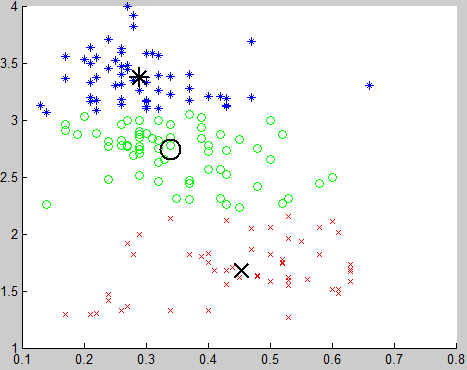
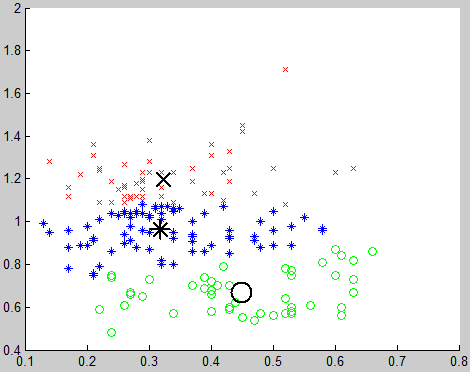
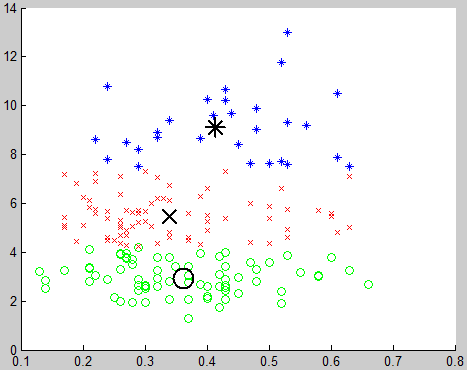
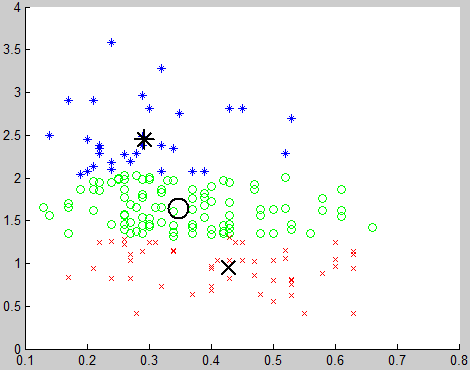
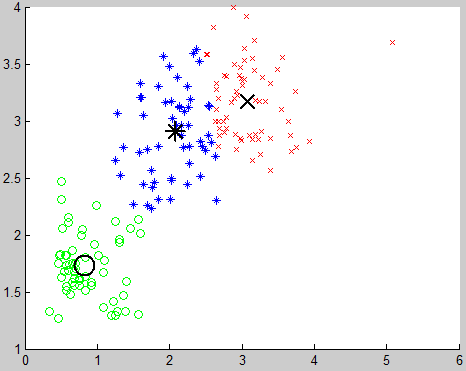
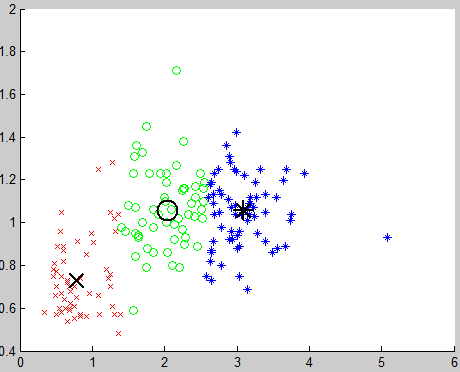
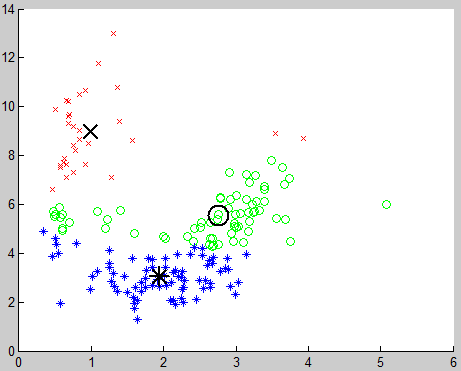
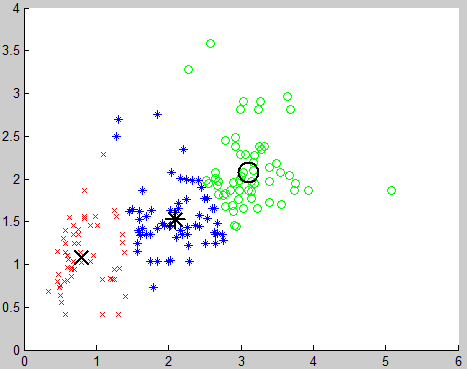
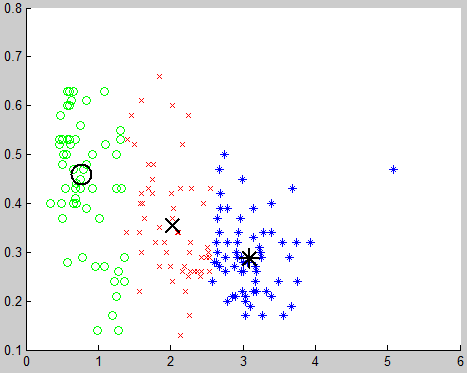
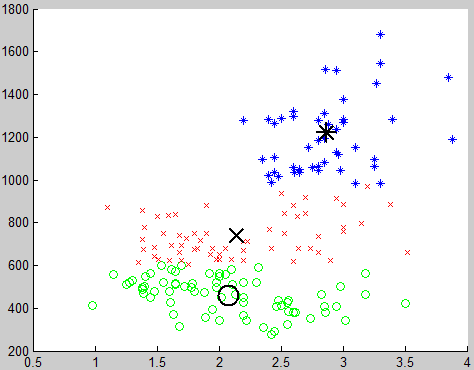
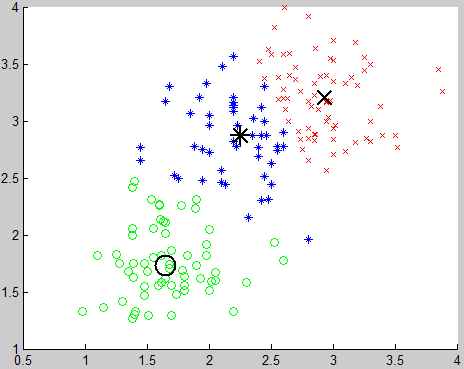
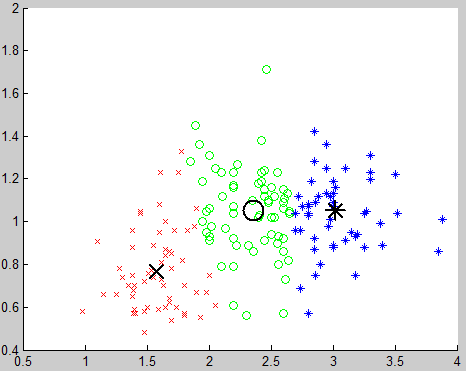
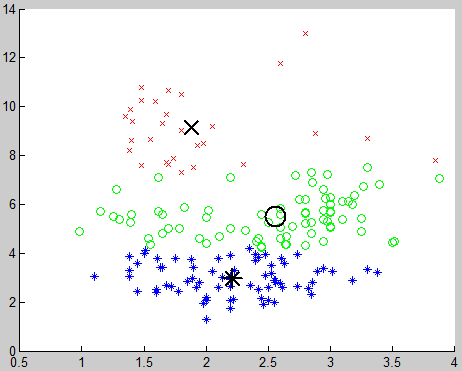
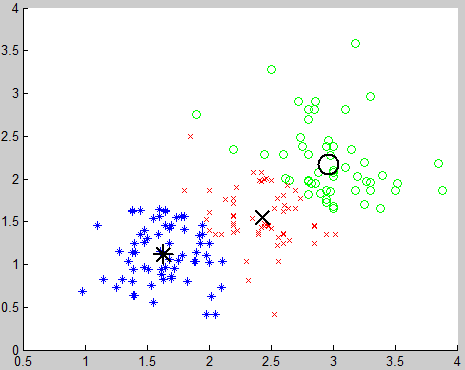
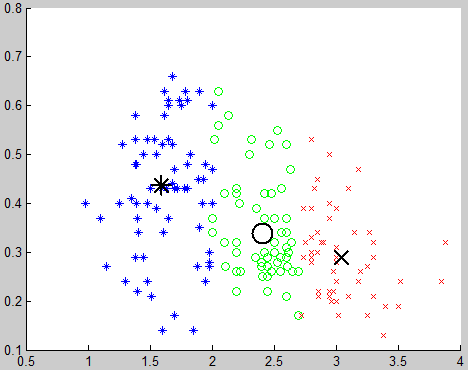
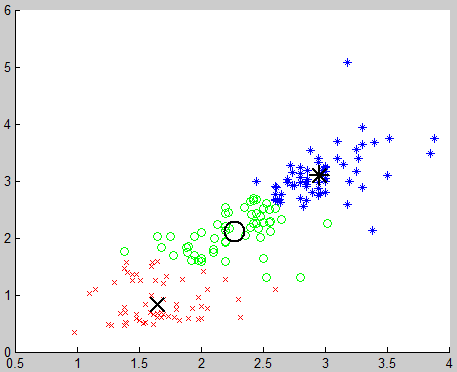
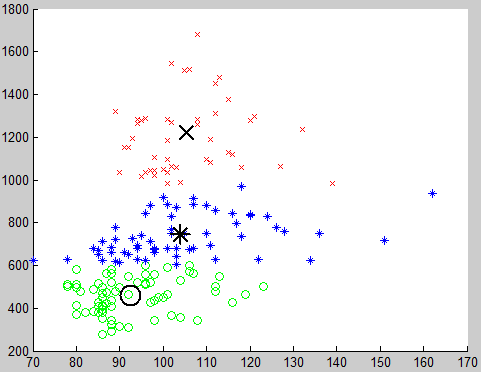
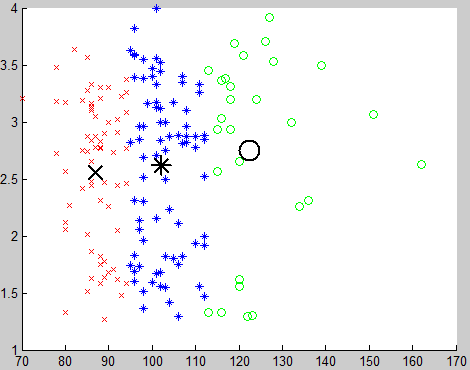
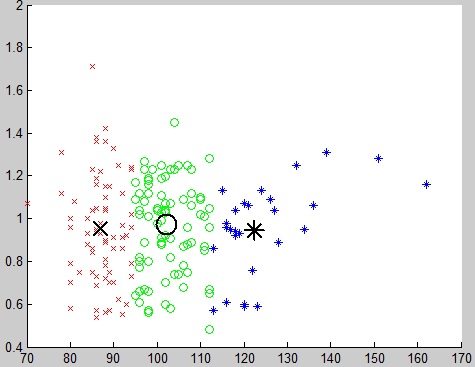
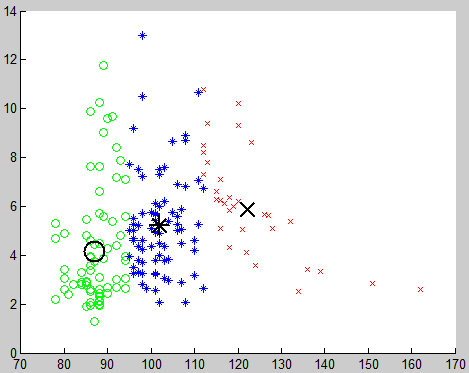
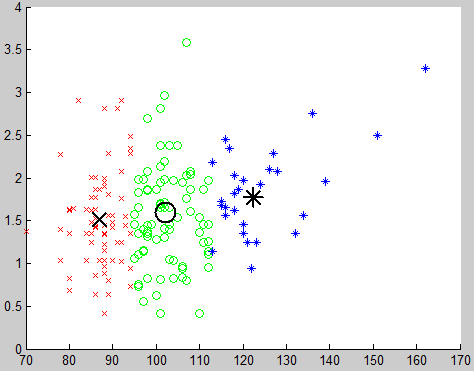
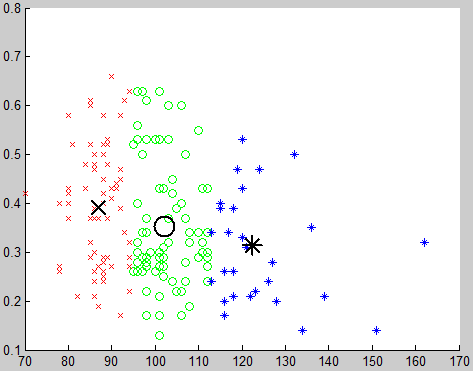
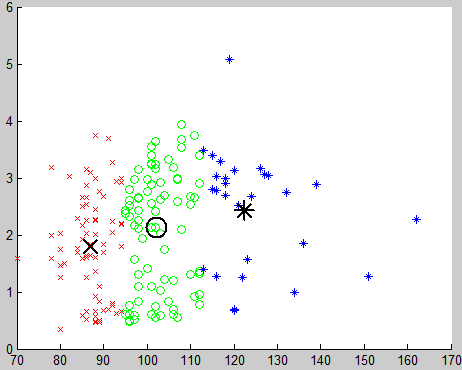
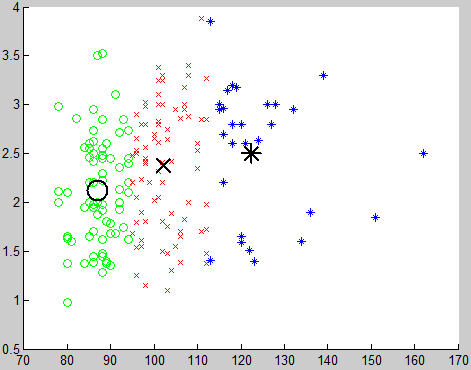
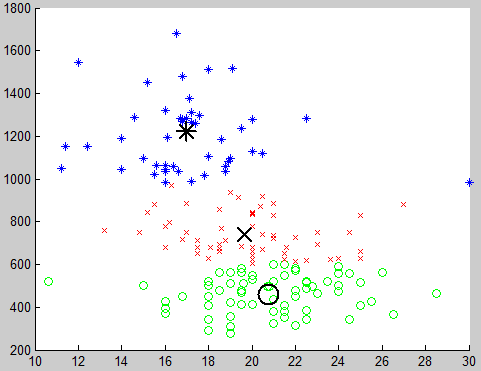
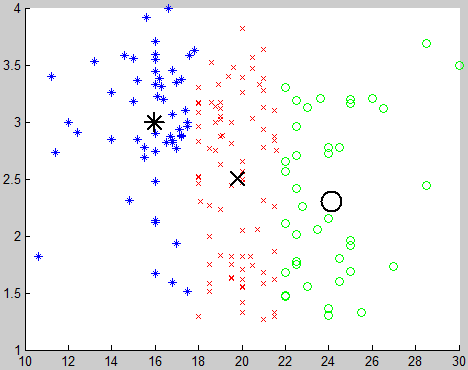
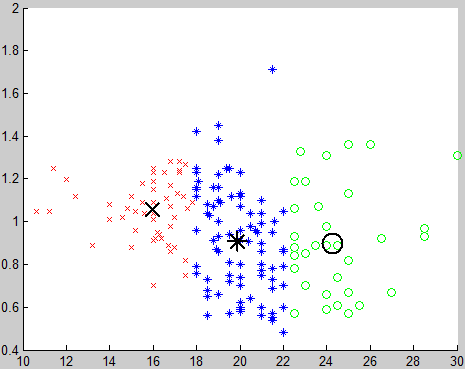
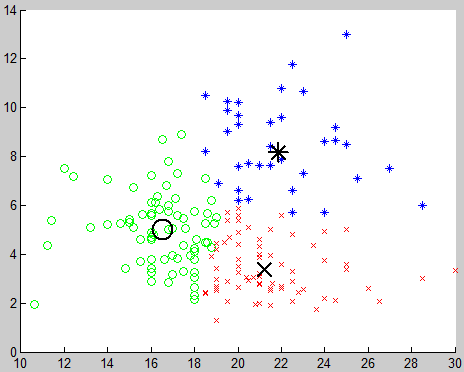
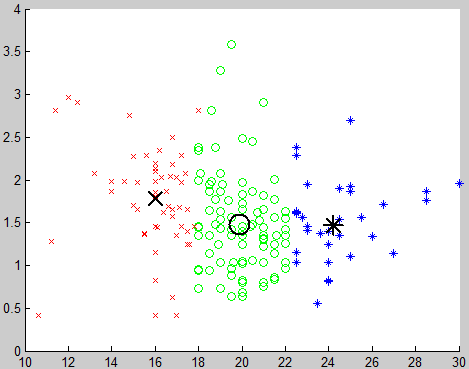
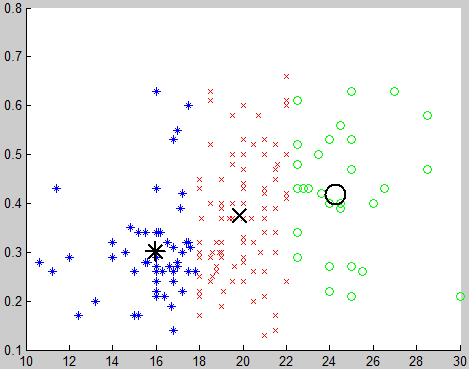
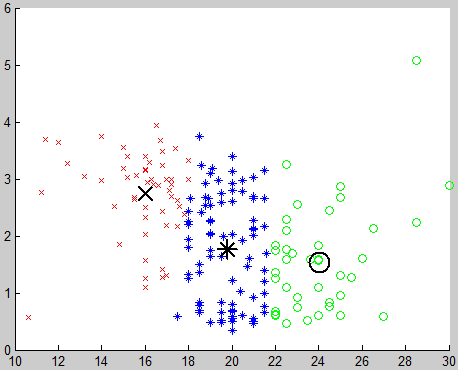
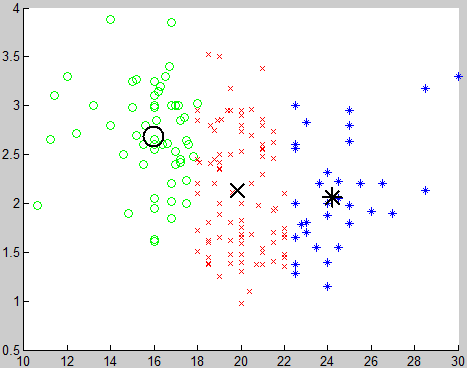
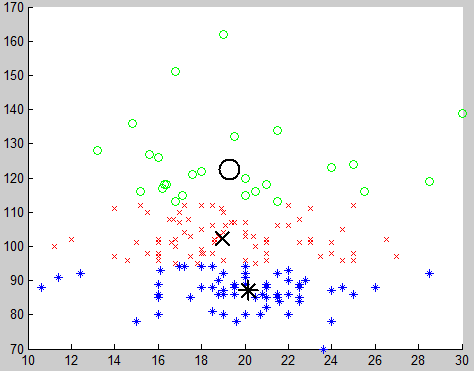
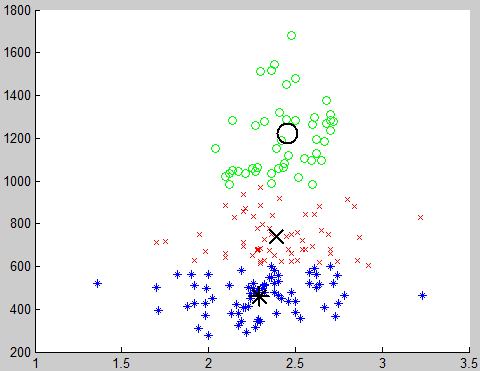
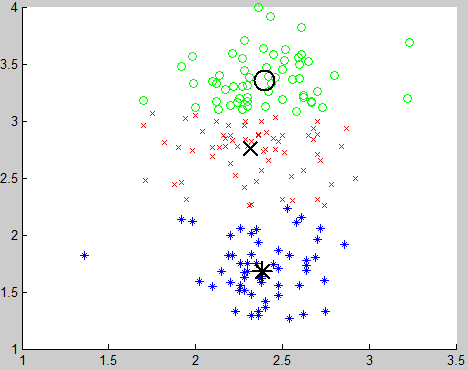
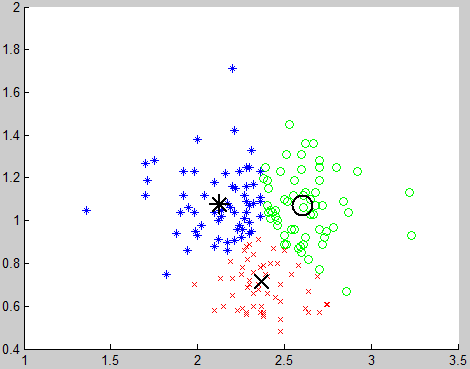
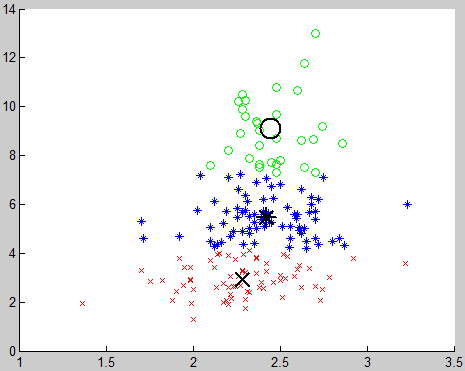
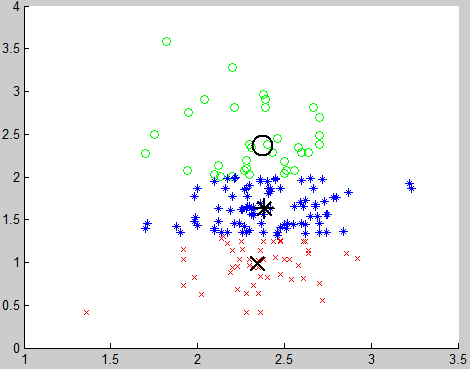
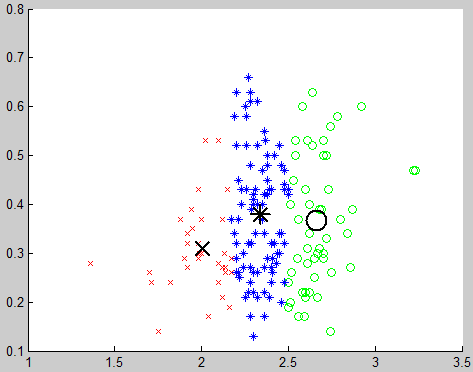
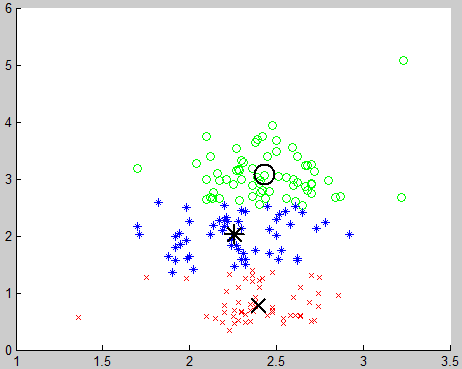
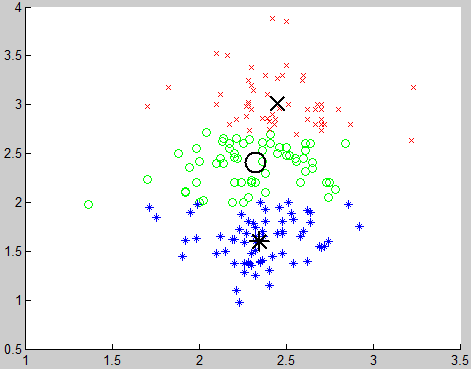
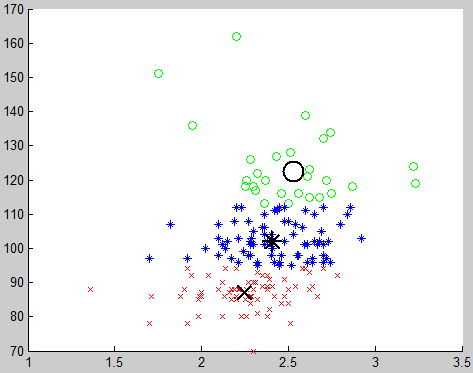
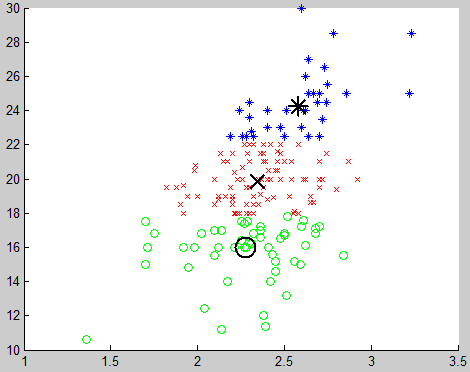
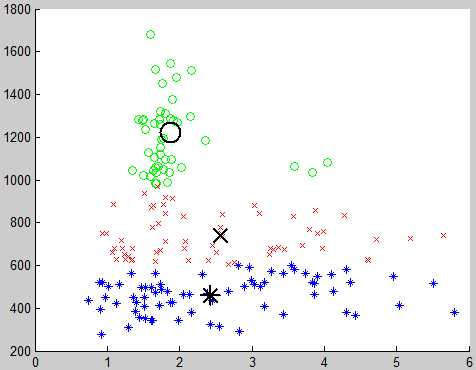
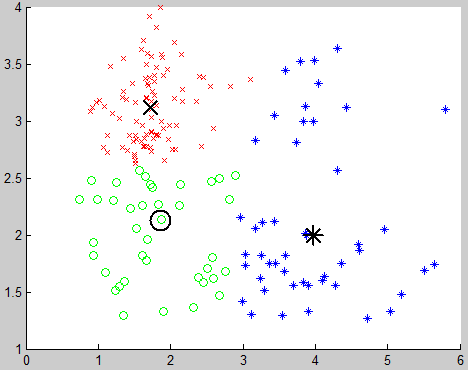
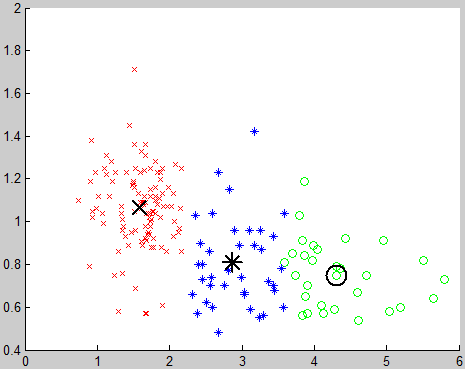
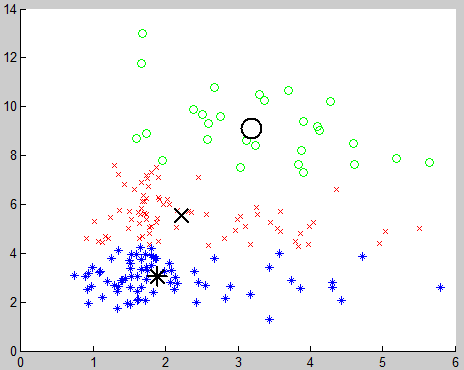
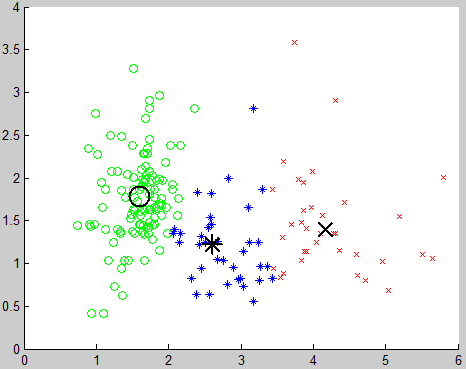
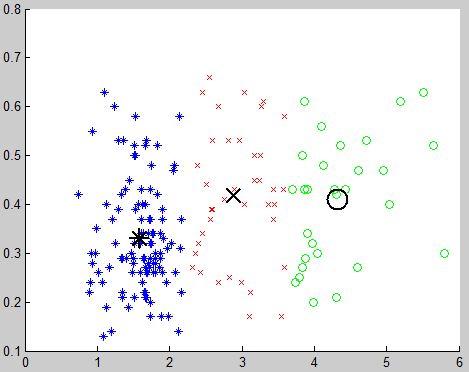
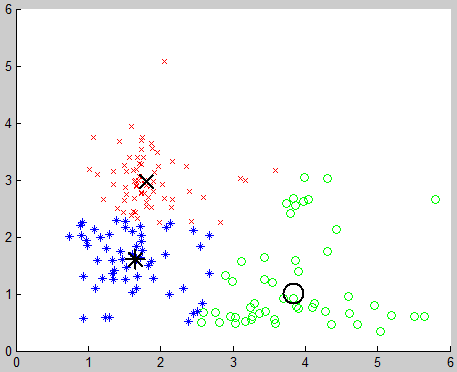
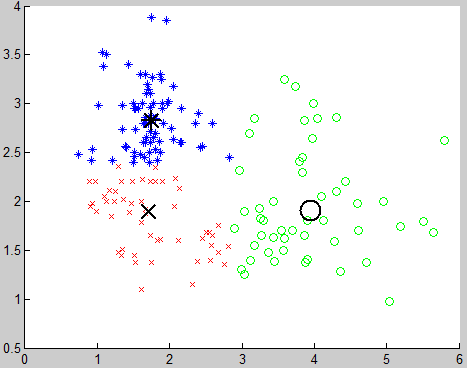
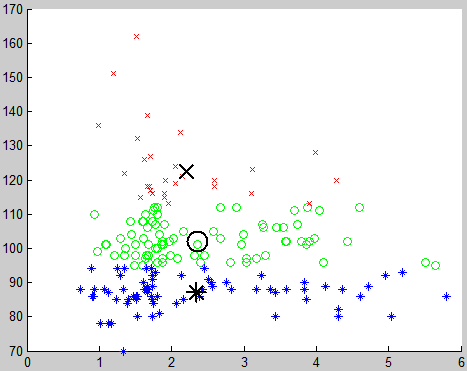
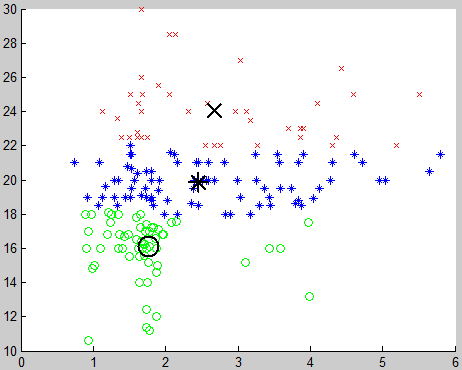
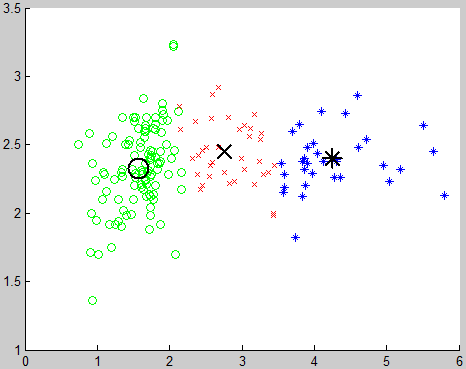
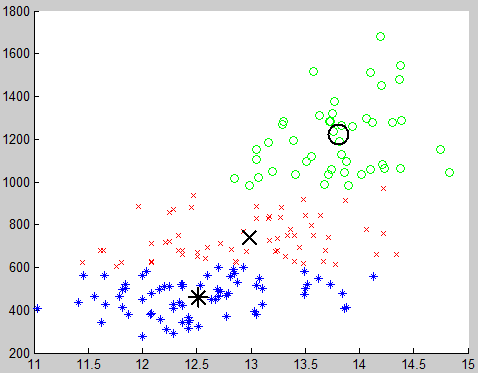
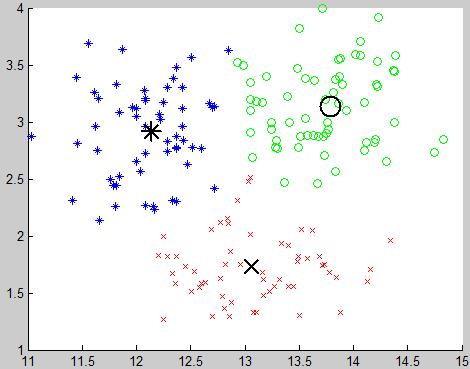
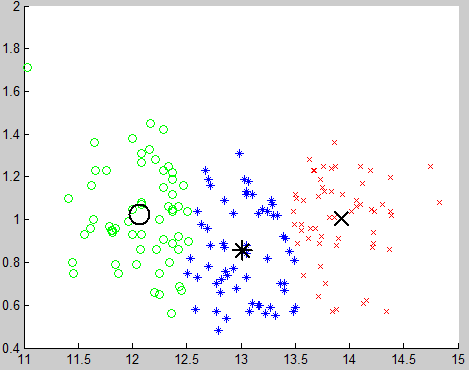
|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Pair | center 4 | radius 4 | std 4 | center 5 | radius 5 | std 5 | avg radius | avgstd |
| 1 | [1 2] | [12.38,2.48] | 1.555 | 3.3486 | [13.27,4.76] | 1.4729 | 3.4402 | 1.3125 | 3.17672 |
| 2 | [1 3] | [13.59,2.49] | 0.5768 | 1.717 | [14.18,2.43] | 0.6944 | 1.124 | 0.75292 | 1.62158 |
| 3 | [1 4] | [13.76,12.38] | 2 | 4 | [13.55,16.39] | 2 | 6 | 2.53348 | 6.21144 |
| 4 | [1 5] | [13.47,117.93] | 10.0988 | 21.5785 | [13.20,104.84] | 6.2402 | 19.8591 | 11.78356 | 20.0583 |
| 5 | [1 6] | [12.02,2.57] | 1.0166 | 2.5912 | [13.29,1.64] | 0.8792 | 2.4048 | 0.85374 | 2.3666 |
| 6 | [1 7] | [13.16,2.74] | 2.8358 | 2.9857 | [12.54,0.97] | 0.8076 | 2.6142 | 1.33388 | 2.73582 |
| 7 | [1 8] | [12.33,0.39] | 0.36 | 1.2059 | [13.00,0.35] | 0.3836 | 1.4184 | 0.48214 | 1.16996 |
| 8 | [1 9] | [14.03,2.08] | 1.0213 | 2.2863 | [11.97,1.46] | 1.0872 | 2.0001 | 1.12594 | 2.42218 |
| 9 | [1 10] | [13.09,4.25] | 1.5351 | 4.0402 | [13.38,10.09] | 3.0693 | 3.826 | 1.9332 | 4.0987 |
| 10 | [1 11] | [14.18,1.02] | 0.6543 | 1.3008 | [12.37,1.02] | 0.4786 | 1.6643 | 0.6308 | 1.52058 |
| 11 | [1 12] | [14.01,3.28] | 0.9259 | 2.4478 | [12.55,1.76] | 0.6959 | 2.2787 | 0.85268 | 2.40872 |
| 12 | [1 13] | [13.74,1066.16] | 128.84 | 262.9182 | [12.76,621.35] | 92.6534 | 289.6523 | 164.8923 | 350.2437 |
| 13 | [2 3] | [2.69,2.46] | 0.5769 | 1.8146 | [1.74,2.44] | 0.847 | 2.4228 | 0.72098 | 1.83934 |
| 14 | [2 4] | [2.36,25.07] | 4.9745 | 8.2956 | [3.20,21.64] | 2.7002 | 8.725 | 2.90264 | 7.19136 |
| 15 | [2 5] | [2.27,96.01] | 5.0425 | 15.9362 | [2.27,85.68] | 15.7123 | 23.6945 | 11.74908 | 20.67408 |
| 16 | [2 6] | [4.49,1.97] | 1.57 | 4.0011 | [1.44,1.88] | 0.9264 | 2.4582 | 1.07438 | 2.73856 |
| 17 | [2 7] | [3.79,2.64] | 2.0064 | 2.5085 | [1.48,1.70] | 1.2521 | 3.9703 | 1.48086 | 3.01764 |
| 18 | [2 8] | [2.74,0.42] | 0.5559 | 1.678 | [5.12,0.48] | 0.7022 | 1.1865 | 0.55276 | 1.43742 |
| 19 | [2 9] | [4.35,1.37] | 2.2884 | 3.9157 | [1.86,1.64] | 0.7547 | 2.0463 | 1.32184 | 2.71506 |
| 20 | [2 10] | [1.55,3.11] | 1.624 | 5.8803 | [3.15,9.51] | 3.7867 | 7.4504 | 2.37978 | 5.49928 |
| 21 | [2 11] | [3.81,0.78] | 0.633 | 1.7659 | [5.10,0.71] | 0.6994 | 1.2045 | 0.65956 | 1.62126 |
| 22 | [2 12] | [1.56,1.94] | 0.949 | 2.3751 | [4.61,1.94] | 1.7284 | 3.7507 | 1.29014 | 3.02192 |
| 23 | [2 13] | [2.60,621.36] | 96.6467 | 300.7791 | [2.01,1066.16] | 128.8355 | 263.0609 | 165.688 | 350.0222 |
| 24 | [3 4] | [2.17,12.17] | 1.85 | 3.1233 | [2.39,21.65] | 1.3704 | 4.6243 | 2.1947 | 4.81646 |
| 25 | [3 5] | [2.56,117.94] | 10.0629 | 21.1793 | [2.39,95.90] | 4.9008 | 13.7879 | 11.72206 | 19.31774 |
| 26 | [3 6] | [2.35,3.22] | 0.6954 | 1.3395 | [2.43,1.87] | 0.5049 | 1.603 | 0.72032 | 1.51458 |
| 27 | [3 7] | [2.31,1.47] | 0.5871 | 1.7548 | [2.39,3.44] | 1.8447 | 1.8116 | 0.98862 | 1.73436 |
| 28 | [3 8] | [2.22,0.28] | 0.1801 | 0.5782 | [2.71,0.42] | 0.5173 | 0.9129 | 0.35004 | 0.69928 |
| 29 | [3 9] | [2.62,1.52] | 0.7227 | 1.5409 | [2.36,0.87] | 1.0932 | 1.4998 | 0.78122 | 1.48078 |
| 30 | [3 10] | [2.26,2.59] | 1.3318 | 3.3278 | [2.35,4.03] | 0.9764 | 3.0549 | 1.47142 | 3.10402 |
| 31 | [3 11] | [2.64,1.16] | 0.5789 | 0.8357 | [2.29,1.07] | 0.6452 | 1.137 | 0.55472 | 0.92334 |
| 32 | [3 12] | [2.13,2.93] | 0.6125 | 1.5776 | [2.44,3.46] | 0.8285 | 1.6542 | 0.75566 | 1.50746 |
| 33 | [3 13] | [2.28,416.07] | 138.0726 | 379.9689 | [2.39,611.18] | 96.1801 | 355.2772 | 164.8468 | 354.7732 |
| 34 | [4 5] | [19.10,117.45] | 12.0869 | 29.4865 | [18.60,95.70] | 8.6001 | 24.3821 | 13.3831 | 26.99768 |
| 35 | [4 6] | [21.64,1.98] | 1.5999 | 5.8663 | [25.24,2.17] | 4.8887 | 6.6591 | 2.3672 | 5.6572 |
| 36 | [4 7] | [21.48,1.45] | 2.066 | 8.0232 | [16.40,2.76] | 1.845 | 6.2383 | 2.85006 | 6.65928 |
| 37 | [4 8] | [25.25,0.41] | 4.7559 | 6.1255 | [16.33,0.30] | 1.7322 | 4.4571 | 2.19498 | 4.61956 |
| 38 | [4 9] | [12.40,2.16] | 2.5053 | 3.8423 | [19.07,1.53] | 2.0973 | 6.7445 | 2.57168 | 5.62562 |
| 39 | [4 10] | [15.63,5.49] | 6.1509 | 11.3199 | [21.05,3.24] | 2.8567 | 7.9116 | 4.5361 | 10.26112 |
| 40 | [4 11] | [16.33,1.06] | 1.7338 | 4.5396 | [25.24,0.89] | 4.7753 | 6.285 | 2.20942 | 4.78196 |
| 41 | [4 12] | [12.29,2.95] | 2.0345 | 3.2069 | [21.64,2.33] | 1.6889 | 6.5754 | 2.44904 | 5.99056 |
| 42 | [4 13] | [16.93,1064.34] | 130.6628 | 281.9129 | [20.73,417.71] | 139.7223 | 399.8607 | 163.7582 | 354.565 |
| 43 | [5 6] | [140.23,2.39] | 21.773 | 21.5819 | [104.91,2.36] | 6.2797 | 19.9053 | 11.74934 | 19.7885 |
| 44 | [5 7] | [140.17,2.07] | 21.8303 | 21.5378 | [85.66,1.80] | 15.6575 | 22.5021 | 11.82886 | 20.52202 |
| 45 | [5 8] | [104.87,0.35] | 6.1258 | 19.1019 | [140.19,0.26] | 21.8145 | 21.3835 | 11.71672 | 19.2065 |
| 46 | [5 9] | [95.91,1.52] | 5.075 | 14.3718 | [85.68,1.49] | 15.6792 | 21.3909 | 11.7608 | 19.62558 |
| 47 | [5 10] | [117.08,6.54] | 11.0101 | 25.7289 | [85.34,3.68] | 15.4659 | 26.8471 | 12.81596 | 22.65646 |
| 48 | [5 11] | [118.04,0.90] | 9.9608 | 21.0777 | [85.69,0.96] | 15.6919 | 21.0899 | 11.6657 | 19.32774 |
| 49 | [5 12] | [140.15,2.87] | 21.8536 | 21.4444 | [117.94,2.69] | 10.0918 | 21.7692 | 11.75998 | 20.00434 |
| 50 | [5 13] | [91.40,411.89] | 133.9956 | 364.6196 | [105.92,1341.31] | 338.6973 | 439.2881 | 166.6719 | 367.1652 |
| 51 | [6 7] | [2.84,2.94] | 0.9655 | 1.726 | [2.42,2.31] | 0.675 | 1.6248 | 0.9873 | 1.83608 |
| 52 | [6 8] | [2.47,0.32] | 0.2894 | 1.0214 | [1.92,0.43] | 0.3434 | 1.0704 | 0.38242 | 0.95574 |
| 53 | [6 9] | [2.46,1.47] | 1.0549 | 2.1549 | [2.85,2.64] | 1.0078 | 2.0186 | 0.8533 | 1.90052 |
| 54 | [6 10] | [2.77,5.65] | 1.7931 | 4.6321 | [2.11,7.60] | 1.7522 | 4.1738 | 1.89254 | 4.21252 |
| 55 | [6 11] | [2.13,1.09] | 0.699 | 1.5445 | [3.15,1.05] | 0.7307 | 1.4289 | 0.56178 | 1.27404 |
| 56 | [6 12] | [2.96,2.90] | 0.9913 | 1.7895 | [1.71,2.22] | 0.9908 | 1.8218 | 0.8769 | 1.92218 |
| 57 | [6 13] | [2.89,1342.12] | 337.8823 | 435.9721 | [1.97,621.36] | 96.6364 | 300.5458 | 165.6838 | 349.9006 |
| 58 | [7 8] | [2.86,0.30] | 0.3354 | 1.2845 | [0.65,0.48] | 0.4802 | 1.0592 | 0.64828 | 1.2265 |
| 59 | [7 9] | [2.24,1.51] | 1.3107 | 2.0362 | [1.52,1.40] | 1.3162 | 2.3528 | 1.23178 | 2.2546 |
| 60 | [7 10] | [0.90,9.56] | 3.4687 | 5.7689 | [1.94,2.70] | 1.568 | 5.0278 | 2.21138 | 4.7711 |
| 61 | [7 11] | [3.42,1.06] | 1.6684 | 1.5085 | [0.66,0.70] | 0.4586 | 1.2677 | 0.7295 | 1.4446 |
| 62 | [7 12] | [2.89,3.33] | 0.6664 | 1.9495 | [1.60,2.33] | 0.8062 | 1.7444 | 1.03408 | 2.07298 |
| 63 | [7 13] | [1.82,814.60] | 122.3959 | 318.616 | [3.04,1342.12] | 337.8856 | 435.9709 | 164.9012 | 350.2629 |
| 64 | [8 9] | [0.35,1.69] | 0.3173 | 1.0008 | [0.29,2.07] | 0.3937 | 1.0213 | 0.44144 | 1.0157 |
| 65 | [8 10] | [0.44,10.12] | 2.8813 | 3.213 | [0.34,4.08] | 0.7699 | 2.6319 | 1.38878 | 2.81096 |
| 66 | [8 11] | [0.47,0.62] | 0.2669 | 0.6105 | [0.27,0.83] | 0.2449 | 0.5472 | 0.27128 | 0.59624 |
| 67 | [8 12] | [0.32,2.78] | 0.3217 | 0.9415 | [0.46,1.59] | 0.4127 | 1.2395 | 0.38584 | 0.92754 |
| 68 | [8 13] | [0.28,1052.62] | 142.3799 | 321.8786 | [0.29,1338.76] | 341.2433 | 431.4585 | 164.247 | 354.1935 |
| 69 | [9 10] | [1.77,5.52] | 1.1682 | 4.5326 | [1.39,10.01] | 3.2668 | 3.6781 | 1.83522 | 4.1022 |
| 70 | [9 11] | [2.80,1.08] | 0.8422 | 1.1587 | [2.00,1.04] | 0.6723 | 1.5828 | 0.60736 | 1.28658 |
| 71 | [9 12] | [1.88,3.37] | 0.6849 | 1.8754 | [1.33,1.63] | 0.9714 | 1.3912 | 0.81674 | 1.99746 |
| 72 | [9 13] | [1.35,621.37] | 96.6333 | 300.5463 | [1.52,420.72] | 142.7225 | 444.0683 | 165.6831 | 349.8794 |
| 73 | [10 11] | [5.56,0.97] | 0.8206 | 2.7432 | [4.08,1.03] | 0.7865 | 2.8221 | 1.4026 | 3.0016 |
| 74 | [10 12] | [5.66,3.03] | 1.6691 | 5.3217 | [2.63,2.89] | 1.3616 | 4.3963 | 1.8494 | 4.29308 |
| 75 | [10 13] | [5.56,813.89] | 123.1465 | 318.9756 | [6.20,1342.08] | 337.9286 | 435.9597 | 165.1429 | 351.0151 |
| 76 | [11 12] | [1.02,3.54] | 0.4707 | 0.945 | [0.66,1.58] | 0.3901 | 1.2123 | 0.47664 | 1.1588 |
| 77 | [11 13] | [0.99,420.69] | 142.6938 | 444.0808 | [0.89,814.58] | 122.4253 | 318.5494 | 164.9092 | 350.2012 |
| 78 | [12 13] | [3.20,1066.16] | 128.8379 | 262.9061 | [2.18,621.35] | 92.6518 | 289.5949 | 164.8896 | 350.2334 |

# Appendix-F:Graphical representation of fcm simulation for cluster number 2, 3, 4 and 5

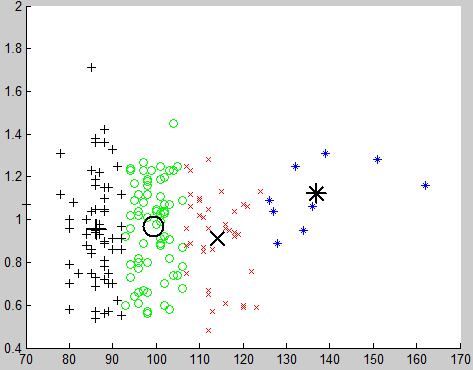
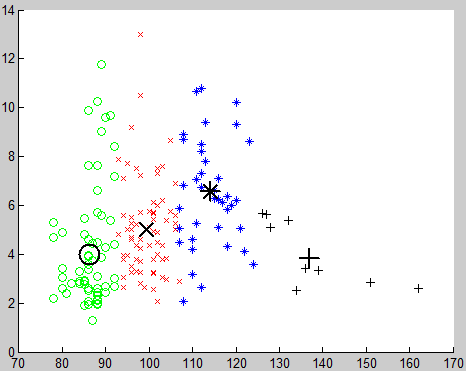
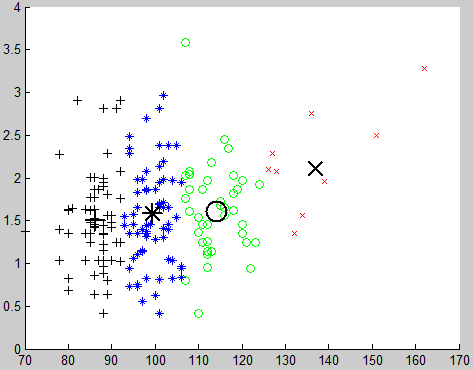
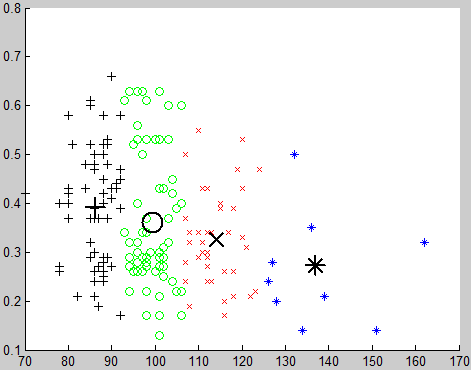
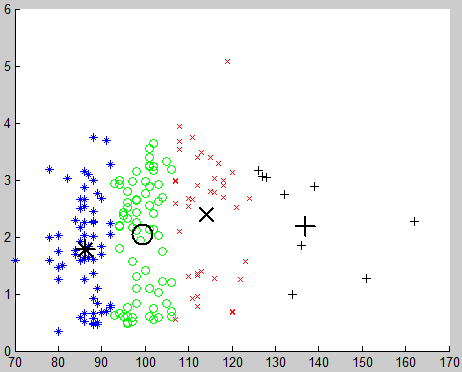
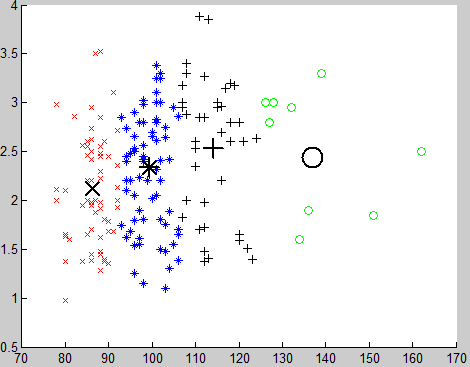
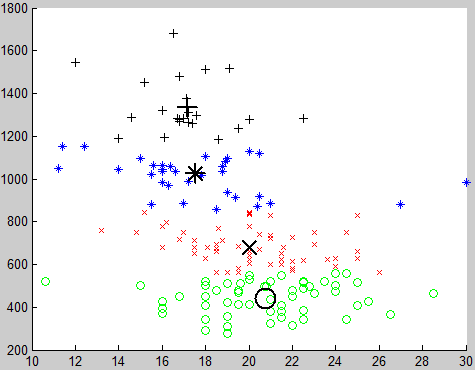
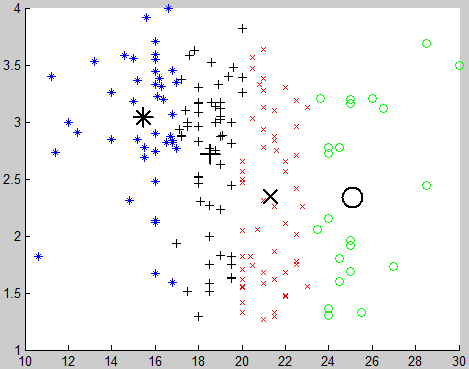
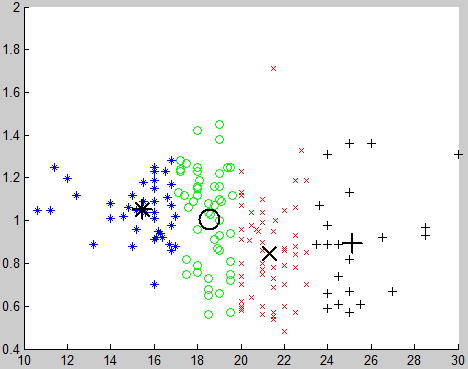
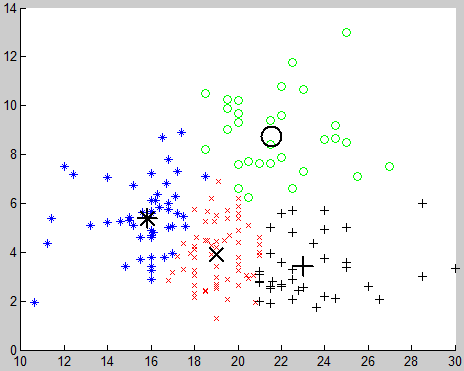
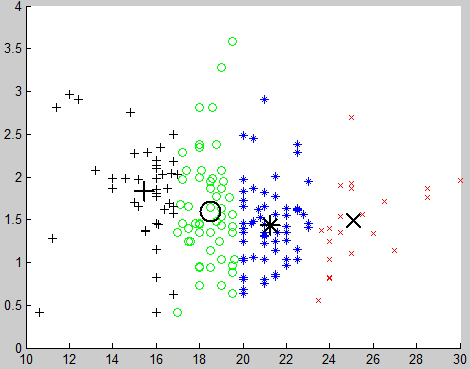
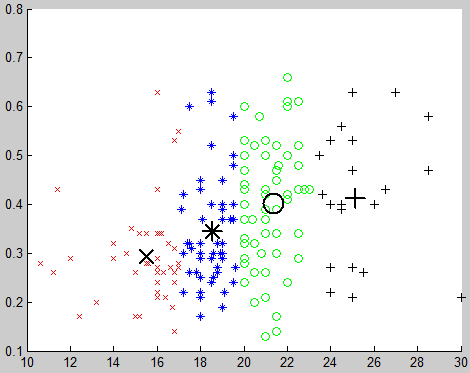
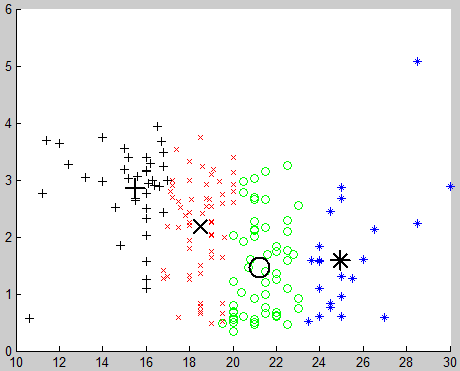
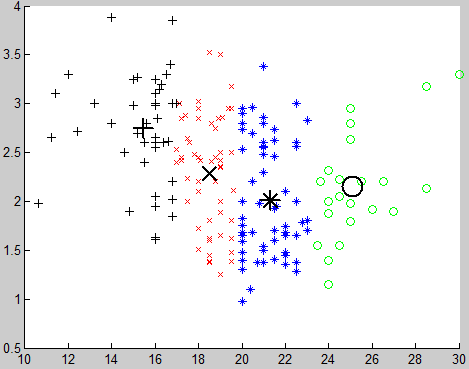
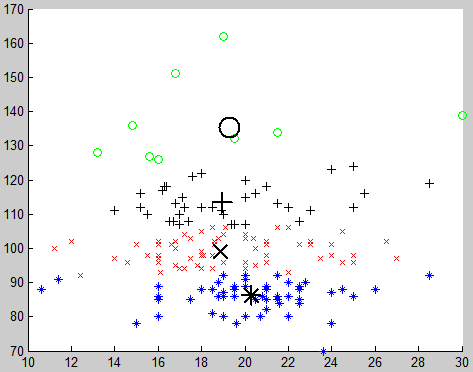
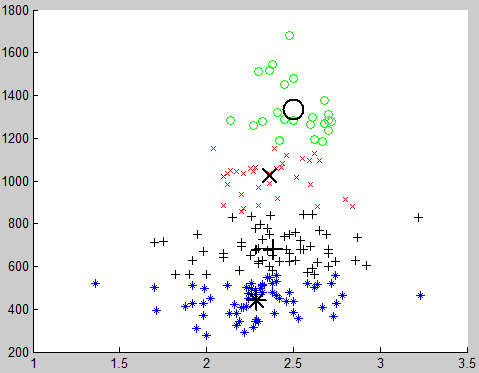
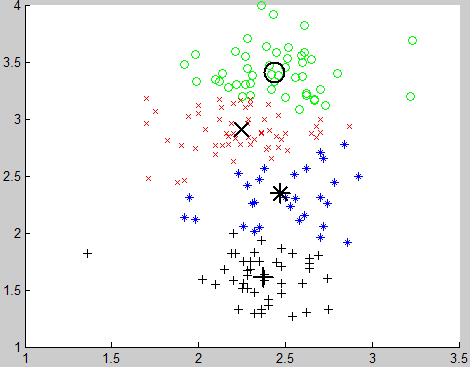
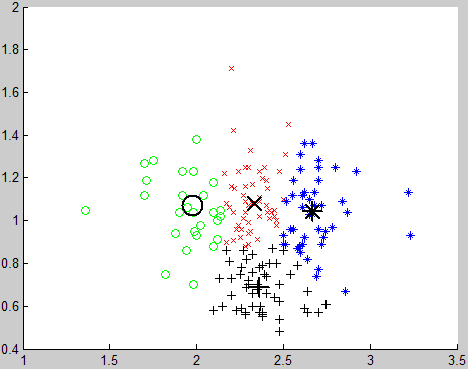
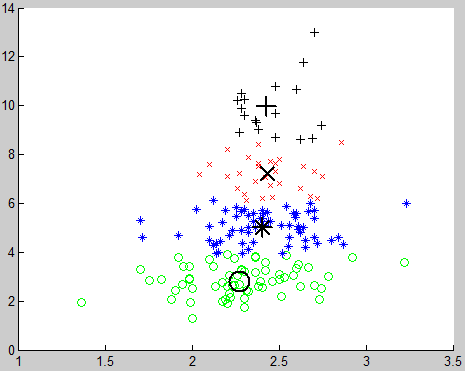
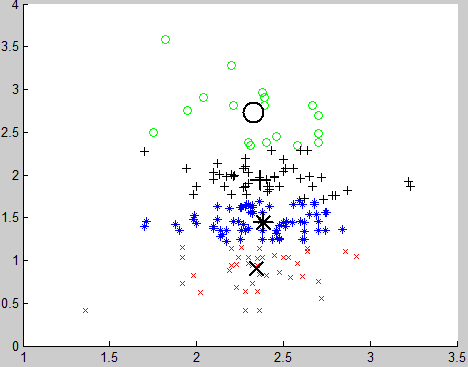
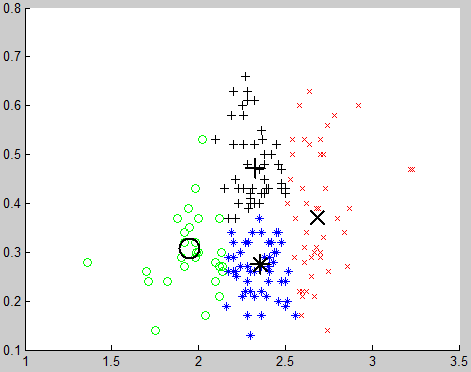
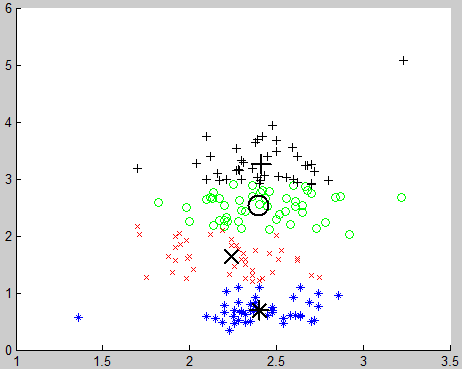
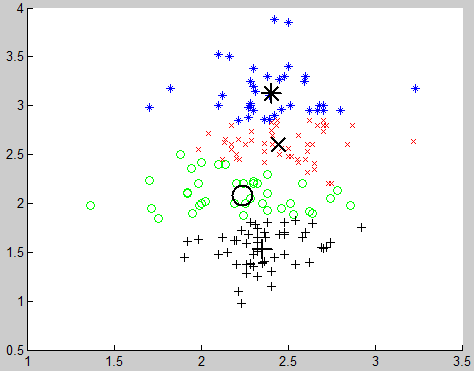
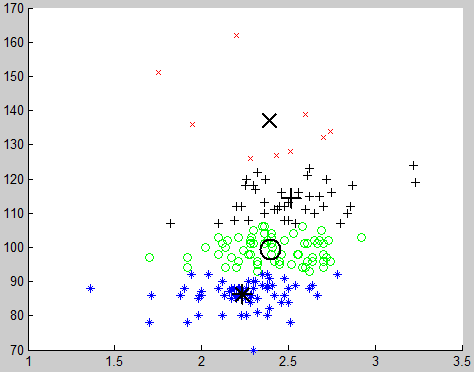
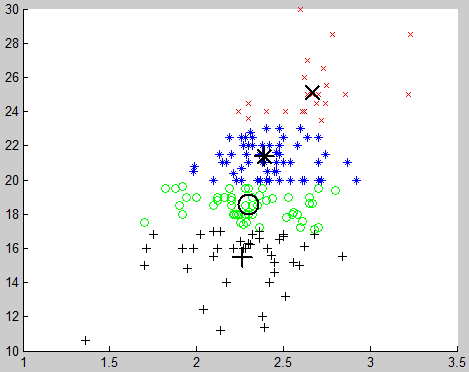
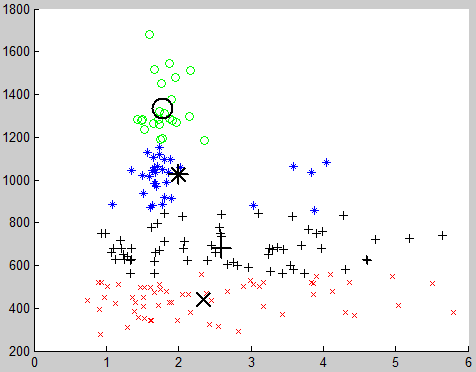
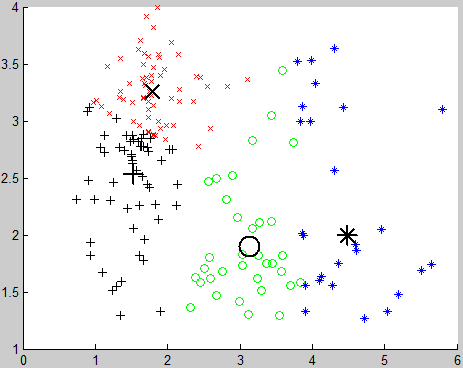
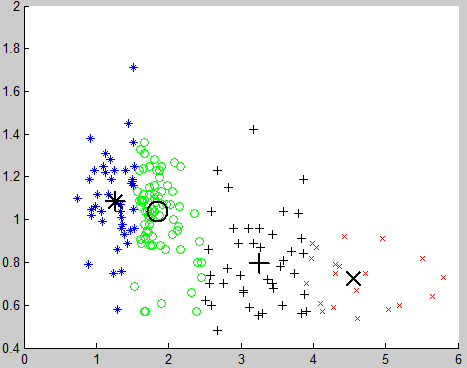
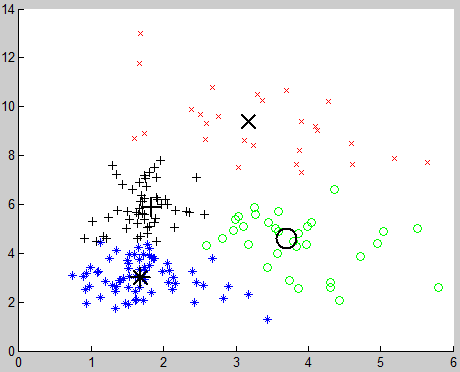
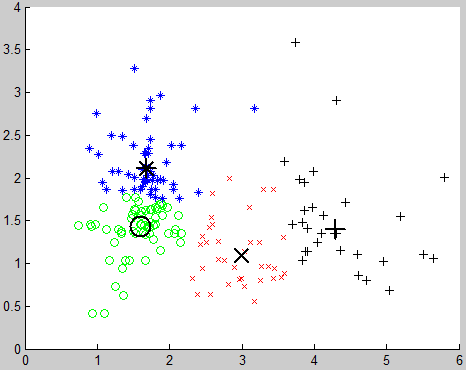
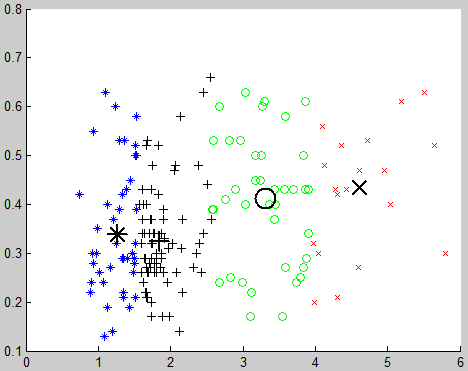
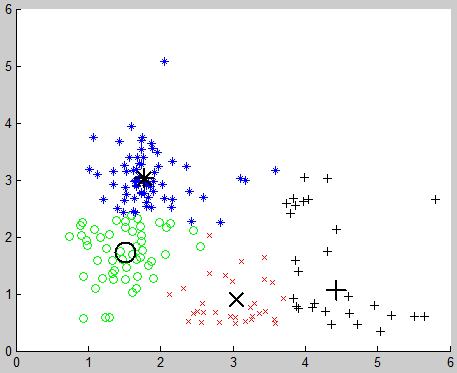
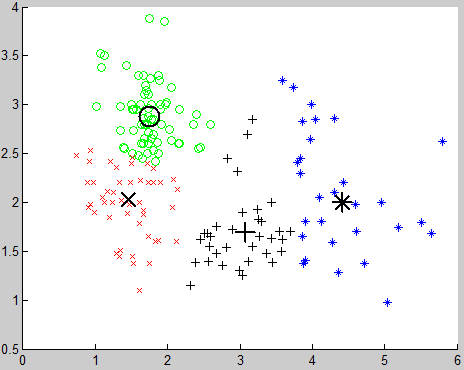
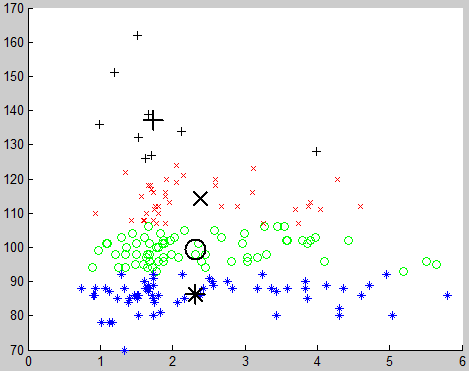
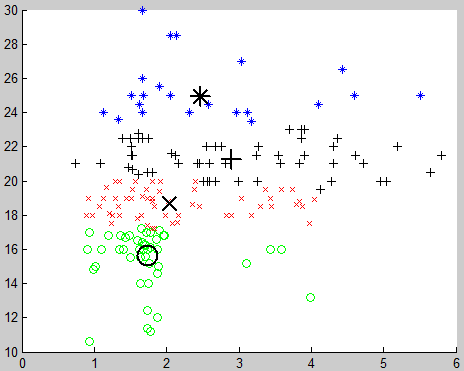
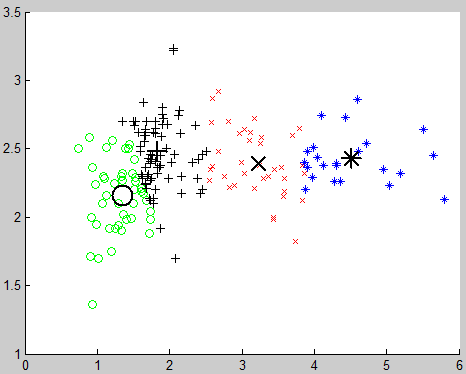
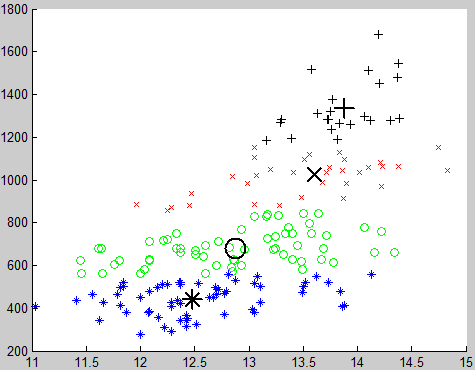
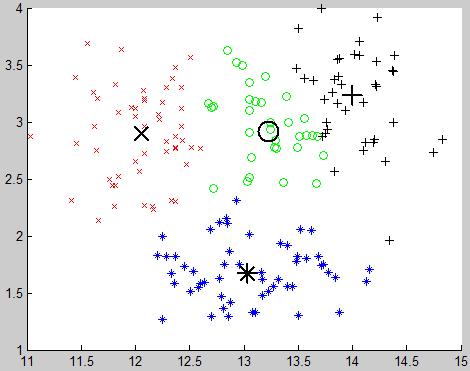
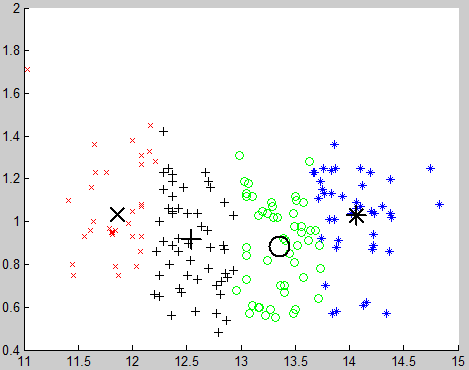
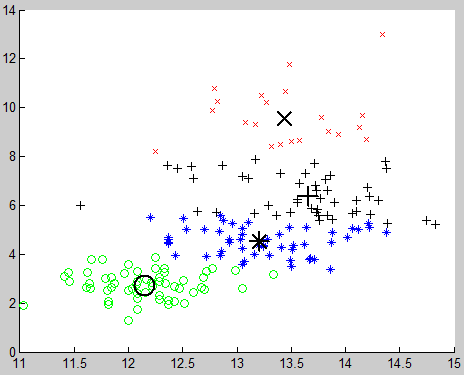
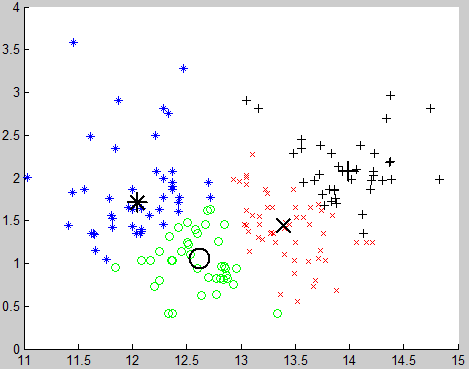
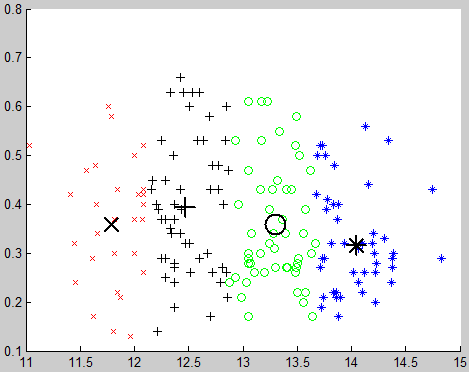
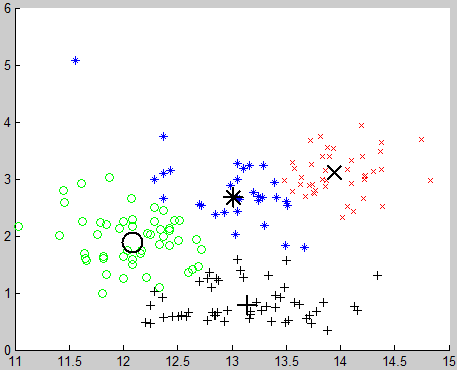
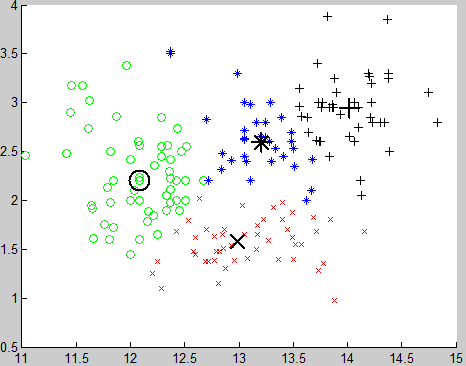
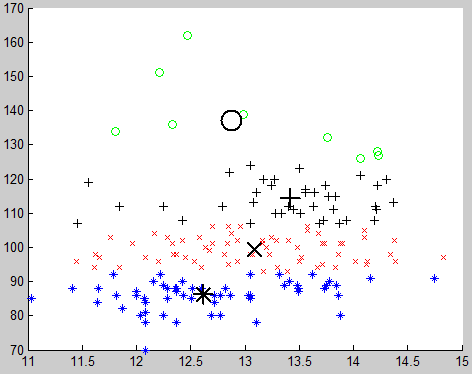
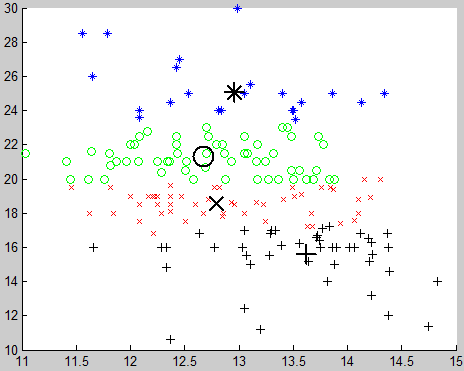
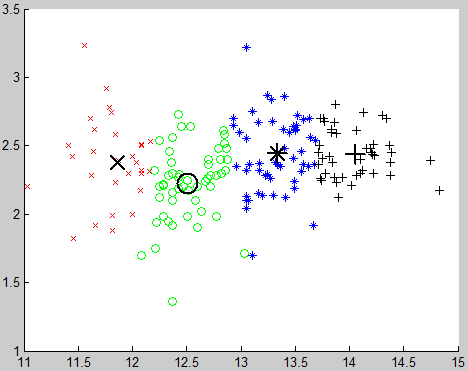
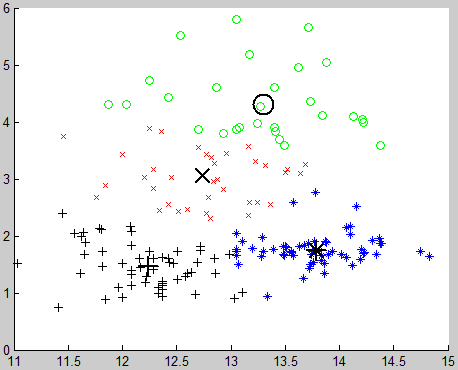
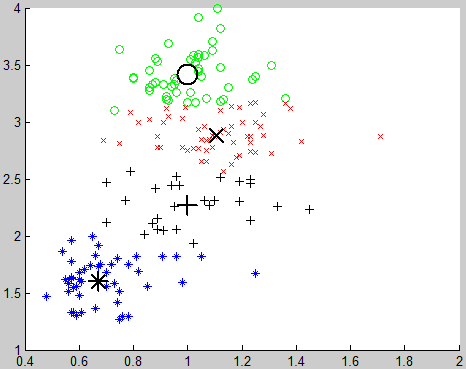
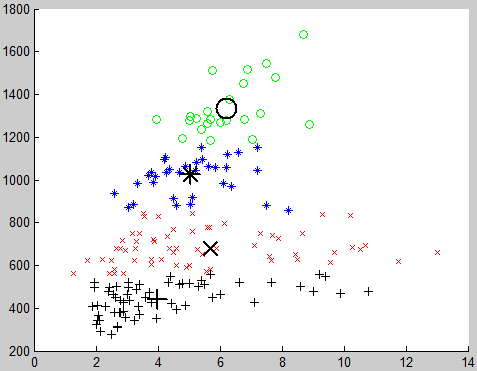
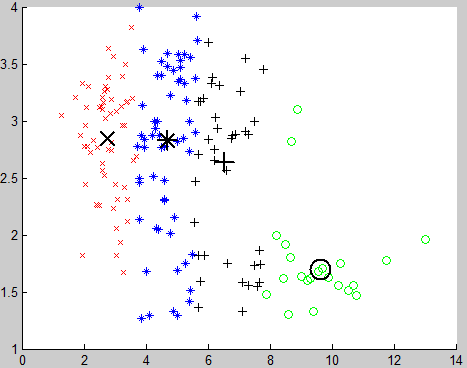
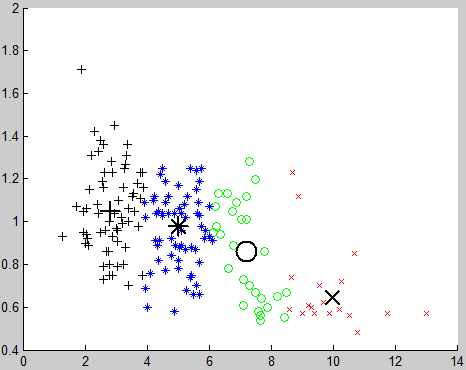
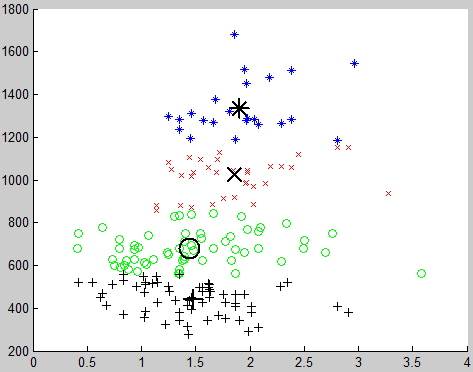
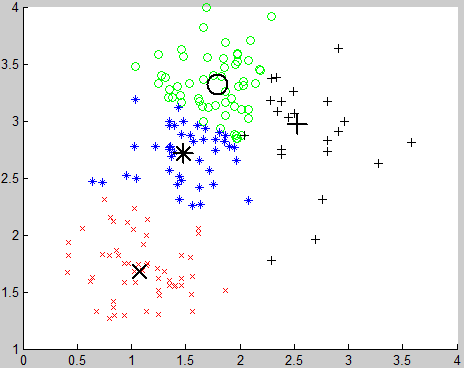
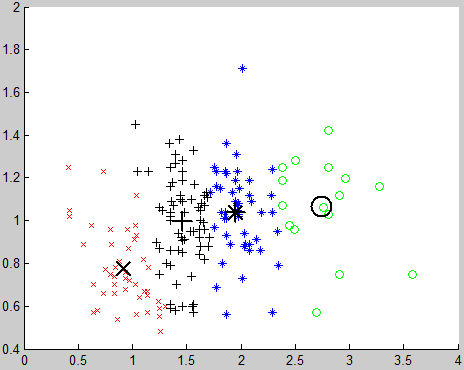
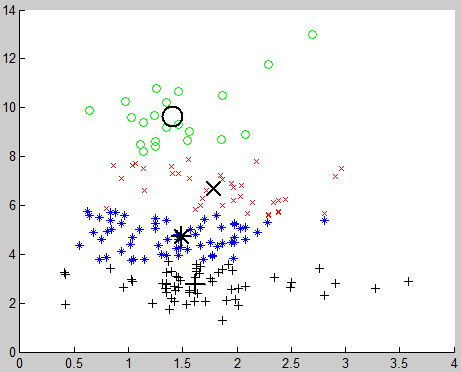
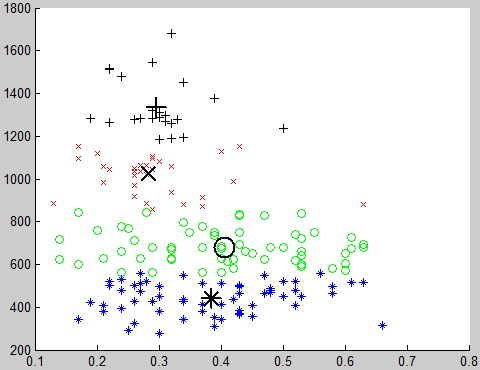
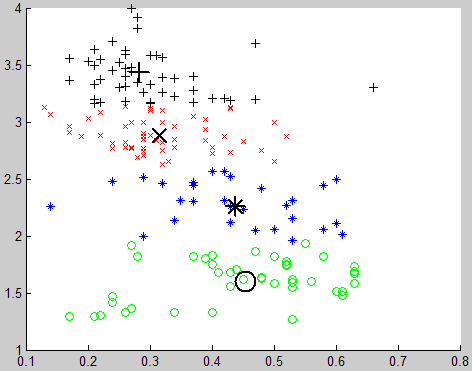
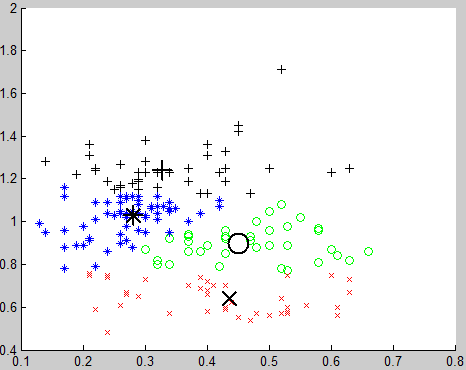
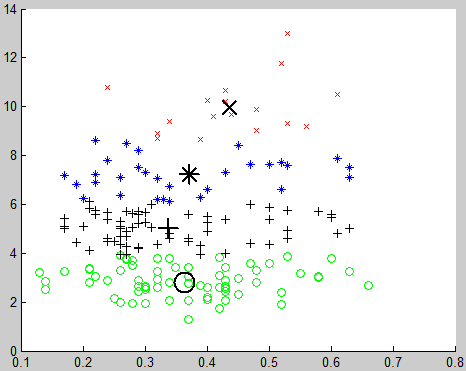
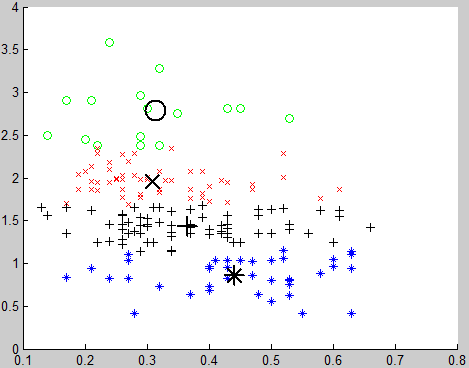
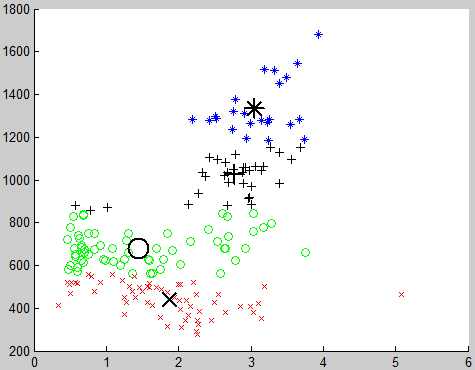
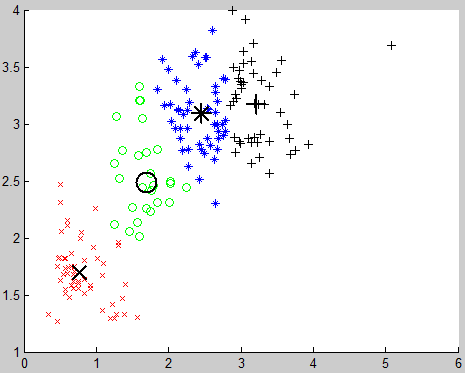
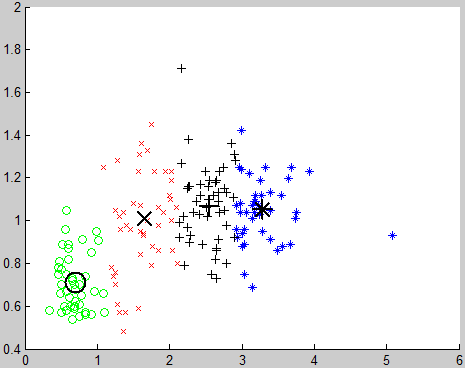
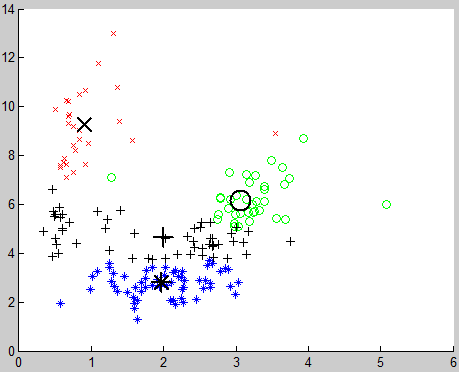
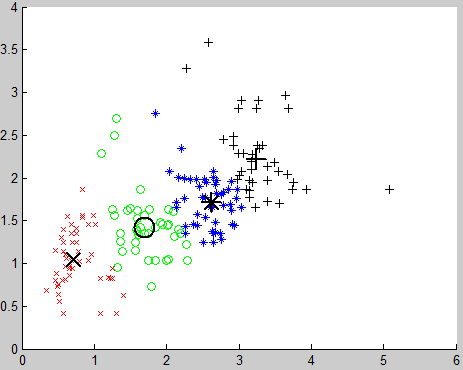
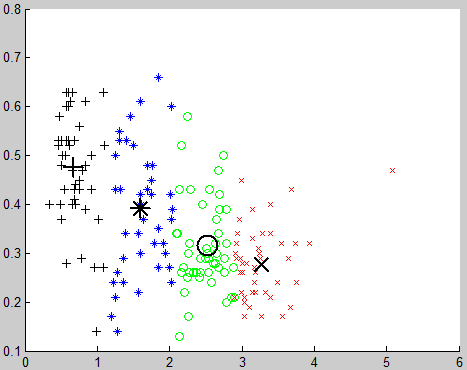
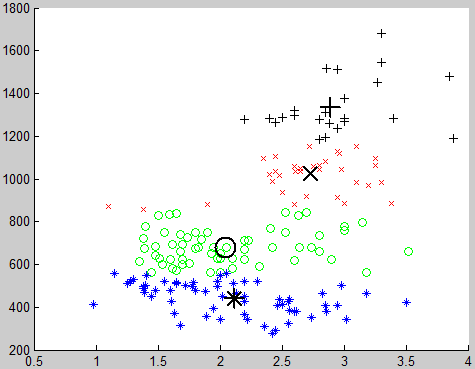
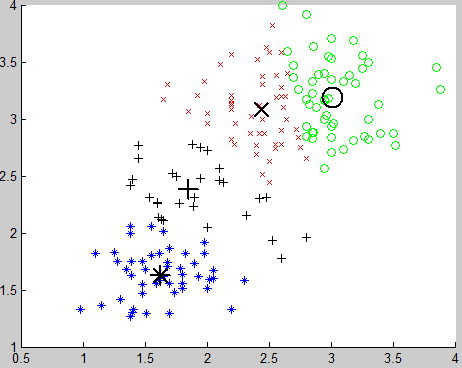
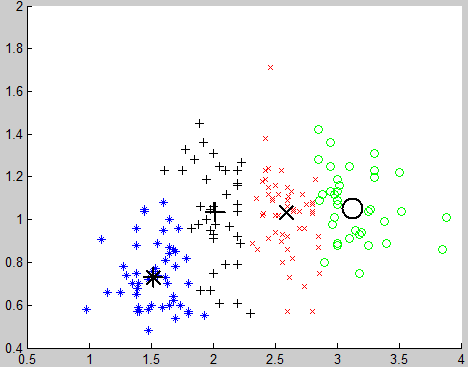
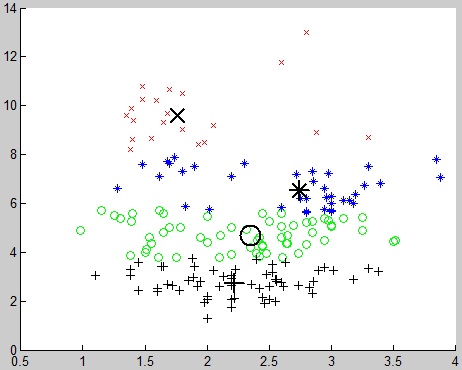
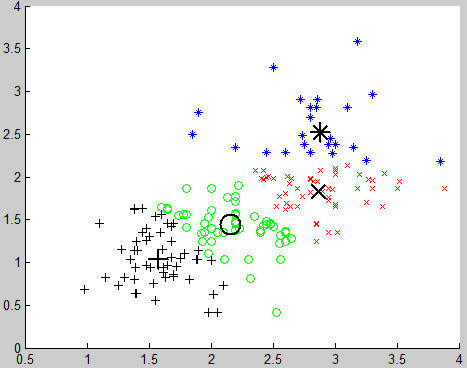
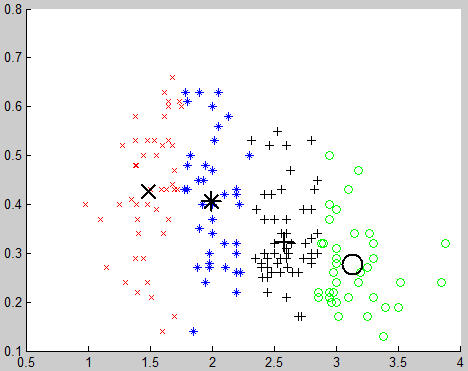
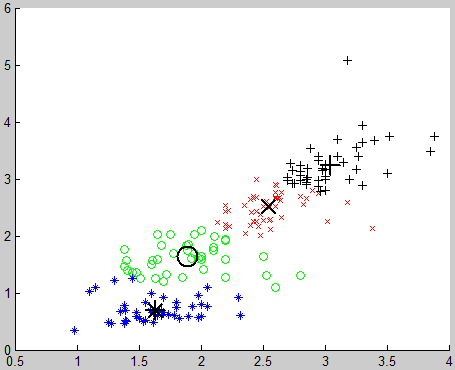
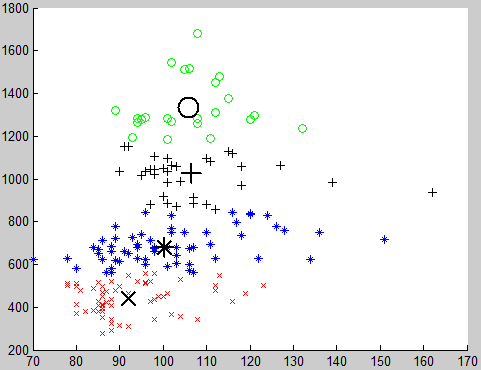
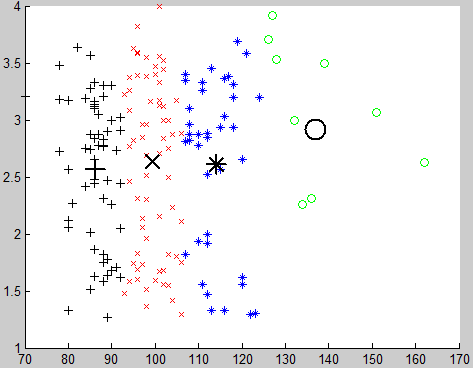
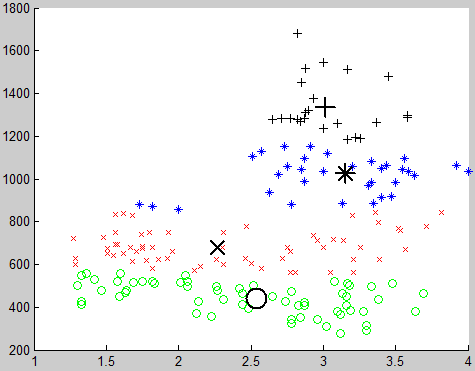
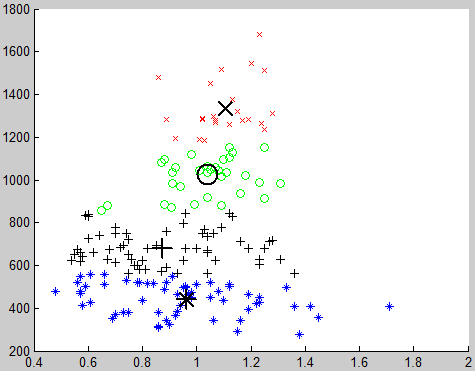
**Number of Cluster = 2**



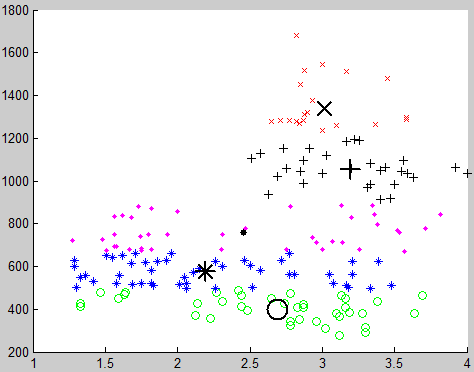
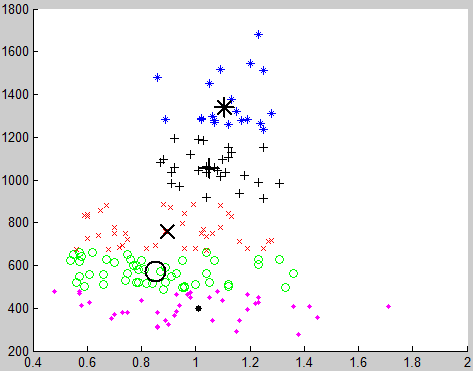
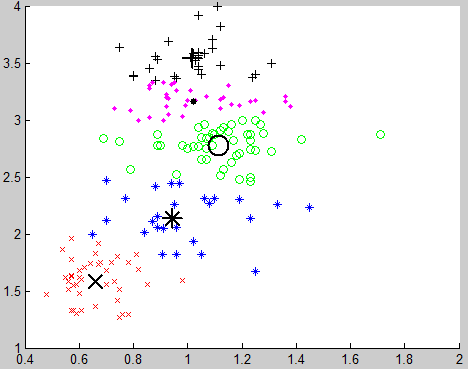
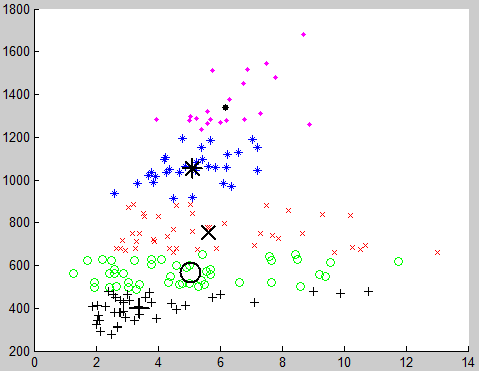
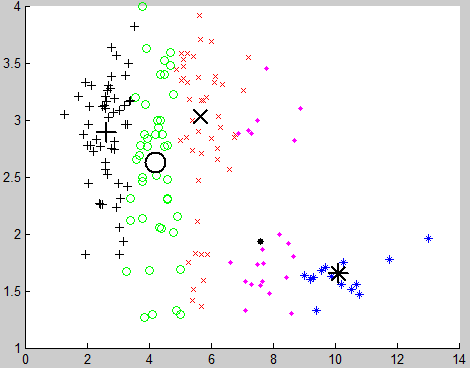
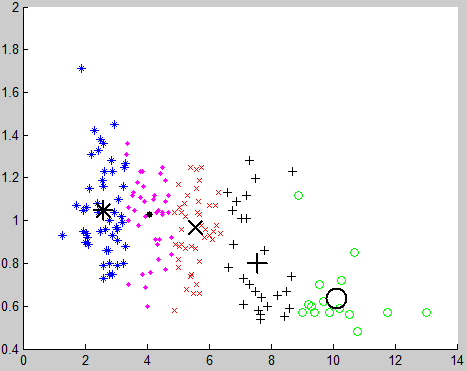
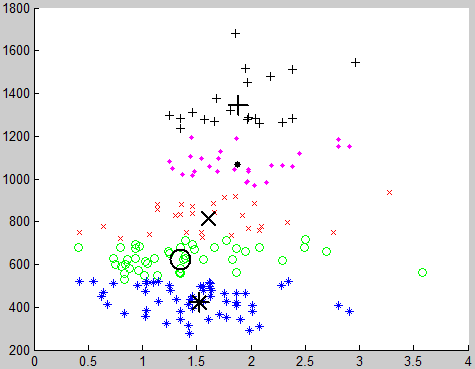
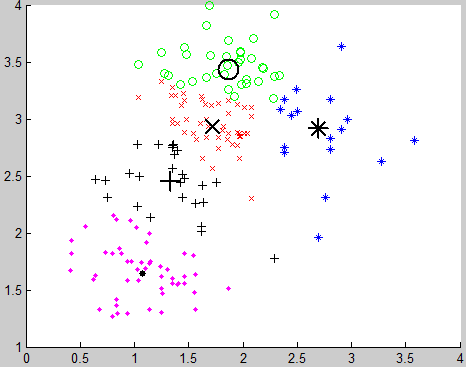
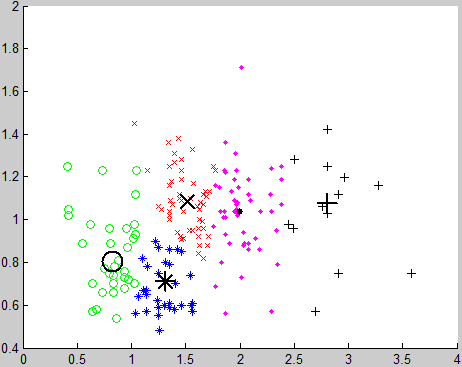
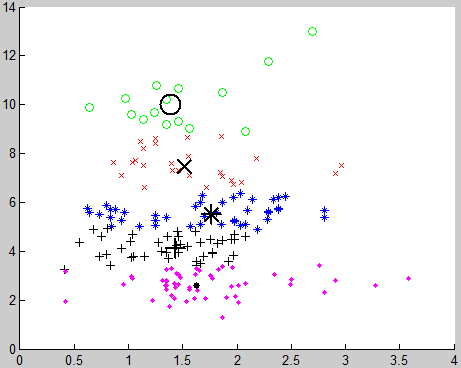
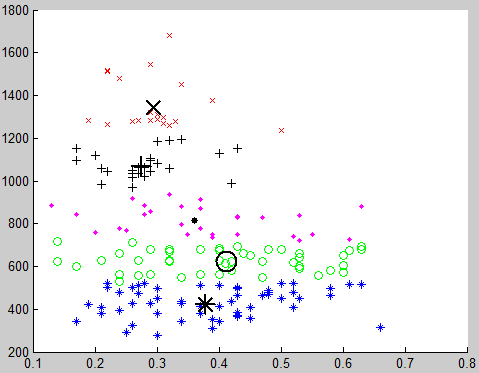
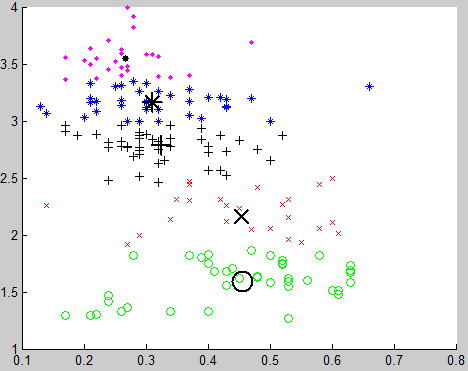
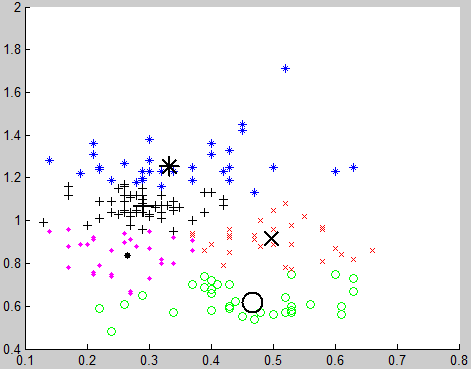
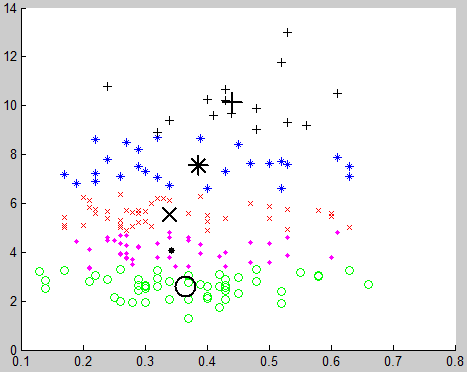
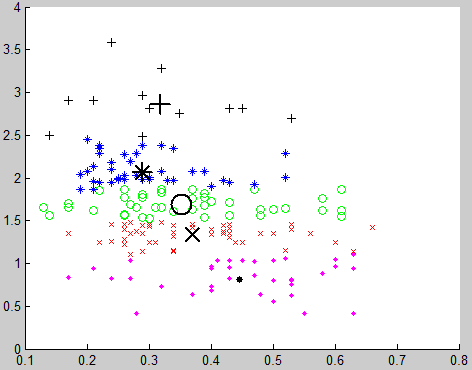
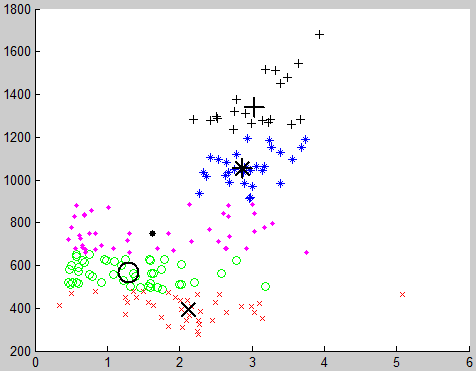
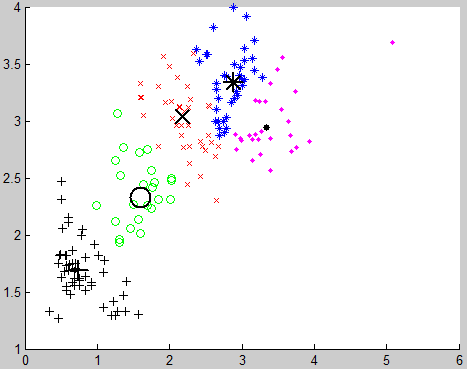
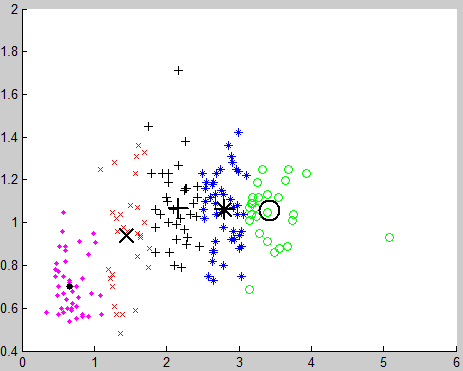
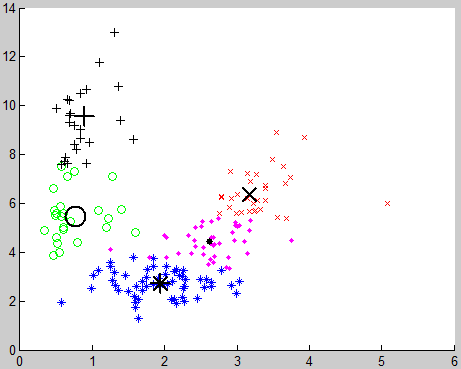
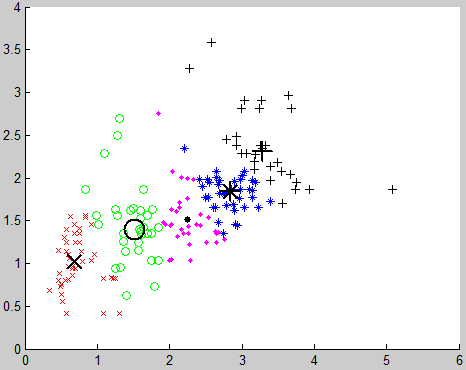
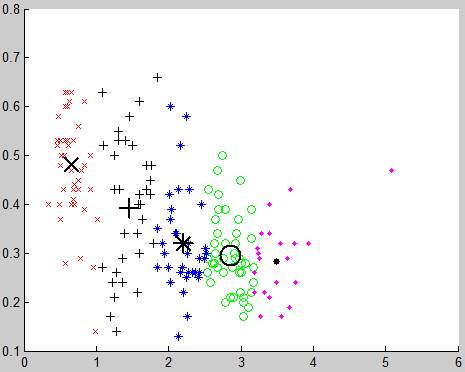
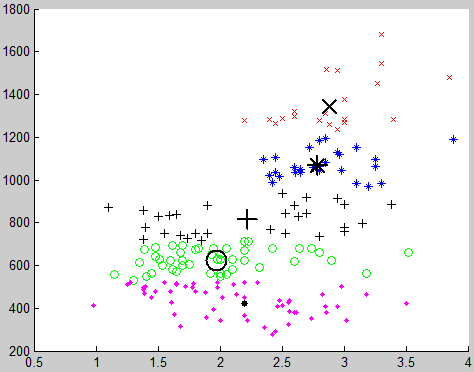
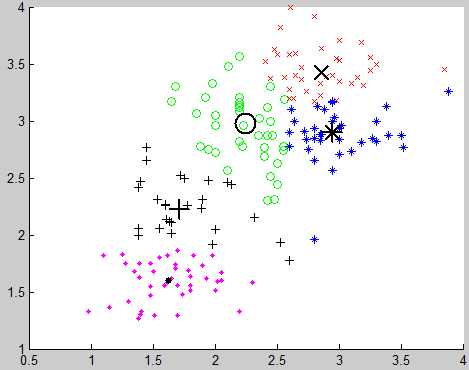
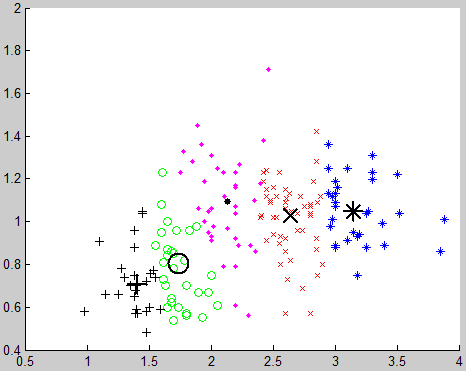
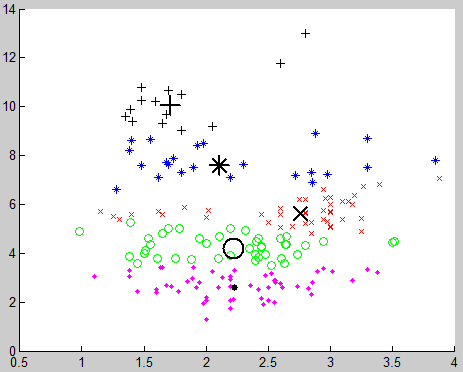
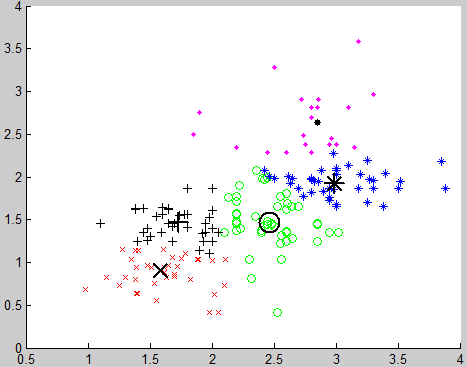
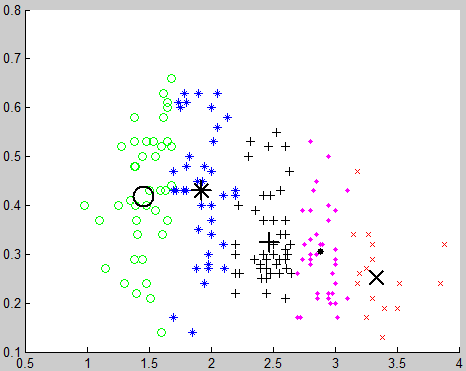
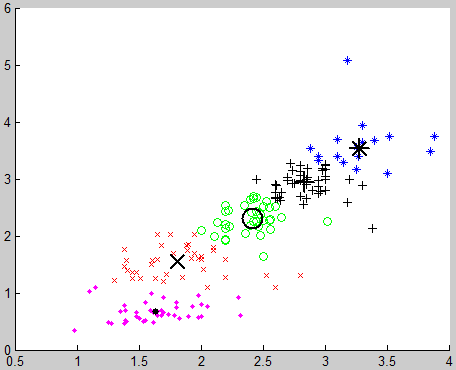
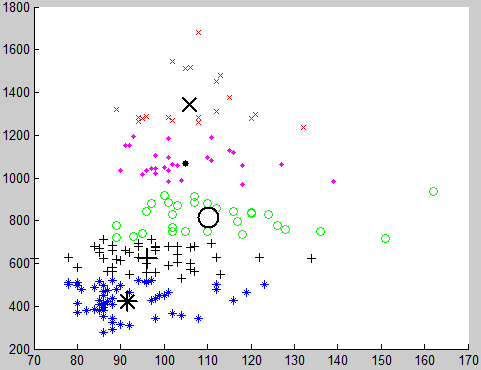
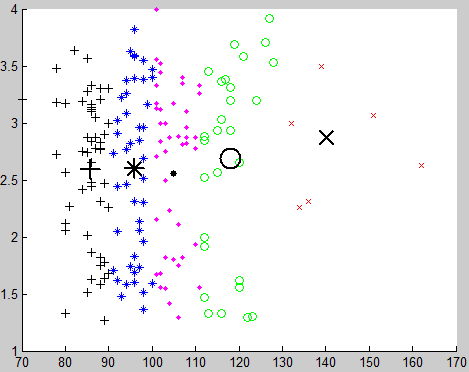
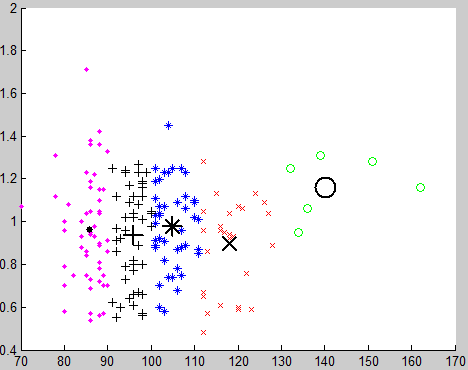
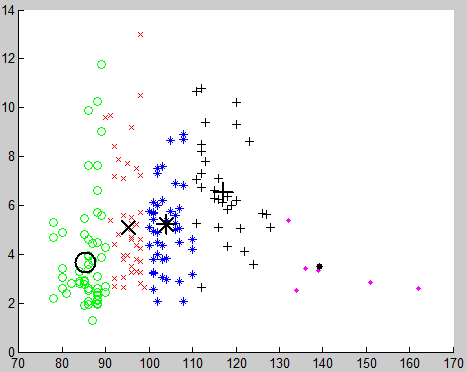
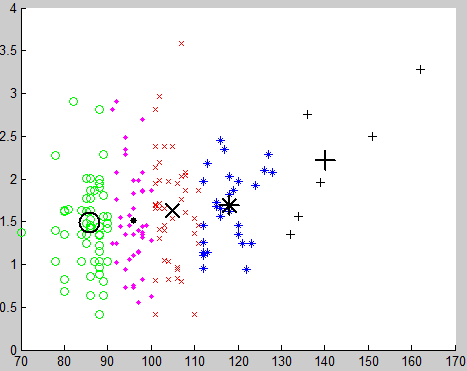
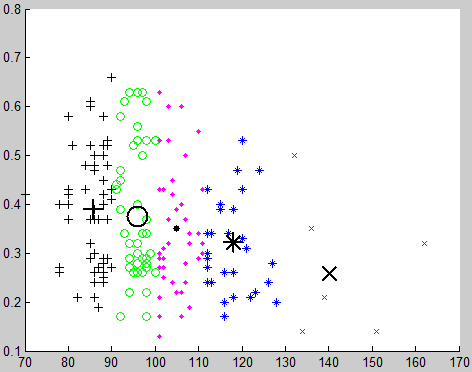
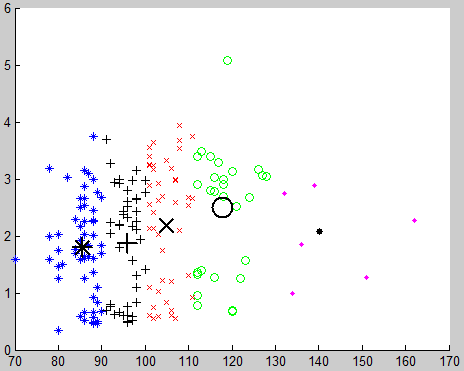
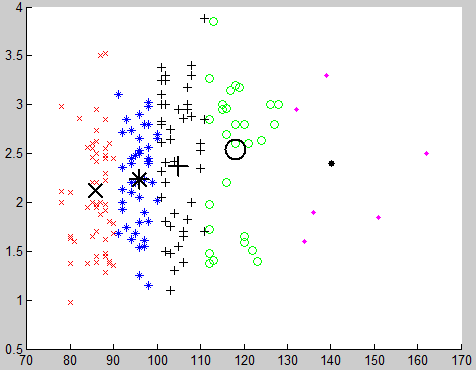
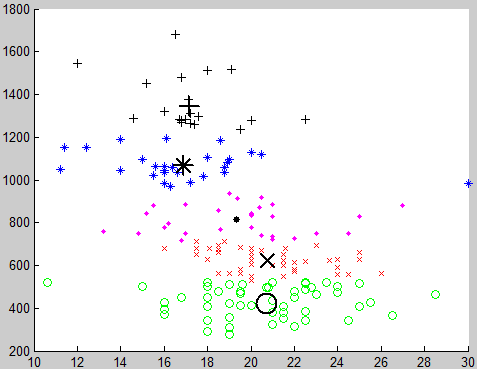
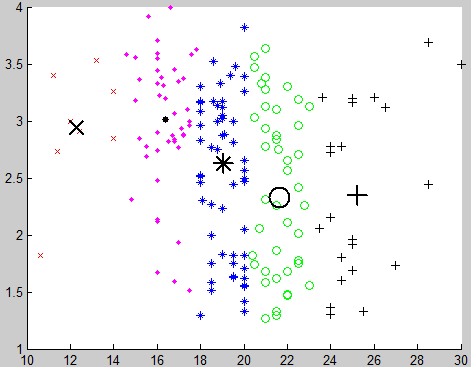
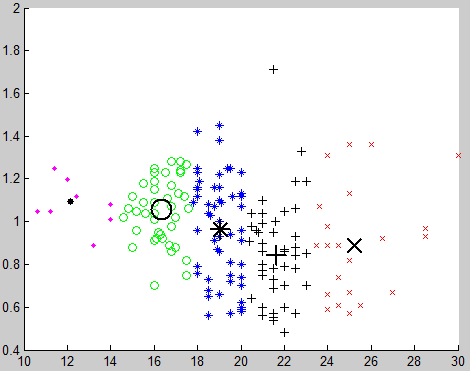
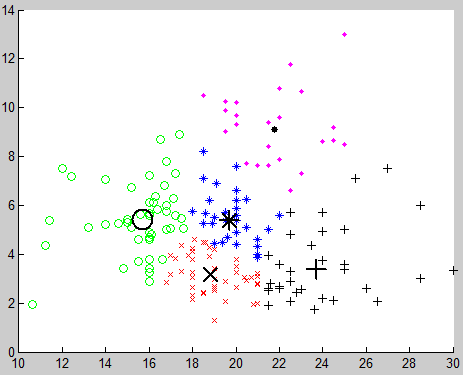
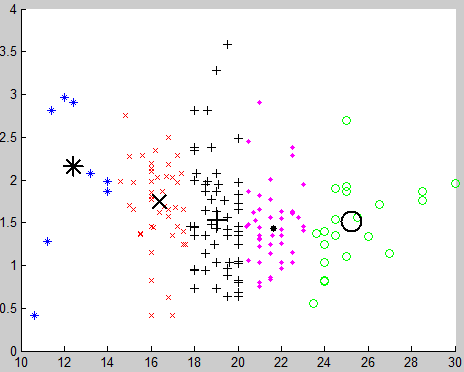
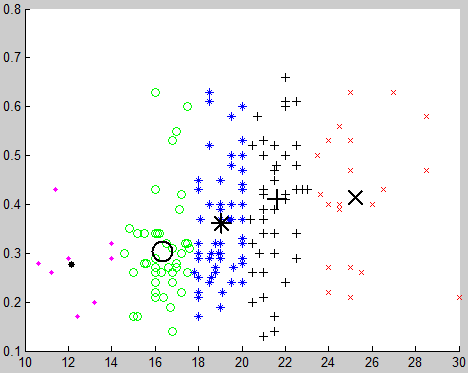
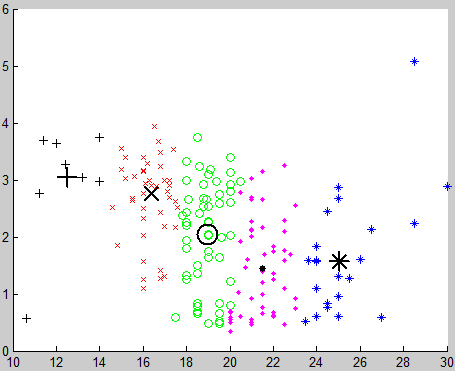
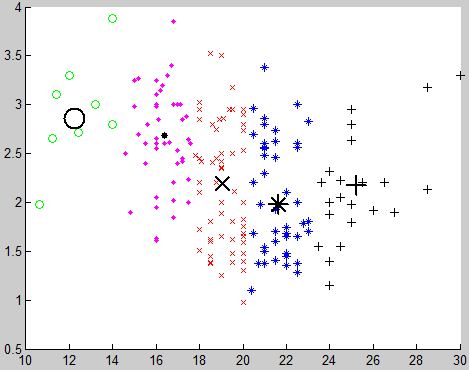
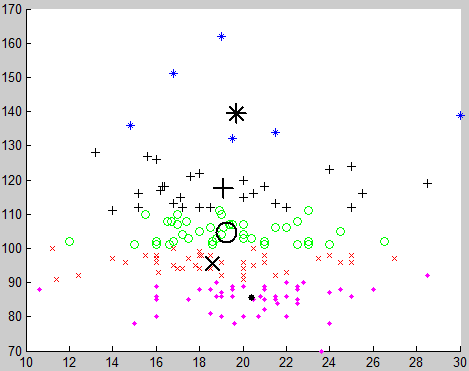
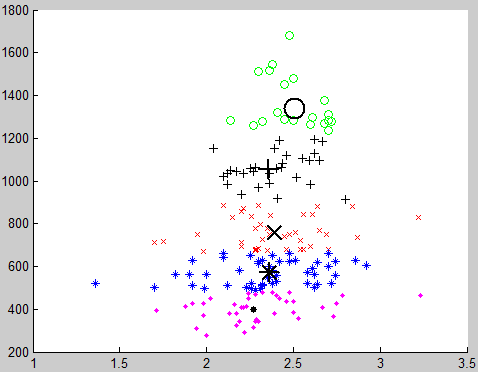
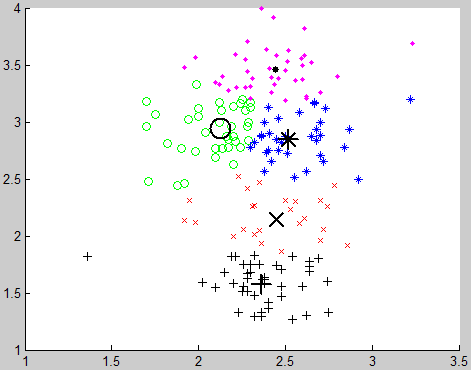
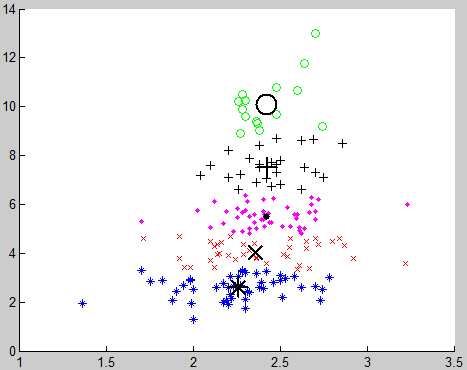
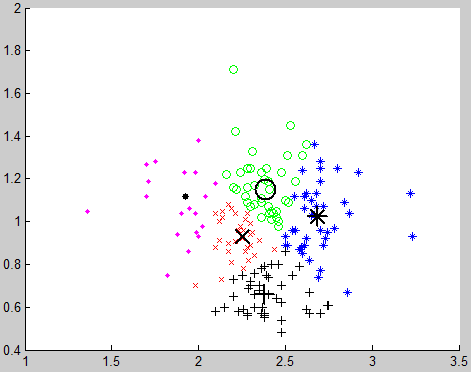
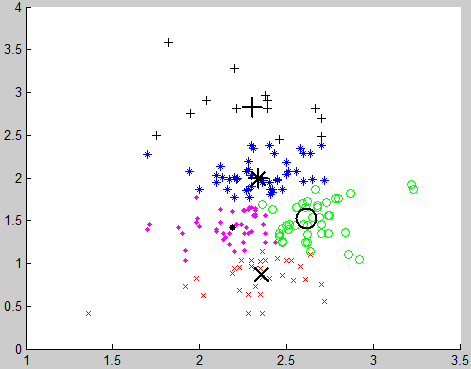
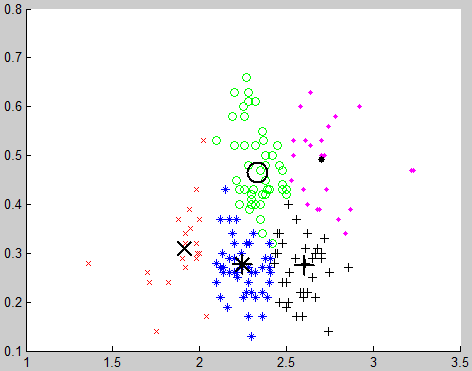
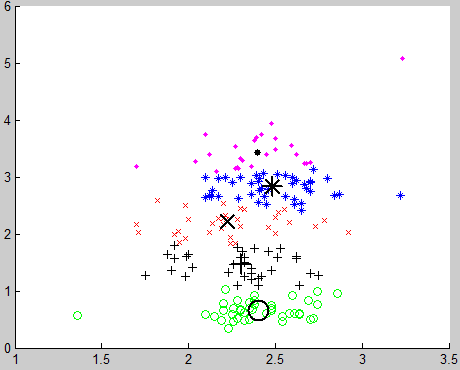
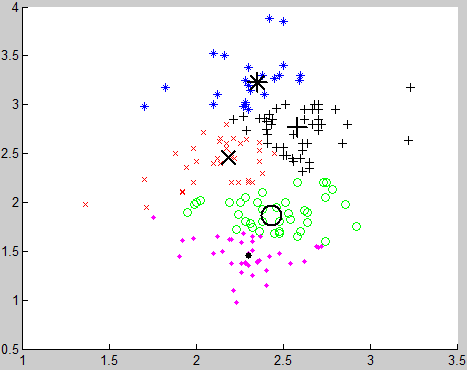
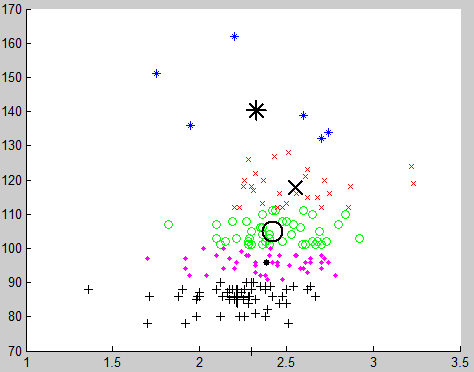
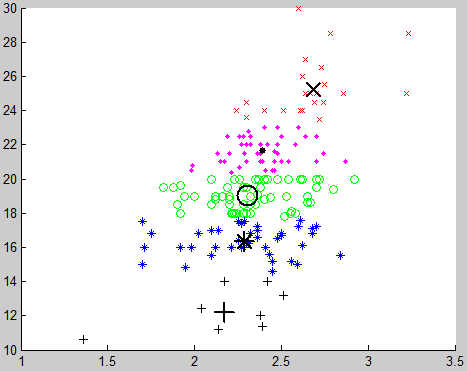
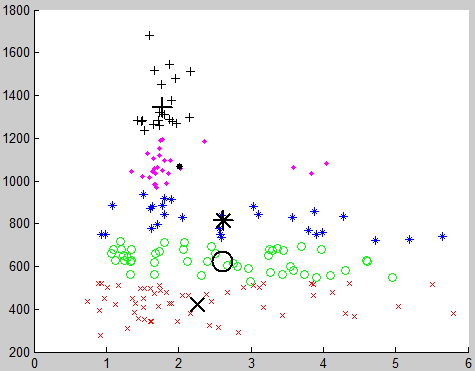
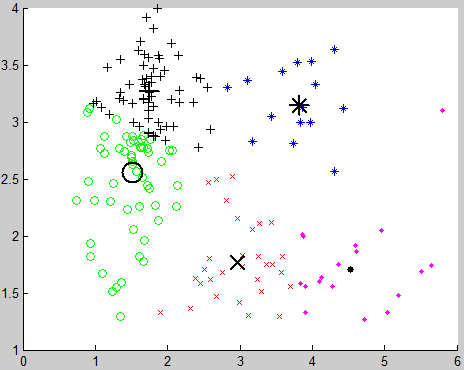
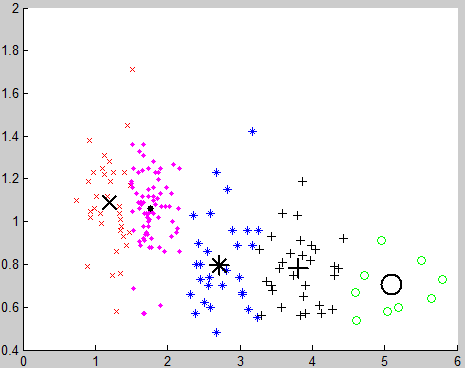
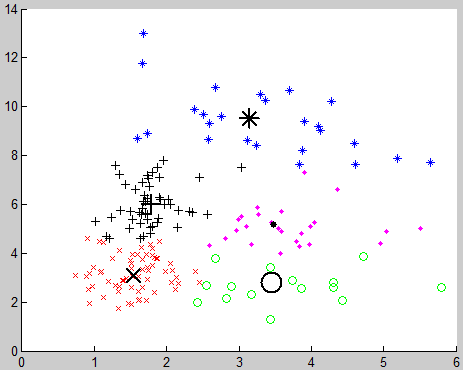
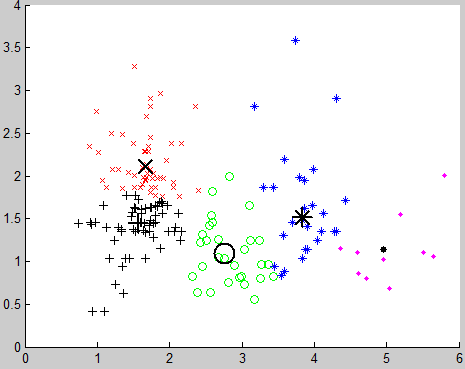
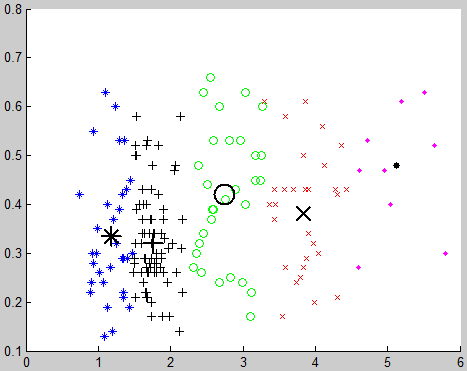
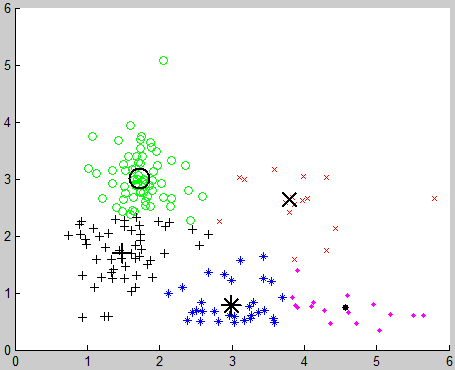
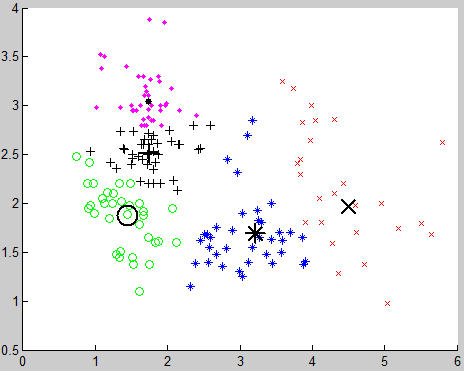
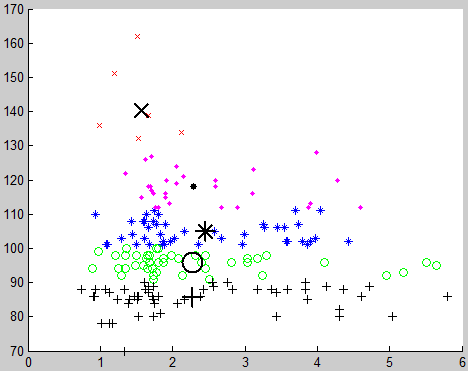
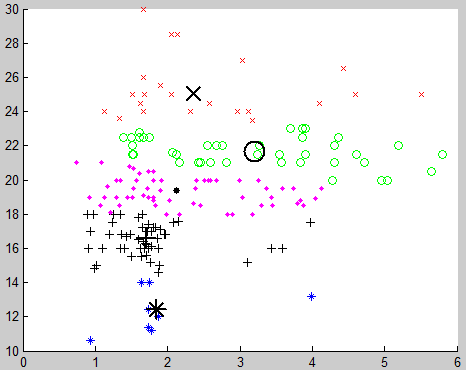
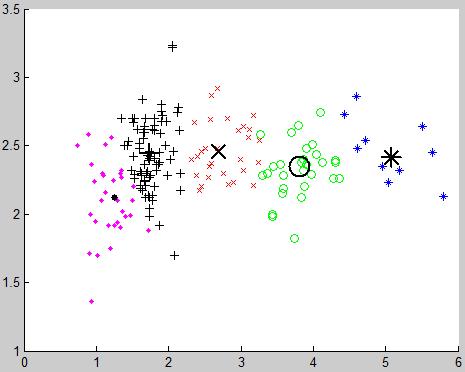
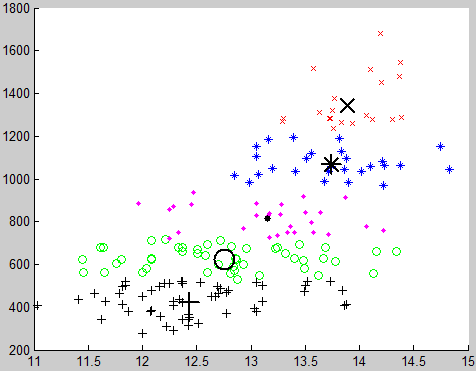
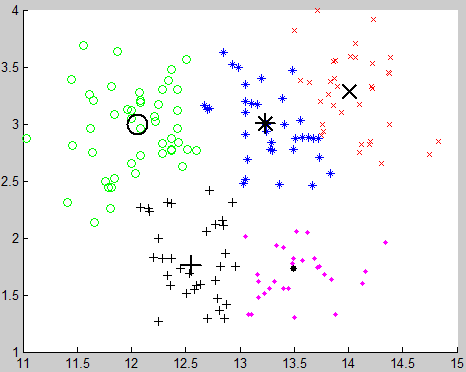
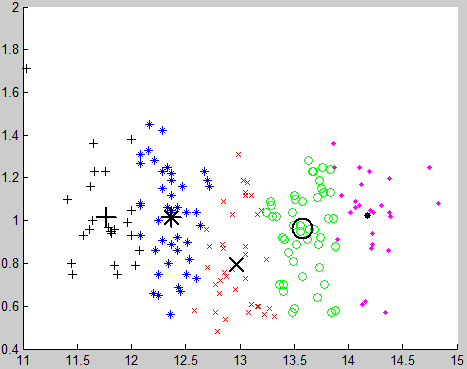
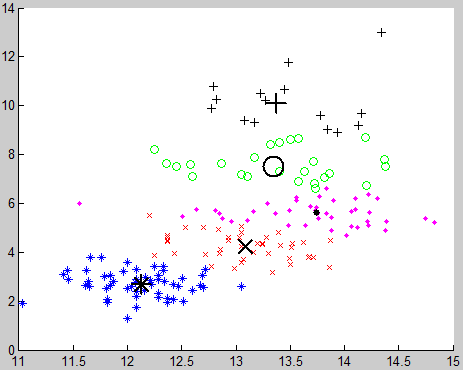
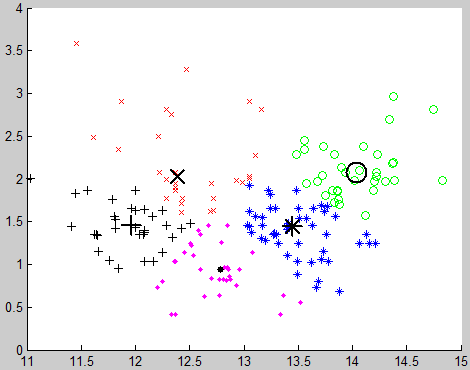
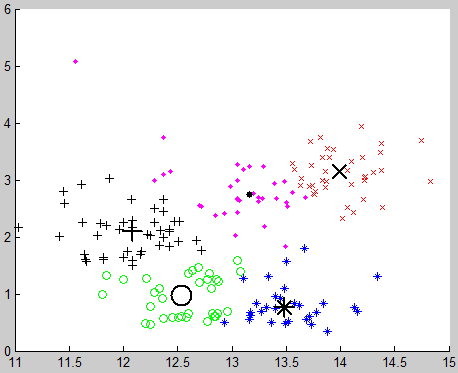
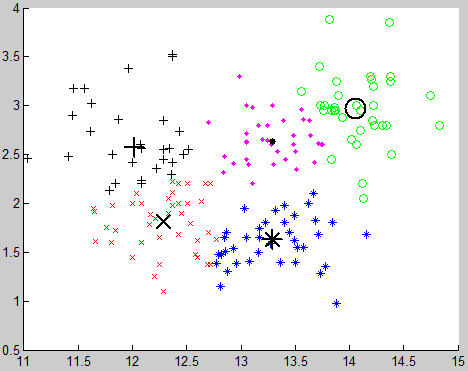
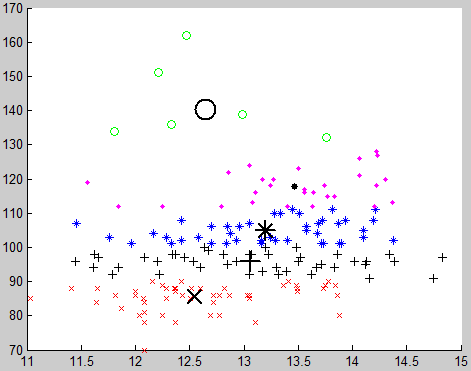
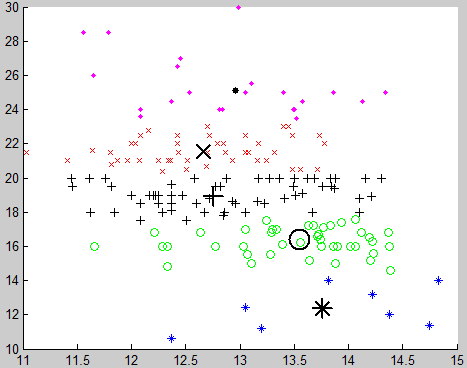
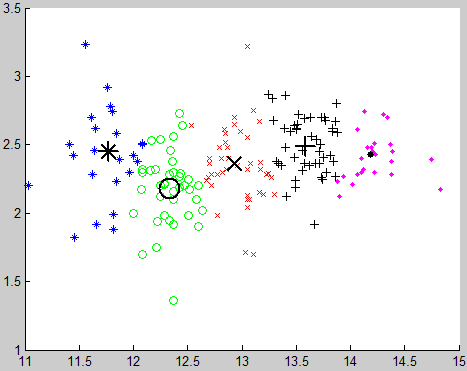
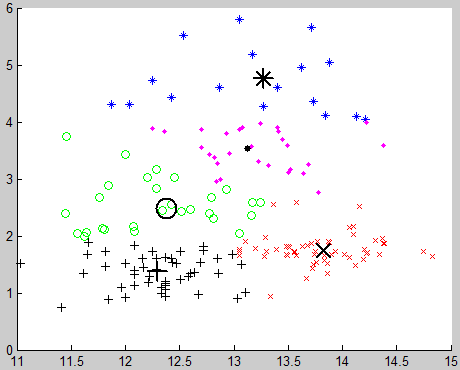
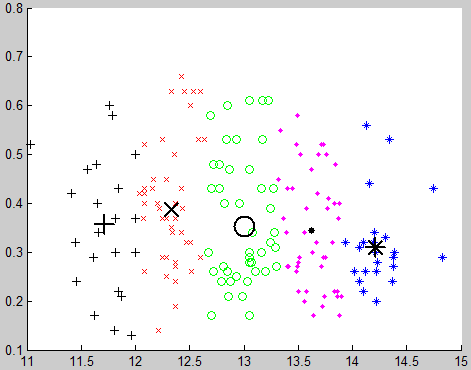
**Number of Cluster = 3**

****

**Number of Cluster = 4**

********

**Number of Cluster = 5**



# Appendix-G: MATlab code for finding cluster members

function [result]=FindClusterMembers( data,nOfc )

[center,U,objFcn] = fcm(data,nOfc);

maxU = max(U);

index1 = find(U(1, :) == maxU)

index2 = find(U(2, :) == maxU)

ifnOfc>=3

index3 = find(U(3, :) == maxU)

end

ifnOfc>=4

index4 = find(U(4, :) == maxU);

end

ifnOfc>=5

index5 = find(U(5, :) == maxU);

end

fileID=fopen('cluster1.txt','a');

fprintf(fileID,'%i\n',index1);

fclose(fileID);

fileID=fopen('cluster2.txt','a');

fprintf(fileID,'%i\n',index2);

fclose(fileID);

ifnOfc>=3

fileID=fopen('cluster3.txt','a');

fprintf(fileID,'%i\n',index3);

fclose(fileID);

end

ifnOfc>=4

fileID=fopen('cluster4.txt','a');

fprintf(fileID,'%i\n',index4);

fclose(fileID);

end

ifnOfc>=5

fileID=fopen('cluster5.txt','a');

fprintf(fileID,'%i\n',index5);

fclose(fileID);

end

end

# References

[1] Fuzzy C-Means Clustering, <http://www.mathworks.com/help/fuzzy/fuzzy-clustering.html#FP43419>

[2] Fuzzy C-Means Clustering for Iris Data, <http://www.mathworks.com/help/fuzzy/examples/fuzzy-c-means-clustering-for-iris-data.html>

[3] Fuzzy C-Means (FCM), <http://www.bindichen.co.uk/post/AI/fuzzy-c-means.html>