AI Assignment 3
2020561
Harjeet Singh Yadav

Accuracies with different classification models:-

Naive Bayes

```
Accuracy: 0.36
Classification Report:
              precision    recall  f1-score   support

           1       0.00      0.00      0.00        48
           2       0.41      1.00      0.58        58
           3       0.00      0.00      0.00        36

    accuracy                           0.41       142
   macro avg       0.14      0.33      0.19       142
weighted avg       0.17      0.41      0.24       142
```

MLP Classification

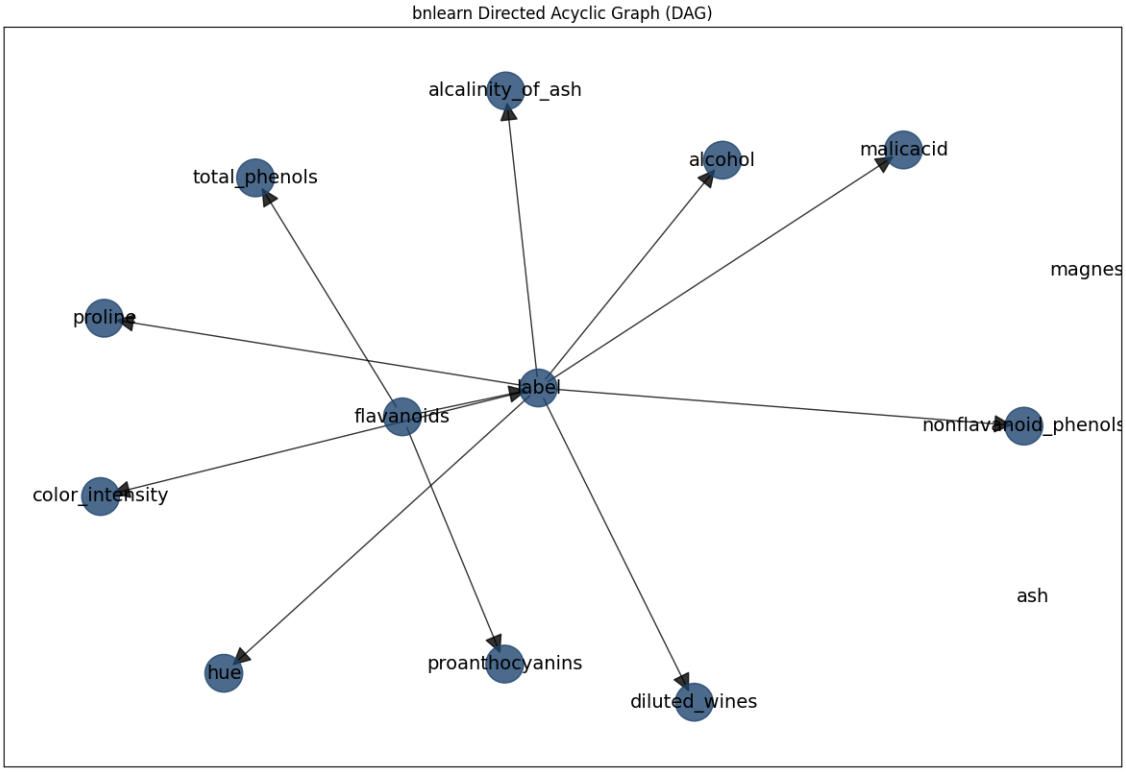
```
Accuracy: 0.97
Classification Report:
              precision    recall  f1-score   support

           1       1.00      1.00      1.00        11
           2       1.00      0.92      0.96        13
           3       0.92      1.00      0.96        12

    accuracy                           0.97        36
   macro avg       0.97      0.97      0.97        36
weighted avg       0.97      0.97      0.97        36
```

Bayesian network (using bnlearn)

Network A

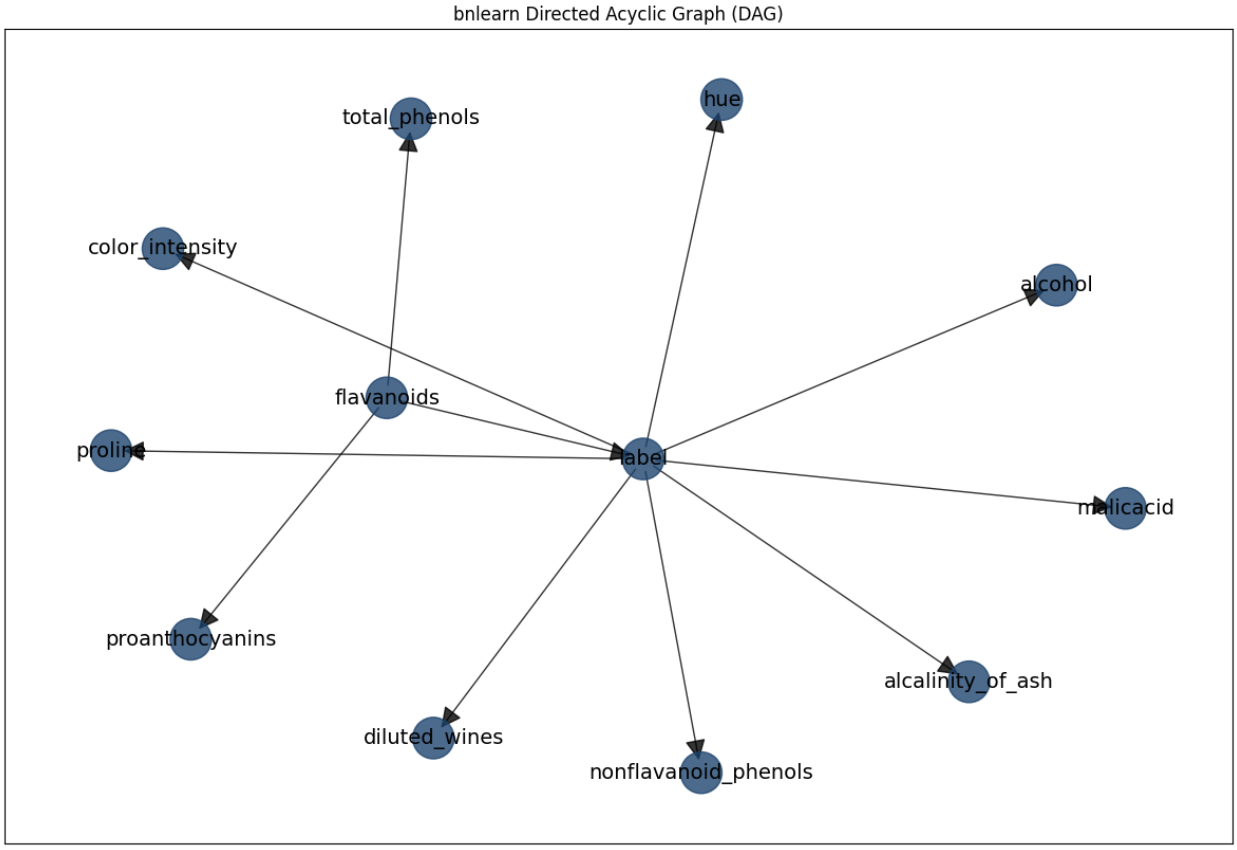


CPD tables

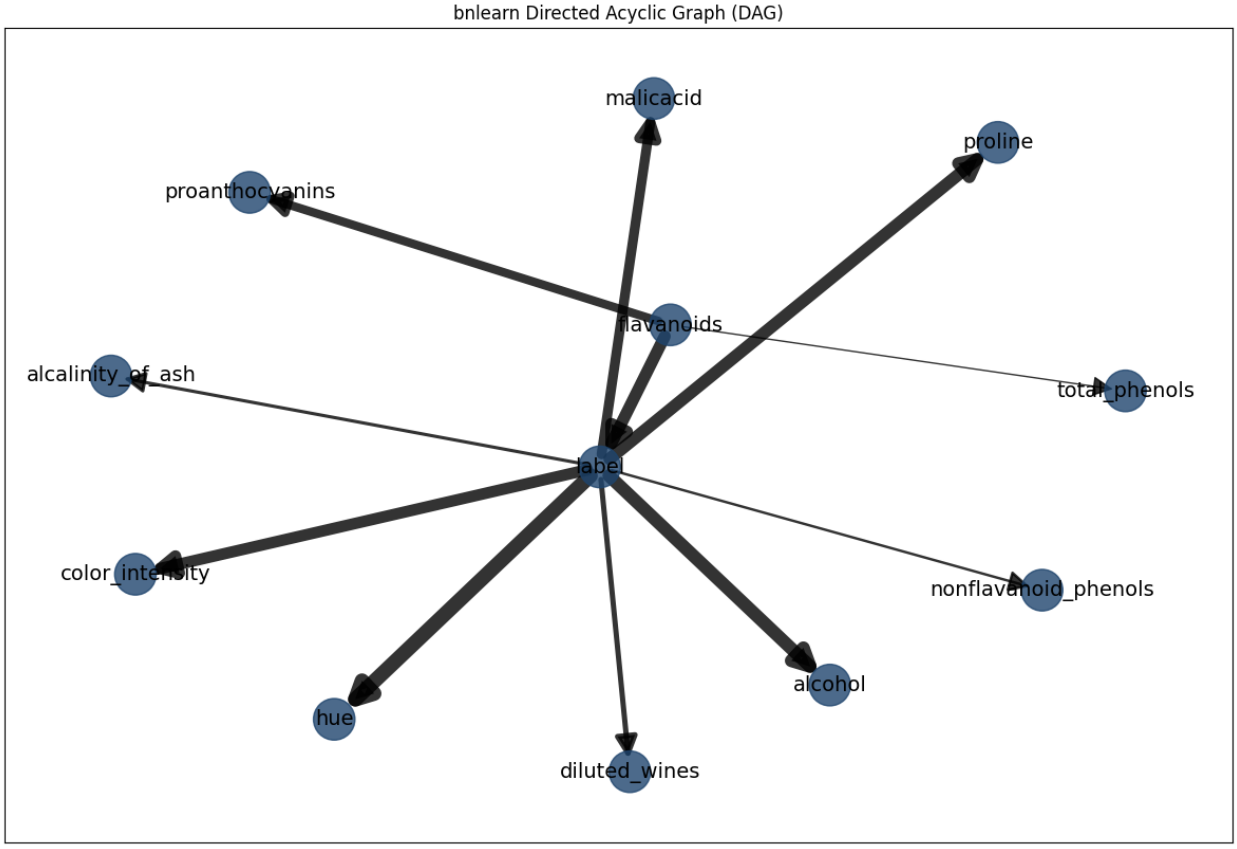
```
[bnlearn] >CPD of flavanoids:
+---------------+----------+
| flavanoids(0) | 0.263158 |
+---------------+----------+
| flavanoids(1) | 0.268251 |
+---------------+----------+
| flavanoids(2) | 0.254669 |
+---------------+----------+
| flavanoids(3) | 0.213922 |
+---------------+----------+
[bnlearn] >CPD of total_phenols:
+------------------+-----+---------------------+
| flavanoids       | ... | flavanoids(3)       |
+------------------+-----+---------------------+
| total_phenols(0) | ... | 0.24801587301587302 |
+------------------+-----+---------------------+
| total_phenols(1) | ... | 0.24801587301587302 |
+------------------+-----+---------------------+
| total_phenols(2) | ... | 0.24801587301587302 |
+------------------+-----+---------------------+
| total_phenols(3) | ... | 0.25595238095238093 |
+------------------+-----+---------------------+
[bnlearn] >CPD of proanthocyanins:
+--------------------+-----+---------------------+
| flavanoids         | ... | flavanoids(3)       |
+--------------------+-----+---------------------+
| proanthocyanins(0) | ... | 0.24801587301587302 |
+--------------------+-----+---------------------+
| proanthocyanins(1) | ... | 0.25595238095238093 |
+--------------------+-----+---------------------+
| proanthocyanins(2) | ... | 0.24801587301587302 |
+--------------------+-----+---------------------+
| proanthocyanins(3) | ... | 0.24801587301587302 |
+--------------------+-----+---------------------+
```

Network B (pruning)

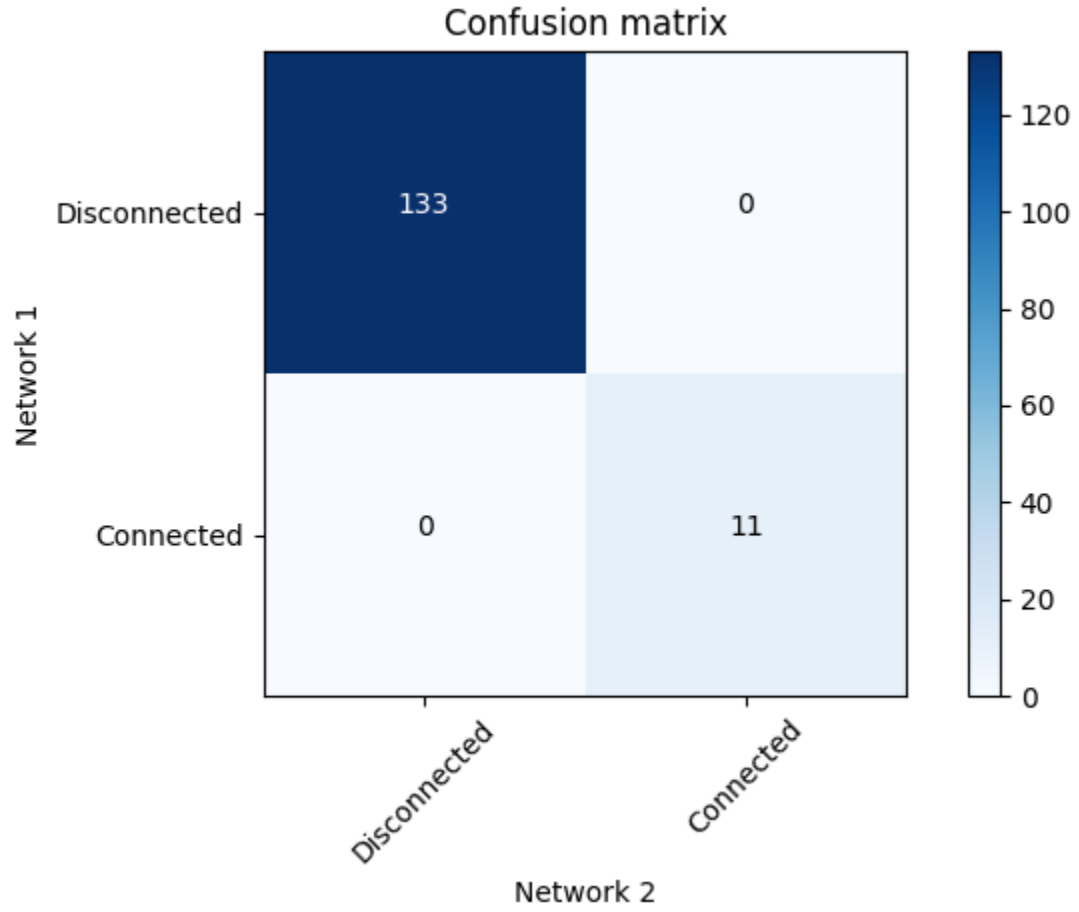
1)

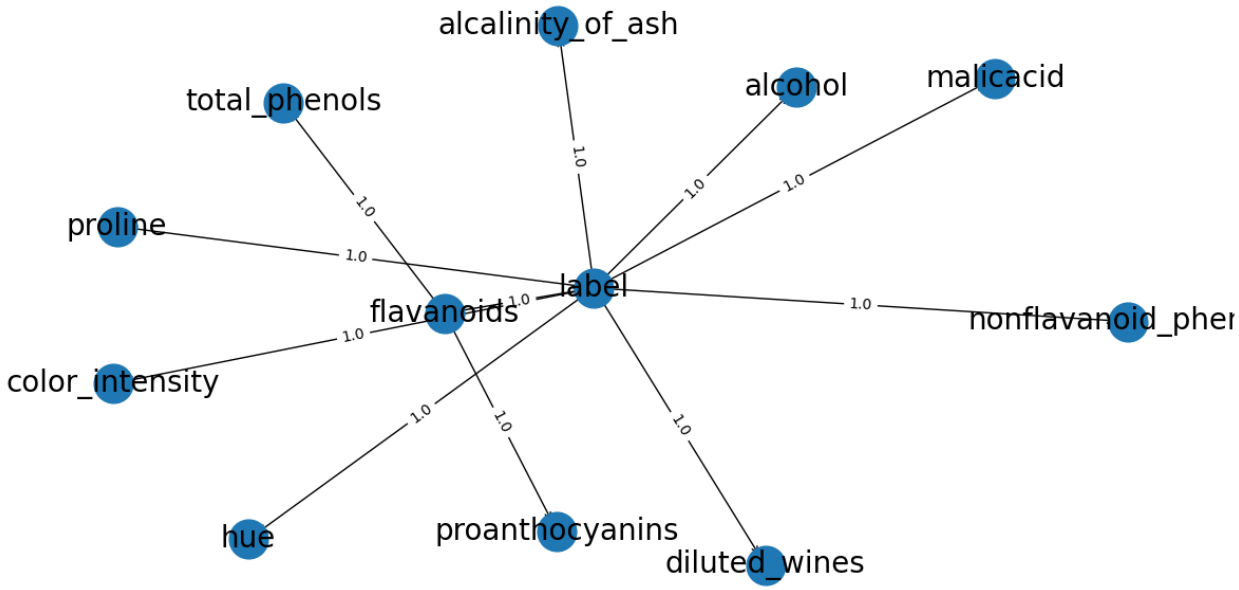


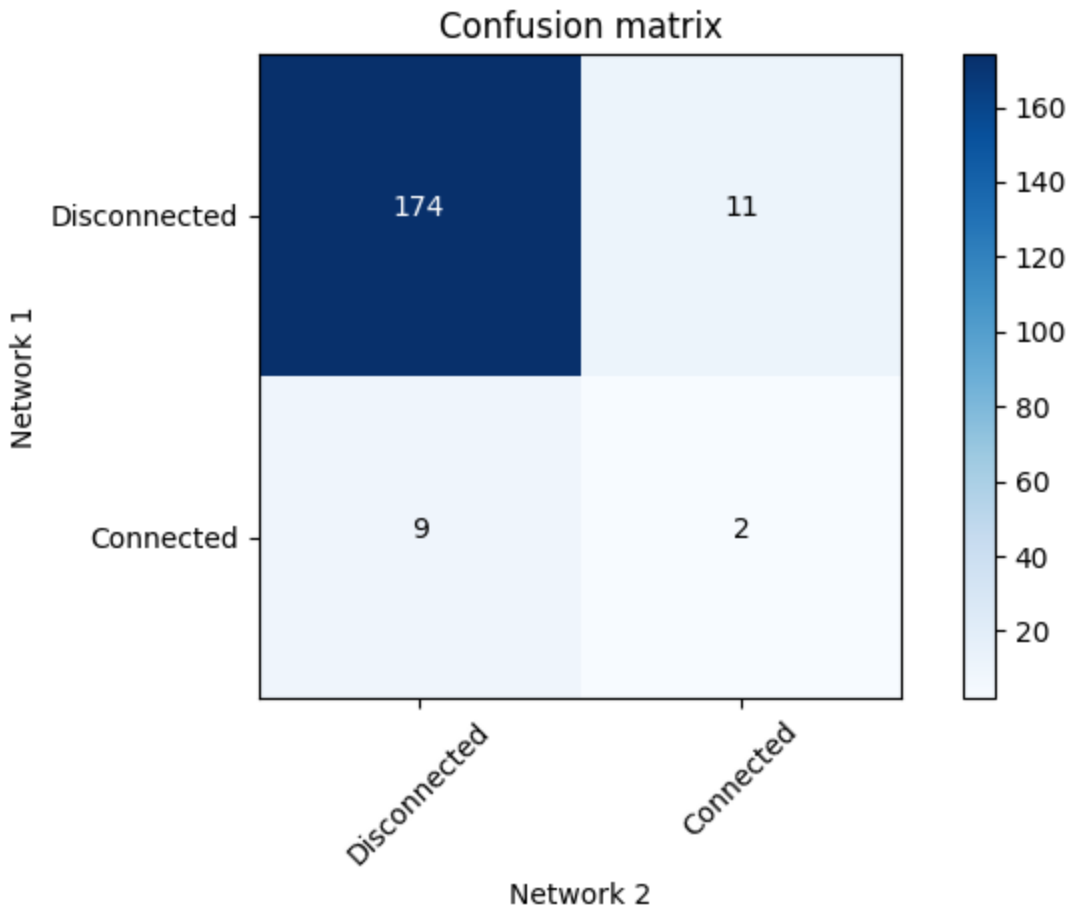
2)

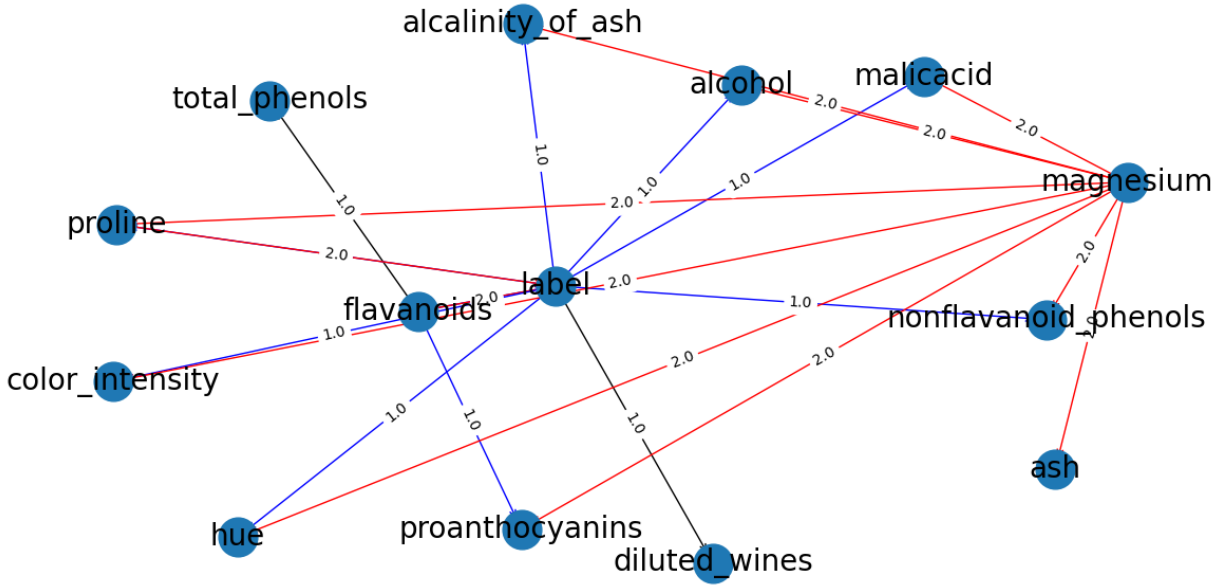


Network A and B comparison.

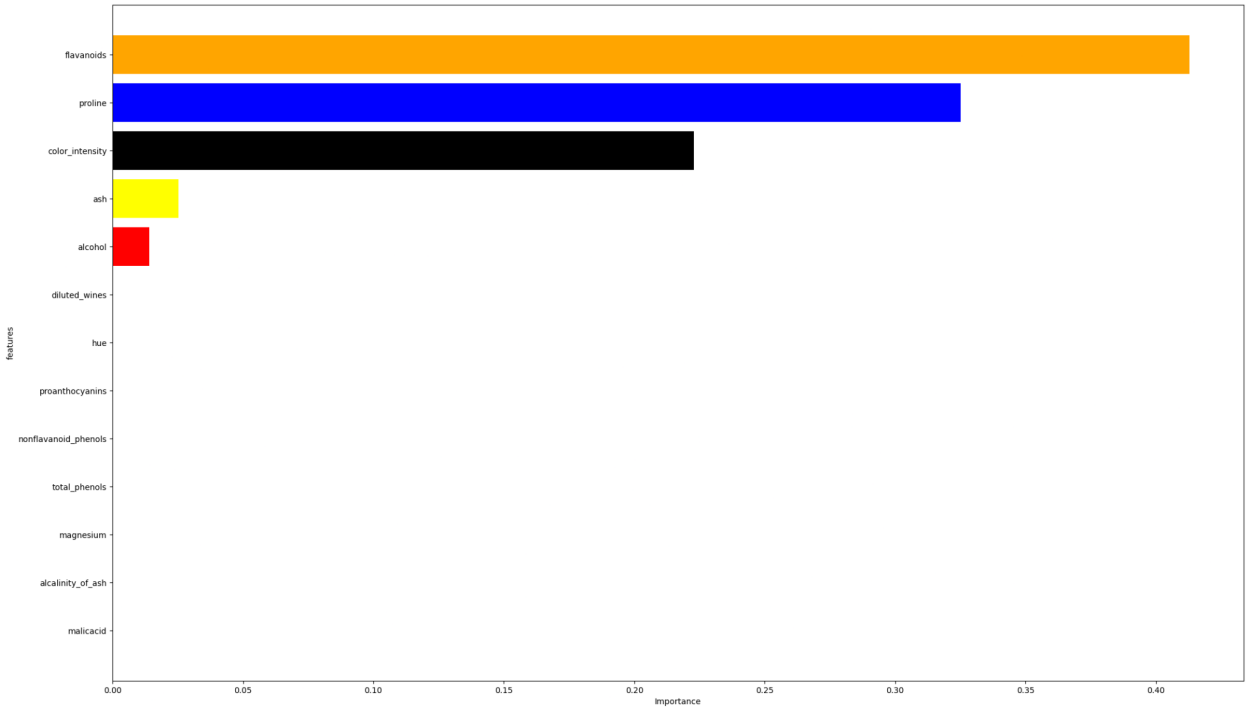


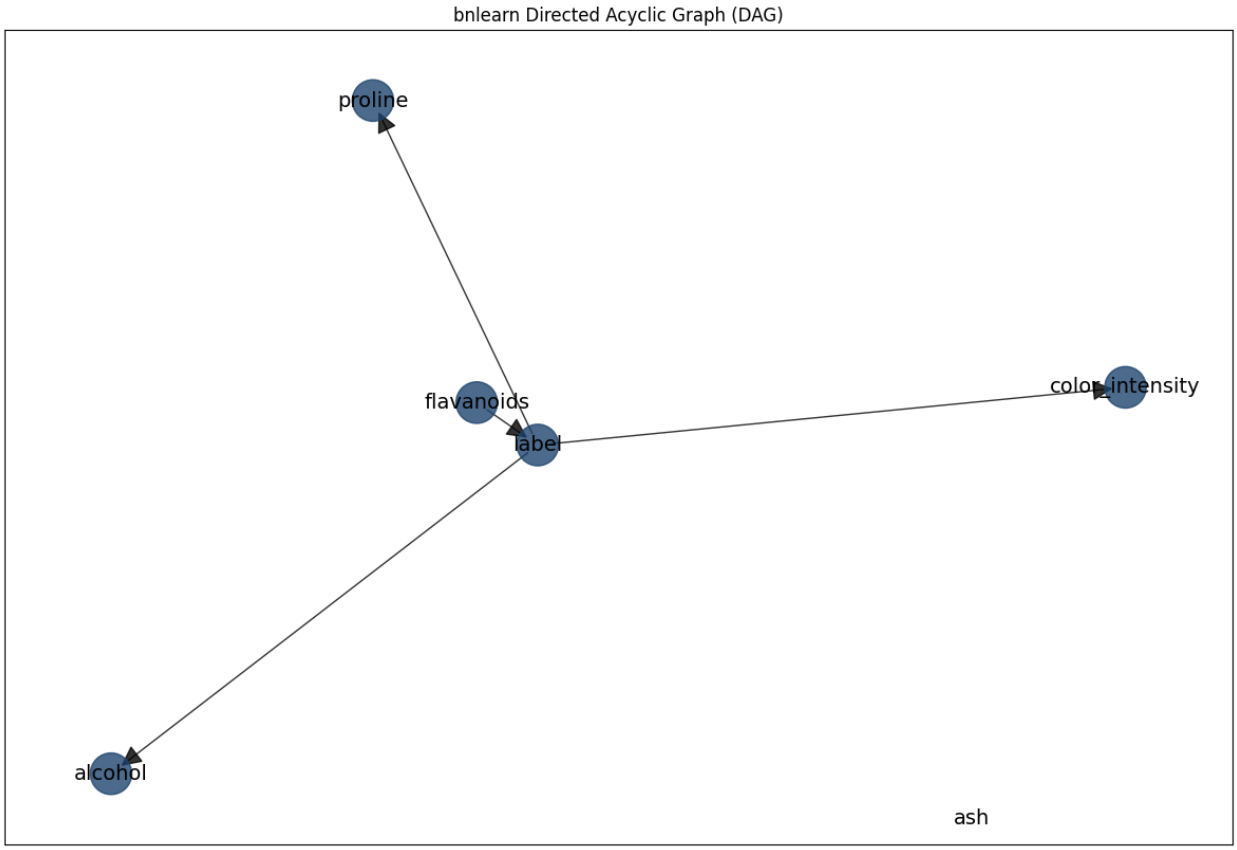



Confusion matrix
Disconnected
Connected
174
11
9
2
Network 1
Disconnected
Connected
Network 2
160
140
120
100
80
60
40
20


alcalinity_of_ash
alcohol
malicacid
total_phenols
magnesium
proline
label
flavanoids
nonflavanoid_phenols
color_intensity
ash
hue
proanthocyanins
diluted_wines

Network C
Feature importance





Posterior probabilities:-

Network A

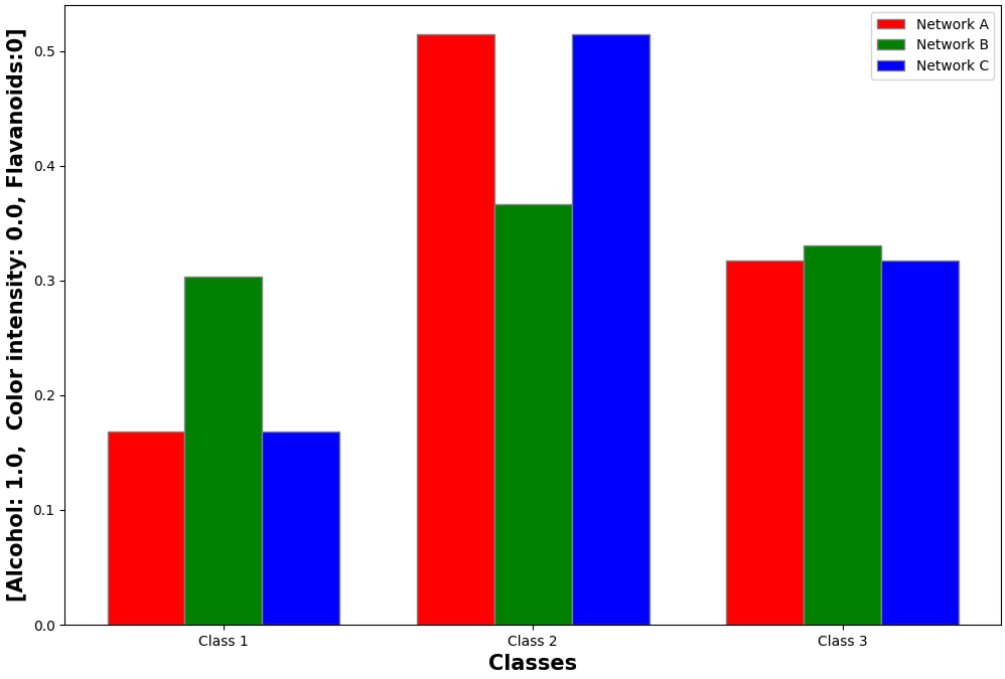
```
[bnlearn] >Variable Elimination.
[bnlearn] >Warning: variable(s) [None] does not exists in DAG.
[bnlearn] >Data is stored in [query.df]
+----+---------+----------+
|    |   label |        p |
+====+=========+==========+
|  0 |       1 | 0.205712 |
+----+---------+----------+
|  1 |       2 | 0.586854 |
+----+---------+----------+
|  2 |       3 | 0.207434 |
+----+---------+----------+
+----------+--------------+
| label    |   phi(label) |
+==========+==============+
| label(1) |       0.2057 |
+----------+--------------+
| label(2) |       0.5869 |
+----------+--------------+
| label(3) |       0.2074 |
+----------+--------------+
[bnlearn] >Variable Elimination.
[bnlearn] >Warning: variable(s) [None] does not exists in DAG.
[bnlearn] >Data is stored in [query.df]
+----+---------+----------+
...
| label(2) |       0.3629 |
+----------+--------------+
| label(3) |       0.3386 |
+----------+--------------+
```

Network B

```
+----+---------+----------+
|    |   label |        p |
+====+=========+==========+
|  0 |       1 | 0.318175 |
+----+---------+----------+
|  1 |       2 | 0.41491  |
+----+---------+----------+
|  2 |       3 | 0.266915 |
+----+---------+----------+
+----------+--------------+
| label    |   phi(label) |
+==========+==============+
| label(1) |       0.3182 |
+----------+--------------+
| label(2) |       0.4149 |
+----------+--------------+
| label(3) |       0.2669 |
+----------+--------------+
[bnlearn] >Variable Elimination.
[bnlearn] >Warning: variable(s) [None] does not exists in DAG.
[bnlearn] >Data is stored in [query.df]
+----+---------+----------+
...
| label(2) |       0.3268 |
+----------+--------------+
| label(3) |       0.3531 |
+----------+--------------+
```

Network C

```
+----+---------+----------+
|    |   label |        p |
+====+=========+==========+
|  0 |       1 | 0.155603 |
+----+---------+----------+
|  1 |       2 | 0.65986  |
+----+---------+----------+
|  2 |       3 | 0.184537 |
+----+---------+----------+
+----------+--------------+
| label    |   phi(label) |
+==========+==============+
| label(1) |       0.1556 |
+----------+--------------+
| label(2) |       0.6599 |
+----------+--------------+
| label(3) |       0.1845 |
+----------+--------------+
[bnlearn] >Variable Elimination.
[bnlearn] >Warning: variable(s) [None] does not exists in DAG.
[bnlearn] >Data is stored in [query.df]
+----+---------+----------+
...
| label(2) |       0.3683 |
+----------+--------------+
| label(3) |       0.3645 |
+----------+--------------+
```



Final evaluation

NETWORK	**ACCURACY**
Network A	**0.929**
Network B1	**0.87.8**
Network B2	**0.94.25**
Network C	**0.93.7**