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## LAB 2 – ADVANCED DATA MINING

### RESULT 1:

### SETTINGS:

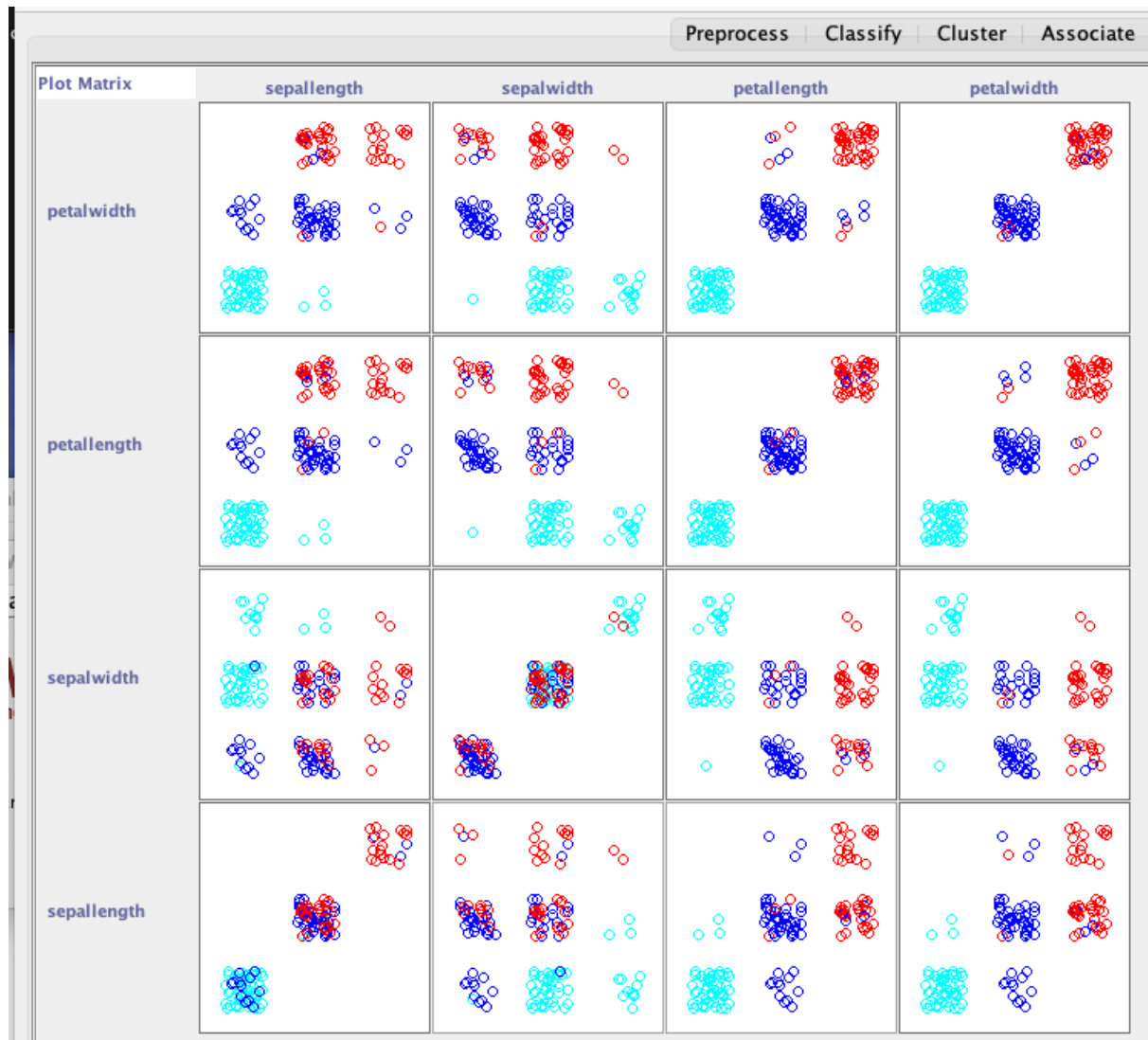
Apriori algorithm -> Using SimpleKMeans->no of bins = 3 -> no of clusters =3, numRules = 10

### RESULTS:

```
== Model and evaluation on training set ==  
  
Clustered Instances  
  
0      55 ( 37%)  
1      45 ( 30%)  
2      50 ( 33%)  
  
Class attribute: class  
Classes to Clusters:  
  
  0  1  2  <-- assigned to cluster  
  0  0  50 | Iris-setosa  
48  2  0  | Iris-versicolor  
  7 43  0 | Iris-virginica  
  
Cluster 0 <-- Iris-versicolor  
Cluster 1 <-- Iris-virginica  
Cluster 2 <-- Iris-setosa  
  
Incorrectly clustered instances :      9.0      6      %
```

After discretizing the Iris dataset into 3 bins and using the SimpleKMeans algorithm to cluster and crosstabulation with the Class, we get the above results. We see that the Iris-Setosa class has been clustered correctly while the other two class have some errors (virginica and versicolor).

Visualization:



## Apriori

Minimum support: 0.3 (45 instances)  
Minimum metric <confidence>: 0.9  
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 16

Size of set of large itemsets L(2): 17

Size of set of large itemsets L(3): 14

Size of set of large itemsets L(4): 6

Size of set of large itemsets L(5): 1

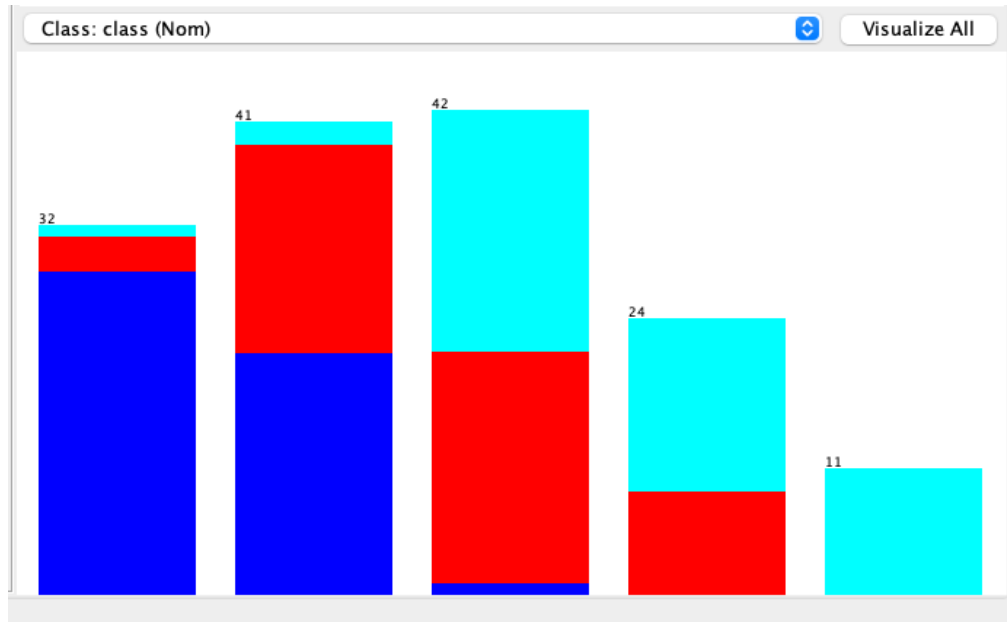
Best rules found:

```
1. petalwidth='(-inf-0.9]' 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
2. petallength='(-inf-2.966667]' 50 ==> petalwidth='(-inf-0.9]' 50    conf:(1)
3. class=Iris-setosa 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
4. petallength='(-inf-2.966667]' 50 ==> class=Iris-setosa 50    conf:(1)
5. cluster=cluster3 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
6. petallength='(-inf-2.966667]' 50 ==> cluster=cluster3 50    conf:(1)
7. class=Iris-setosa 50 ==> petalwidth='(-inf-0.9]' 50    conf:(1)
8. petalwidth='(-inf-0.9]' 50 ==> class=Iris-setosa 50    conf:(1)
9. cluster=cluster3 50 ==> petalwidth='(-inf-0.9]' 50    conf:(1)
10. petalwidth='(-inf-0.9]' 50 ==> cluster=cluster3 50    conf:(1)
11. cluster=cluster3 50 ==> class=Iris-setosa 50    conf:(1)
12. class=Iris-setosa 50 ==> cluster=cluster3 50    conf:(1)
13. petalwidth='(-inf-0.9]' class=Iris-setosa 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
14. petallength='(-inf-2.966667]' class=Iris-setosa 50 ==> petalwidth='(-inf-0.9]' 50    conf:(1)
15. petallength='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50 ==> class=Iris-setosa 50    conf:(1)
16. class=Iris-setosa 50 ==> petallength='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50    conf:(1)
17. petalwidth='(-inf-0.9]' 50 ==> petallength='(-inf-2.966667]' class=Iris-setosa 50    conf:(1)
18. petallength='(-inf-2.966667]' 50 ==> petalwidth='(-inf-0.9]' class=Iris-setosa 50    conf:(1)
19. petalwidth='(-inf-0.9]' cluster=cluster3 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
20. petallength='(-inf-2.966667]' cluster=cluster3 50 ==> petalwidth='(-inf-0.9]' 50    conf:(1)
21. petallength='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50 ==> cluster=cluster3 50    conf:(1)
22. cluster=cluster3 50 ==> petallength='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50    conf:(1)
23. petalwidth='(-inf-0.9]' 50 ==> petallength='(-inf-2.966667]' cluster=cluster3 50    conf:(1)
24. petallength='(-inf-2.966667]' 50 ==> petalwidth='(-inf-0.9]' cluster=cluster3 50    conf:(1)
25. class=Iris-setosa cluster=cluster3 50 ==> petallength='(-inf-2.966667]' 50    conf:(1)
```

We have listed the best 25 rules. Among these rules, we have highlighted some of the rules which do not have the class attribute in the antecedent and the consequent contains only the cluster attribute. These rules have a high confidence level of 1 which suggests strong correlation. However, these rules only describe only cluster, namely, cluster 3 which represents the Iris-setosa class, with a high degree of confidence. This seems to be expected behavior, since the documentation of the IRIS dataset mentions that only one of the classes is linearly separable from the other 2. This is also evident from the image above from the Visualize tab of WEKA (The dark blue cluster).

## VARIATION: DIFFERENT NUMBER OF BINS

Settings: Number of bins = 5, no of clusters = 3, SimpleKMeans algorithm, Apriori algorithm to associate.



=== Model and evaluation on training set ===

Clustered Instances

0	63	( 42%)
1	35	( 23%)
2	52	( 35%)

Class attribute: class

Classes to Clusters:

	0	1	2	
	0	0	50	Iris-setosa
	15	33	2	Iris-versicolor
	48	2	0	Iris-virginica

Cluster 0 <-- Iris-virginica

Cluster 1 <-- Iris-versicolor

Cluster 2 <-- Iris-setosa

Incorrectly clustered instances :	19.0	12.6667 %
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After setting the number of bins to 5 and proceeding with the application of the SimpleKMeans Clustering algorithm, we observe that the number of incorrectly classified instances has increased to 12.67% compared to the previous result of 6%.

Clustering through Association analysis:

```
Apriori
=====

Minimum support: 0.3 (45 instances)
Minimum metric <confidence>: 0.6
Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 10
Size of set of large itemsets L(2): 7
Size of set of large itemsets L(3): 4
Size of set of large itemsets L(4): 1

Best rules found:

1. class=Iris-setosa 50 ==> petallength='(-inf-2.18]' 50    conf:(1)
2. petallength='(-inf-2.18]' 50 ==> class=Iris-setosa 50    conf:(1)
3. petallength='(-inf-2.18]' 50 ==> cluster=cluster3 50    conf:(1)
4. class=Iris-setosa 50 ==> cluster=cluster3 50    conf:(1)
5. class=Iris-setosa cluster=cluster3 50 ==> petallength='(-inf-2.18]' 50    conf:(1)
6. petallength='(-inf-2.18]' cluster=cluster3 50 ==> class=Iris-setosa 50    conf:(1)
7. petallength='(-inf-2.18]' class=Iris-setosa 50 ==> cluster=cluster3 50    conf:(1)
8. class=Iris-setosa 50 ==> petallength='(-inf-2.18]' cluster=cluster3 50    conf:(1)
9. petallength='(-inf-2.18]' 50 ==> class=Iris-setosa cluster=cluster3 50    conf:(1)
10. petalwidth='(-inf-0.58]' 49 ==> petallength='(-inf-2.18]' 49    conf:(1)
11. petalwidth='(-inf-0.58]' 49 ==> class=Iris-setosa 49    conf:(1)
12. petalwidth='(-inf-0.58]' 49 ==> cluster=cluster3 49    conf:(1)
13. petalwidth='(-inf-0.58]' class=Iris-setosa 49 ==> petallength='(-inf-2.18]' 49    conf:(1)
14. petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 ==> class=Iris-setosa 49    conf:(1)
15. petalwidth='(-inf-0.58]' 49 ==> petallength='(-inf-2.18]' class=Iris-setosa 49    conf:(1)
16. petalwidth='(-inf-0.58]' cluster=cluster3 49 ==> petallength='(-inf-2.18]' 49    conf:(1)
17. petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 ==> cluster=cluster3 49    conf:(1)
18. petalwidth='(-inf-0.58]' 49 ==> petallength='(-inf-2.18]' cluster=cluster3 49    conf:(1)
19. petalwidth='(-inf-0.58]' cluster=cluster3 49 ==> class=Iris-setosa 49    conf:(1)
20. petalwidth='(-inf-0.58]' class=Iris-setosa 49 ==> cluster=cluster3 49    conf:(1)
21. petalwidth='(-inf-0.58]' 49 ==> class=Iris-setosa cluster=cluster3 49    conf:(1)
22. petalwidth='(-inf-0.58]' class=Iris-setosa cluster=cluster3 49 ==> petallength='(-inf-2.18]' 49    conf:(1)
23. petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' cluster=cluster3 49 ==> class=Iris-setosa 49    conf:(1)
24. petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' class=Iris-setosa 49 ==> cluster=cluster3 49    conf:(1)
25. petalwidth='(-inf-0.58]' cluster=cluster3 49 ==> petallength='(-inf-2.18]' class=Iris-setosa 49    conf:(1)
```

```

26. petalwidth='(-inf-0.58]' class=Iris-setosa 49 ==> petallength='(-inf-2.18]' cluster=cluster3 49 conf:(1)
27. petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 ==> class=Iris-setosa cluster=cluster3 49 conf:(1)
28. petalwidth='(-inf-0.58]' 49 ==> petallength='(-inf-2.18]' class=Iris-setosa cluster=cluster3 49 conf:(1)
29. petallength='(4.54-5.72]' class=Iris-virginica 33 ==> cluster=cluster1 33 conf:(1)
30. petallength='(-inf-2.18]' 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
31. class=Iris-setosa 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
32. petallength='(-inf-2.18]' class=Iris-setosa 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
33. class=Iris-setosa 50 ==> petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 conf:(0.98)
34. petallength='(-inf-2.18]' 50 ==> petalwidth='(-inf-0.58]' class=Iris-setosa 49 conf:(0.98)
35. petallength='(-inf-2.18]' cluster=cluster3 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
36. petallength='(-inf-2.18]' 50 ==> petalwidth='(-inf-0.58]' cluster=cluster3 49 conf:(0.98)
37. class=Iris-setosa cluster=cluster3 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
38. class=Iris-setosa 50 ==> petalwidth='(-inf-0.58]' cluster=cluster3 49 conf:(0.98)
39. petallength='(-inf-2.18]' class=Iris-setosa cluster=cluster3 50 ==> petalwidth='(-inf-0.58]' 49 conf:(0.98)
40. class=Iris-setosa cluster=cluster3 50 ==> petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 conf:(0.98)
41. petallength='(-inf-2.18]' cluster=cluster3 50 ==> petalwidth='(-inf-0.58]' class=Iris-setosa 49 conf:(0.98)
42. petallength='(-inf-2.18]' class=Iris-setosa 50 ==> petalwidth='(-inf-0.58]' cluster=cluster3 49 conf:(0.98)
43. class=Iris-setosa 50 ==> petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' cluster=cluster3 49 conf:(0.98)
44. petallength='(-inf-2.18]' 50 ==> petalwidth='(-inf-0.58]' class=Iris-setosa cluster=cluster3 49 conf:(0.98)
45. petallength='(3.36-4.54]' 34 ==> class=Iris-versicolor 33 conf:(0.97)
46. cluster=cluster3 52 ==> petallength='(-inf-2.18]' 50 conf:(0.96)
47. cluster=cluster3 52 ==> class=Iris-setosa 50 conf:(0.96)
48. cluster=cluster3 52 ==> petallength='(-inf-2.18]' class=Iris-setosa 50 conf:(0.96)
49. class=Iris-virginica 50 ==> cluster=cluster1 48 conf:(0.96)
50. cluster=cluster2 35 ==> class=Iris-versicolor 33 conf:(0.94)
51. cluster=cluster3 52 ==> petalwidth='(-inf-0.58]' 49 conf:(0.94)
52. cluster=cluster3 52 ==> petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' 49 conf:(0.94)
53. cluster=cluster3 52 ==> petalwidth='(-inf-0.58]' class=Iris-setosa 49 conf:(0.94)
54. cluster=cluster3 52 ==> petallength='(-inf-2.18]' petalwidth='(-inf-0.58]' class=Iris-setosa 49 conf:(0.94)
55. sepalwidth='(-inf-5.02]' 32 ==> cluster=cluster3 30 conf:(0.94)
56. petallength='(4.54-5.72]' 47 ==> cluster=cluster1 44 conf:(0.94)
57. petalwidth='(-inf-0.58]' 49 ==> cluster=cluster3 49 conf:(0.94)
58. petallength='(3.36-4.54]' 34 ==> cluster=cluster2 30 conf:(0.88)
59. cluster=cluster2 35 ==> petallength='(3.36-4.54]' 30 conf:(0.86)
60. cluster=cluster1 63 ==> class=Iris-virginica 48 conf:(0.76)

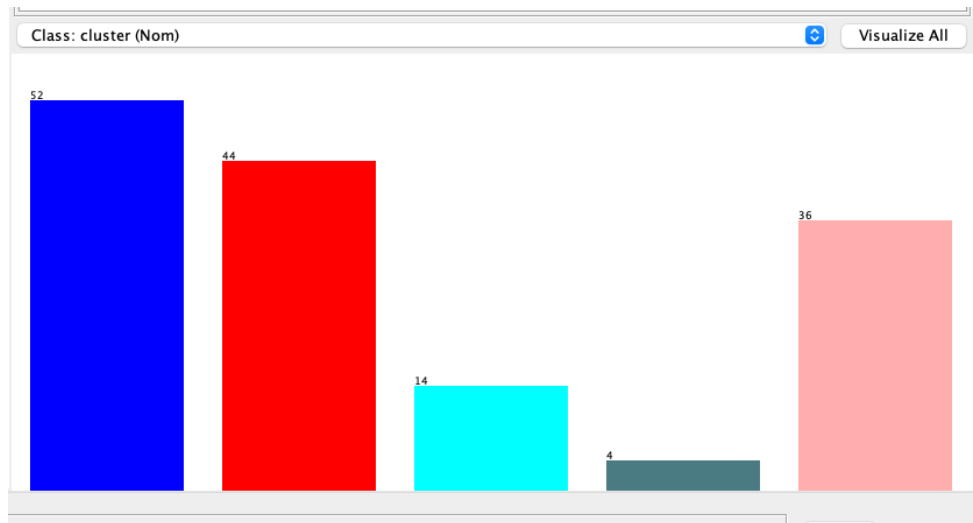
```

FIGURE 1-1 APRIORI RULES FOR K = 3 AND BINS = 5

The best rules generated are listed above and the ones that fulfill the condition listed in the lab are marked with red. ( Rule 8,17,18). We notice that these rules have different intervals, this is because we have increased the number of bins and as a result, the intervals also change. This influences the Apriori rules generated. As before, the cluster 3 seems be alluded to in the majority of rules with a high confidence, but we begin to see some rules for the other clusters lower down, but they have a lower confidence score (0.94) and lower support of 44 compared to rules for cluster 3. Examples: (rules 55,56,58).

## VARIATION: DIFFERENT NUMBER OF CLUSTERS

Settings: Number of clusters = 5, no of bins = 3, SimpleKMeans and Apriori Algorithm.



### Clustered Instances

0	52 ( 35%)
1	44 ( 29%)
2	14 ( 9%)
3	4 ( 3%)
4	36 ( 24%)

Class attribute: class  
Classes to Clusters:

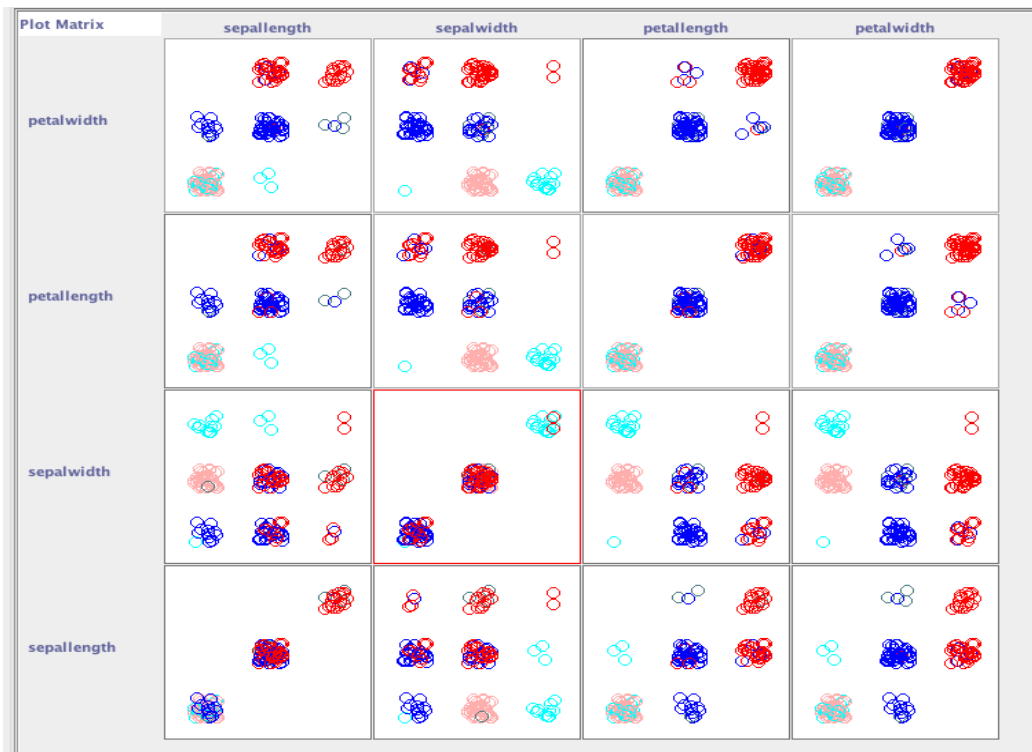
	0	1	2	3	4	
	0	0	14	0	36	Iris-setosa
	45	2	0	3	0	Iris-versicolor
	7	42	0	1	0	Iris-virginica

Cluster 0 <-- Iris-versicolor  
Cluster 1 <-- Iris-virginica  
Cluster 2 <-- No class  
Cluster 3 <-- No class  
Cluster 4 <-- Iris-setosa

Incorrectly clustered instances : 27.0 18 %

Experimenting by changing the number of clusters to 5, leads to an increase in the number of incorrectly clustered instances (18%). We see that cluster 2 and 3 do not match any class, these clusters could contain the outliers from the different classes.





## Apriori

Minimum support: 0.3 (45 instances)  
 Minimum metric <confidence>: 0.6  
 Number of cycles performed: 14

Generated sets of large itemsets:

Size of set of large itemsets L(1): 14

Size of set of large itemsets L(2): 13

Size of set of large itemsets L(3): 7

Size of set of large itemsets L(4): 1

Best rules found:

- petalwidth='(-inf-0.9]' 50 ==> petalwidth='(-inf-2.966667]' 50 conf:(1)
- petalwidth='(-inf-2.966667]' 50 ==> petalwidth='(-inf-0.9]' 50 conf:(1)
- class=Iris-setosa 50 ==> petalwidth='(-inf-2.966667]' 50 conf:(1)
- petalwidth='(-inf-2.966667]' 50 ==> class=Iris-setosa 50 conf:(1)
- class=Iris-setosa 50 ==> petalwidth='(-inf-0.9]' 50 conf:(1)
- petalwidth='(-inf-0.9]' 50 ==> class=Iris-setosa 50 conf:(1)
- petalwidth='(-inf-0.9]' class=Iris-setosa 50 ==> petalwidth='(-inf-2.966667]' 50 conf:(1)
- petalwidth='(-inf-2.966667]' class=Iris-setosa 50 ==> petalwidth='(-inf-0.9]' 50 conf:(1)
- petalwidth='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50 ==> class=Iris-setosa 50 conf:(1)
- class=Iris-setosa 50 ==> petalwidth='(-inf-2.966667]' petalwidth='(-inf-0.9]' 50 conf:(1)
- petalwidth='(-inf-0.9]' 50 ==> petalwidth='(-inf-2.966667]' class=Iris-setosa 50 conf:(1)
- petalwidth='(-inf-2.966667]' 50 ==> petalwidth='(-inf-0.9]' class=Iris-setosa 50 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-0.9]' 47 ==> petalwidth='(-inf-2.966667]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-2.966667]' 47 ==> petalwidth='(-inf-0.9]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' class=Iris-setosa 47 ==> petalwidth='(-inf-2.966667]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-2.966667]' 47 ==> class=Iris-setosa 47 conf:(1)
- sepalwidth='(-inf-5.5]' class=Iris-setosa 47 ==> petalwidth='(-inf-0.9]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-0.9]' class=Iris-setosa 47 ==> petalwidth='(-inf-2.966667]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-2.966667]' class=Iris-setosa 47 ==> petalwidth='(-inf-0.9]' 47 conf:(1)
- sepalwidth='(-inf-5.5]' petalwidth='(-inf-2.966667]' petalwidth='(-inf-0.9]' 47 ==> class=Iris-setosa 47 conf:(1)



```

22. sepalength=(-inf-5.5]' class=Iris-setosa 47 ==> petallength=(-inf-2.966667]' petalwidth=(-inf-0.9]' 47 conf:(1)
23. sepalength=(-inf-5.5]' petalwidth=(-inf-0.9]' 47 ==> petallength=(-inf-2.966667]' class=Iris-setosa 47 conf:(1)
24. sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' 47 ==> petalwidth=(-inf-0.9]' class=Iris-setosa 47 conf:(1)
25. class=Iris-versicolor cluster=cluster1 45 ==> petalwidth=(0.9-1.7]' 45 conf:(1)
26. class=Iris-versicolor 50 ==> petalwidth=(0.9-1.7]' 49 conf:(0.98)
27. petallength=(2.966667-4.933333]' class=Iris-versicolor 48 ==> petalwidth=(0.9-1.7]' 47 conf:(0.98)
28. petallength=(2.966667-4.933333]' petalwidth=(0.9-1.7]' 48 ==> class=Iris-versicolor 47 conf:(0.98)
29. petalwidth=(1.7-inf)' 46 ==> class=Iris-virginica 45 conf:(0.98)
30. class=Iris-versicolor 50 ==> petallength=(2.966667-4.933333]' 48 conf:(0.96)
31. petalwidth=(0.9-1.7]' class=Iris-versicolor 49 ==> petallength=(2.966667-4.933333]' 47 conf:(0.96)
32. cluster=cluster1 52 ==> petalwidth=(0.9-1.7]' 49 conf:(0.94)
33. petallength=(-inf-2.966667]' 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
34. petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
35. class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
36. petallength=(-inf-2.966667]' petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
37. petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' 47 conf:(0.94)
38. petallength=(-inf-2.966667]' 50 ==> sepalength=(-inf-5.5]' petalwidth=(-inf-0.9]' 47 conf:(0.94)
39. petallength=(-inf-2.966667]' class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
40. class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' 47 conf:(0.94)
41. petallength=(-inf-2.966667]' 50 ==> sepalength=(-inf-5.5]' class=Iris-setosa 47 conf:(0.94)
42. petalwidth=(-inf-0.9]' class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
43. class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' petalwidth=(-inf-0.9]' 47 conf:(0.94)
44. petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' class=Iris-setosa 47 conf:(0.94)
45. class=Iris-versicolor 50 ==> petallength=(2.966667-4.933333]' petalwidth=(0.9-1.7]' 47 conf:(0.94)
46. petallength=(-inf-2.966667]' petalwidth=(-inf-0.9]' class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' 47 conf:(0.94)
47. petalwidth=(-inf-0.9]' class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' 47 conf:(0.94)
48. petallength=(-inf-2.966667]' class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' petalwidth=(-inf-0.9]' 47 conf:(0.94)
49. petallength=(-inf-2.966667]' petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' class=Iris-setosa 47 conf:(0.94)
50. class=Iris-setosa 50 ==> sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' petalwidth=(-inf-0.9]' 47 conf:(0.94)
51. petalwidth=(-inf-0.9]' 50 ==> sepalength=(-inf-5.5]' petallength=(-inf-2.966667]' class=Iris-setosa 47 conf:(0.94)
52. petallength=(-inf-2.966667]' 50 ==> sepalength=(-inf-5.5]' petalwidth=(-inf-0.9]' class=Iris-setosa 47 conf:(0.94)
53. petallength=(2.966667-4.933333]' cluster=cluster1 48 ==> petalwidth=(0.9-1.7]' 45 conf:(0.94)
54. petallength=(2.966667-4.933333]' petalwidth=(0.9-1.7]' 48 ==> cluster=cluster1 45 conf:(0.94)
55. cluster=cluster1 52 ==> petallength=(2.966667-4.933333]' 48 conf:(0.92)
56. petalwidth=(0.9-1.7]' cluster=cluster1 49 ==> petallength=(2.966667-4.933333]' 45 conf:(0.92)
57. petalwidth=(0.9-1.7]' cluster=cluster1 49 ==> class=Iris-versicolor 45 conf:(0.92)
58. petalwidth=(0.9-1.7]' class=Iris-versicolor 49 ==> cluster=cluster1 45 conf:(0.92)
59. petalwidth=(0.9-1.7]' 54 ==> class=Iris-versicolor 49 conf:(0.91)
60. petalwidth=(0.9-1.7]' 54 ==> cluster=cluster1 49 conf:(0.91)
61. class=Iris-virginica 50 ==> petalwidth=(1.7-inf)' 45 conf:(0.9)
62. class=Iris-versicolor 50 ==> cluster=cluster1 45 conf:(0.9)
63. class=Iris-versicolor 50 ==> petalwidth=(0.9-1.7]' cluster=cluster1 45 conf:(0.9)
64. petalwidth=(0.9-1.7]' 54 ==> petallength=(2.966667-4.933333]' 48 conf:(0.89)
65. petallength=(2.966667-4.933333]' 54 ==> petalwidth=(0.9-1.7]' 48 conf:(0.89)

```

The rules generated from the Apriori algorithm in this variation are not “good”, they do not contain many rules without the class attribute in the antecedent. We are only able to find some rules for the cluster 1, which represents class Iris-versicolour. The other clusters do not seem to have any rules generated. Additionally, by setting the number of clusters to 5, we have some clusters with very few members. This could lead to the clustering algorithm to have difficulty in generating rules for these clusters due to lack of sufficient support.

We observed from our different variations that changing the number of clusters and the number of bins affects the clustering. Having a larger number of clusters than optimal increases the complexity and may result in decrease of accuracy, whereas having a smaller number of clusters may increase the difficulty is capturing a key difference between the clusters. Changing the number of bins affects the number of instances within each bin which could lead to issues in support for the Apriori rules.