JADAVPUR UNIVERSITY

MACHINE LEARNING LABORATORY

ASSIGNMENT #2 - C) IONOSPHERE DATASET

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DEPARTMENT - INFORMATION TECHNOLOGY

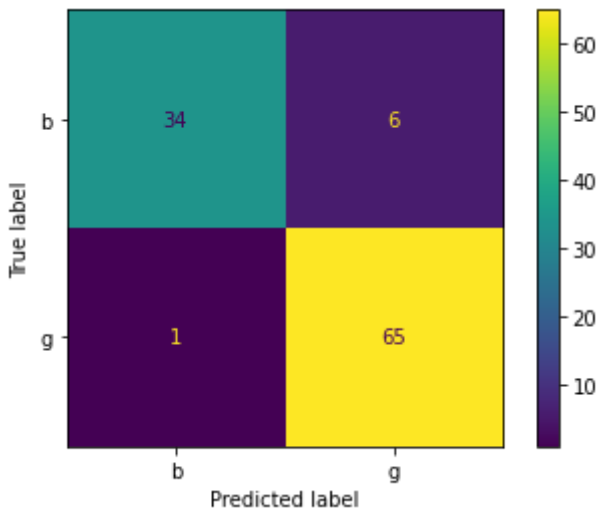
ROLL NO - 001811001035

In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.30,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------------")
print("-------------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[34  6]
 [ 1 65]]
-------------------------------------------------------
-------------------------------------------------------
```

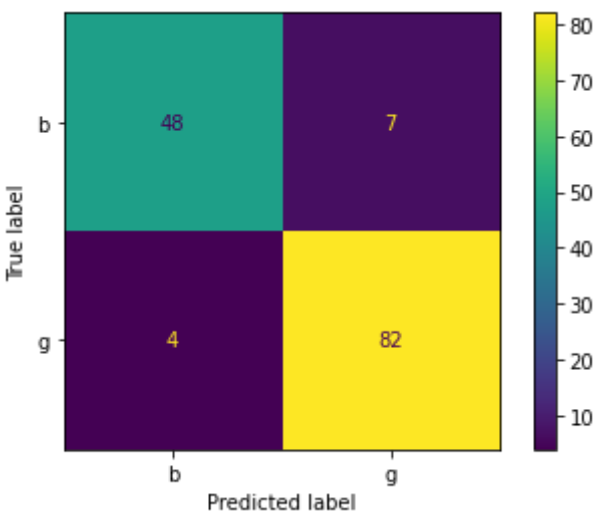
```
Performance Evaluation
              precision    recall  f1-score   support

           b       0.97      0.85      0.91        40
           g       0.92      0.98      0.95        66

    accuracy                           0.93       106
   macro avg       0.94      0.92      0.93       106
weighted avg       0.94      0.93      0.93       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9339622641509434
```



In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[48  7]
 [ 4 82]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.92      0.87      0.90        55
           g       0.92      0.95      0.94        86

    accuracy                           0.92       141
   macro avg       0.92      0.91      0.92       141
weighted avg       0.92      0.92      0.92       141

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9219858156028369
```

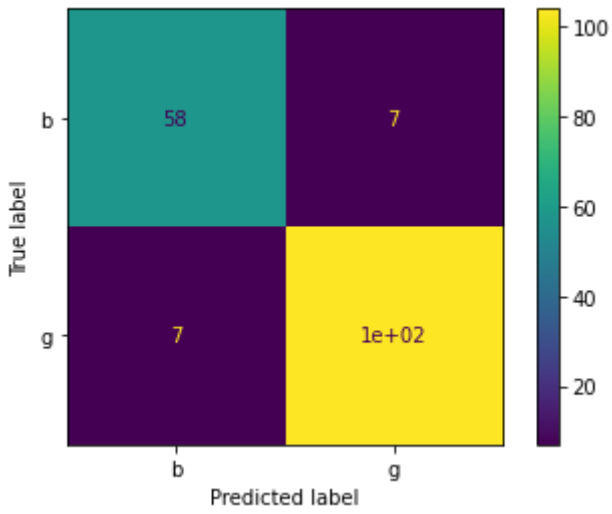


In [ ]:

```python
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
```

```
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 58   7]
 [  7 104]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.89      0.89      0.89        65
           g       0.94      0.94      0.94       111

    accuracy                           0.92       176
   macro avg       0.91      0.91      0.91       176
weighted avg       0.92      0.92      0.92       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9204545454545454
```

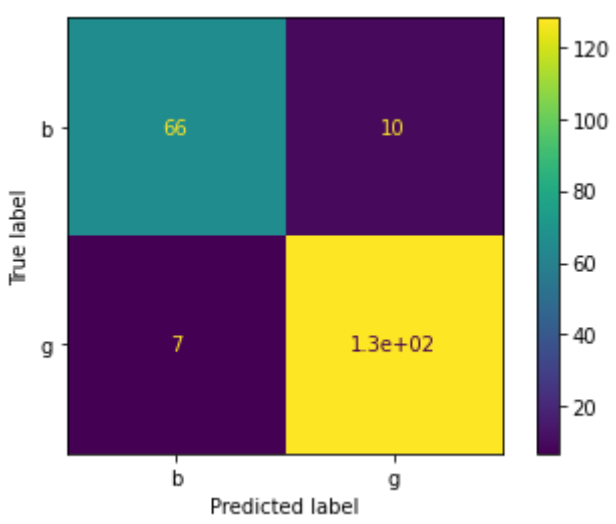


In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[40-60 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))
```

```
print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 66  10]
 [  7 128]]
-----------------------------------------------------
-----------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.90      0.87      0.89        76
           g       0.93      0.95      0.94       135

    accuracy                           0.92       211
   macro avg       0.92      0.91      0.91       211
weighted avg       0.92      0.92      0.92       211

-----------------------------------------------------
-----------------------------------------------------
Accuracy:
0.919431279620853
```

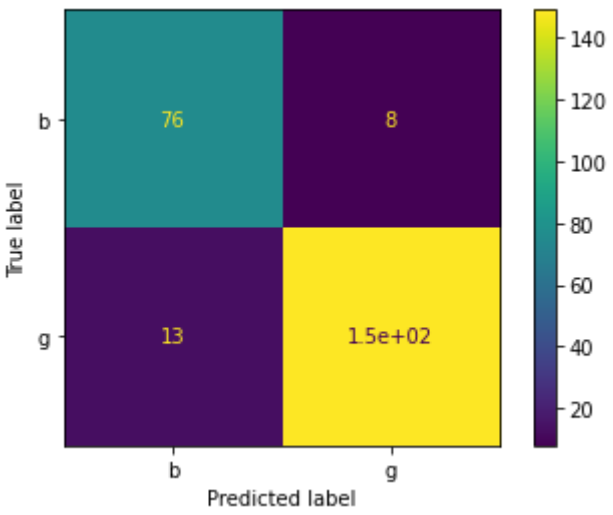


In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))
```

```
print("-------------------------------------------------")
print("-------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------")
print("-------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 76   8]
 [ 13 149]]
-------------------------------------------------
-------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.85      0.90      0.88        84
           g       0.95      0.92      0.93       162

    accuracy                           0.91       246
   macro avg       0.90      0.91      0.91       246
weighted avg       0.92      0.91      0.92       246

-------------------------------------------------
-------------------------------------------------
Accuracy:
0.9146341463414634
```



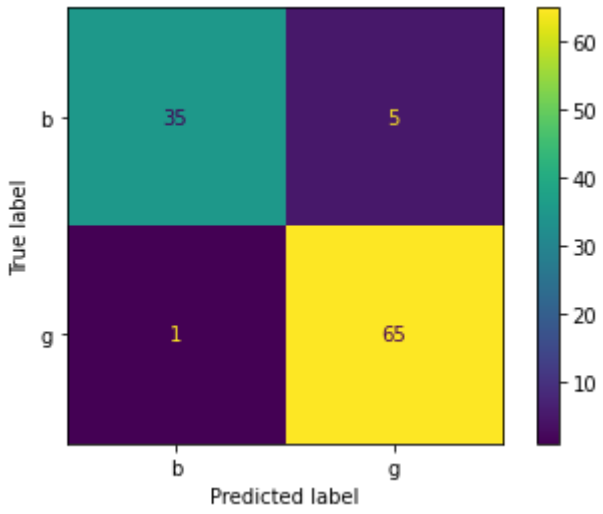
In [ ]:
```
##########################################################################################################
```

In [ ]:
```
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier
```

```
classifier = RandomForestClassifier()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

################################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")


print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
```

```
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   54.0s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  3.6min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  6.8min finished
Confusion Matrix:
[[35  5]
 [ 1 65]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.97      0.88      0.92        40
           g       0.93      0.98      0.96        66

    accuracy                           0.94       106
   macro avg       0.95      0.93      0.94       106
weighted avg       0.95      0.94      0.94       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9433962264150944
```



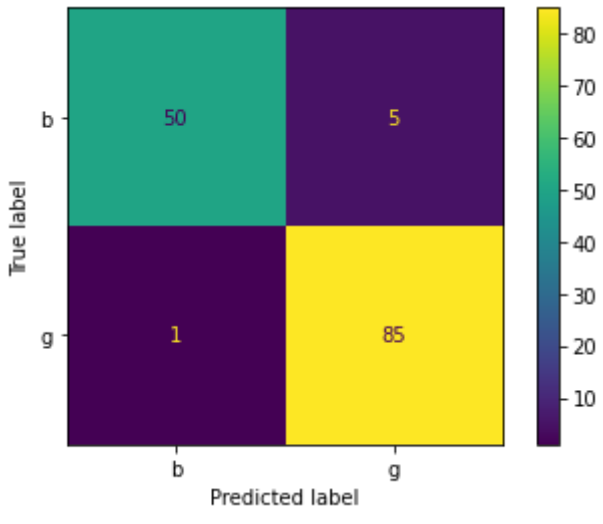
In [ ]:

```python
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier()

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features
```

```python
from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

################################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   50.8s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  3.5min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  6.6min finished
Confusion Matrix:
[[50  5]
 [ 1 85]]
--------------------------------------------------
```

```
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.98      0.91      0.94        55
           g       0.94      0.99      0.97        86

    accuracy                           0.96       141
   macro avg       0.96      0.95      0.95       141
weighted avg       0.96      0.96      0.96       141

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9574468085106383
```

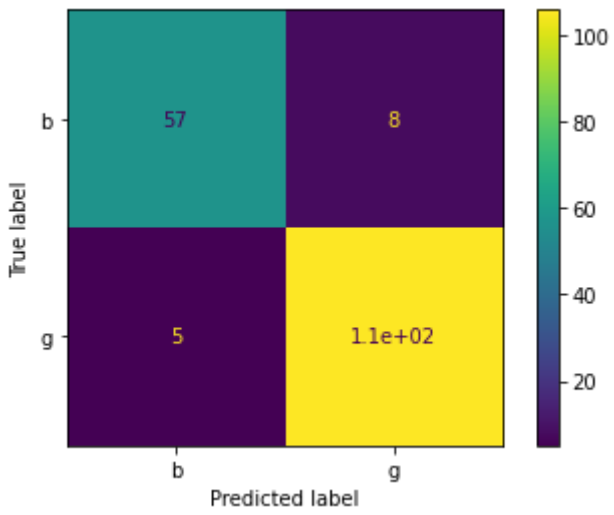


In [ ]:

```python
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
```

```python
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

################################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   49.3s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  3.4min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  6.4min finished
Confusion Matrix:
[[ 57   8]
 [  5 106]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.92      0.88      0.90        65
           g       0.93      0.95      0.94       111

    accuracy                           0.93       176
   macro avg       0.92      0.92      0.92       176
weighted avg       0.93      0.93      0.93       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9261363636363636
```

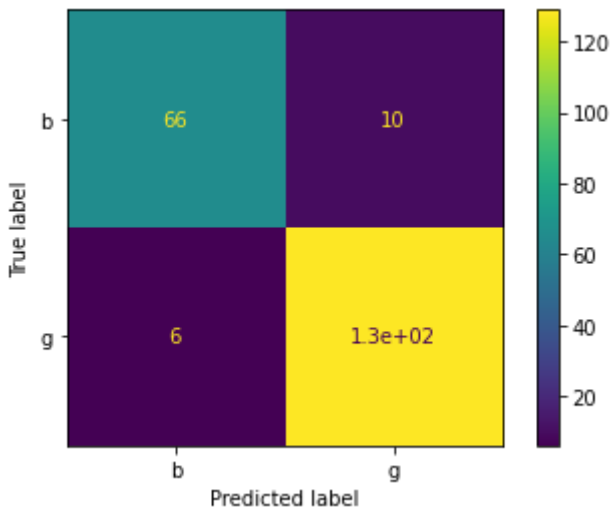


In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[40-60 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

################################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
```

```python
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   47.1s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  3.5min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  6.9min finished
Confusion Matrix:
[[ 66  10]
 [  6 129]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.92      0.87      0.89        76
           g       0.93      0.96      0.94       135

    accuracy                           0.92       211
   macro avg       0.92      0.91      0.92       211
weighted avg       0.92      0.92      0.92       211

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9241706161137441
```

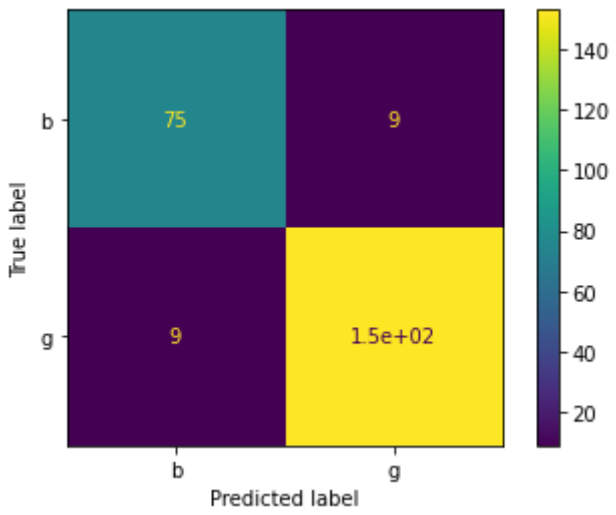


In [ ]:

```
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

################################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
```

```python
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   48.1s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  3.4min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  6.4min finished
Confusion Matrix:
[[ 75   9]
 [  9 153]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.89      0.89      0.89        84
           g       0.94      0.94      0.94       162

    accuracy                           0.93       246
   macro avg       0.92      0.92      0.92       246
weighted avg       0.93      0.93      0.93       246

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.926829268292683
```

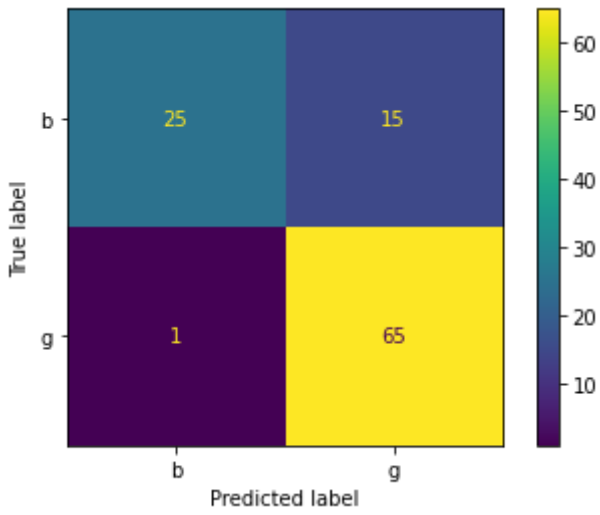


In [ ]:
```
##########################################################################################################
```

In [ ]:
```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------")
print("-------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------")
print("-------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[25 15]
 [ 1 65]]
-------------------------------------------------
-------------------------------------------------
Performance Evaluation
```

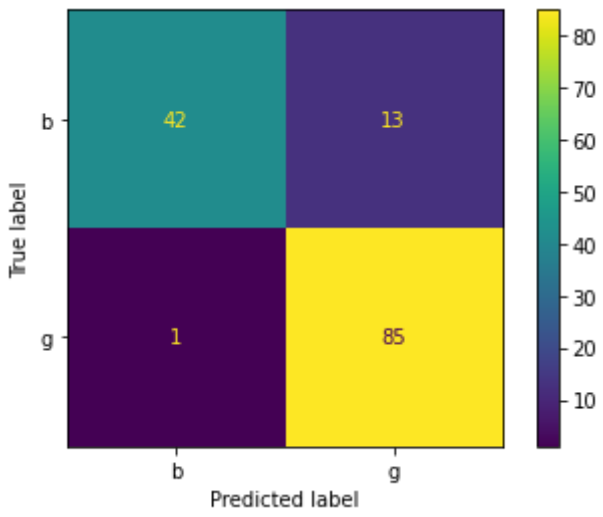
```
              precision    recall  f1-score   support

           b       0.96      0.62      0.76        40
           g       0.81      0.98      0.89        66

    accuracy                           0.85       106
   macro avg       0.89      0.80      0.82       106
weighted avg       0.87      0.85      0.84       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.8490566037735849
```



In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[42 13]
 [ 1 85]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.98      0.76      0.86        55
           g       0.87      0.99      0.92        86

    accuracy                           0.90       141
   macro avg       0.92      0.88      0.89       141
weighted avg       0.91      0.90      0.90       141

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.900709219858156
```

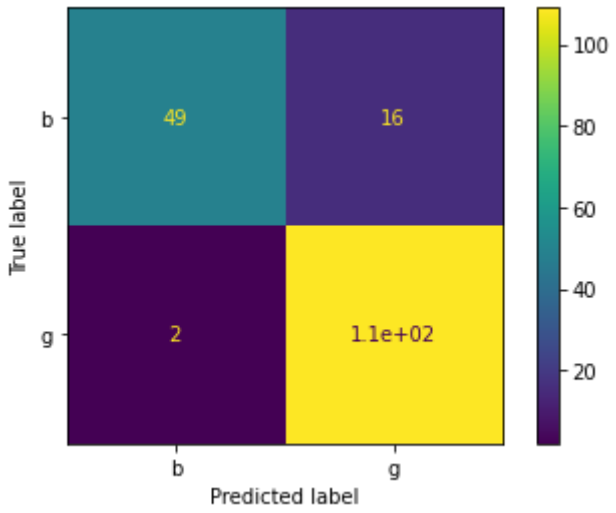


In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")
```

```
print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[ 49  16]
 [  2 109]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.96      0.75      0.84        65
           g       0.87      0.98      0.92       111

    accuracy                           0.90       176
   macro avg       0.92      0.87      0.88       176
weighted avg       0.90      0.90      0.89       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.8977272727272727
```

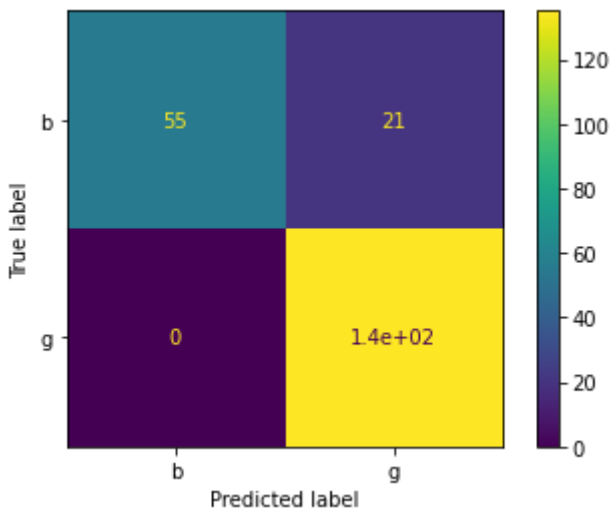


In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[40-60 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
```

```
print("-------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------")
print("-------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[ 55  21]
 [  0 135]]
-------------------------------------------------
-------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.72      0.84        76
           g       0.87      1.00      0.93       135

    accuracy                           0.90       211
   macro avg       0.93      0.86      0.88       211
weighted avg       0.91      0.90      0.90       211

-------------------------------------------------
-------------------------------------------------
Accuracy:
0.9004739336492891
```

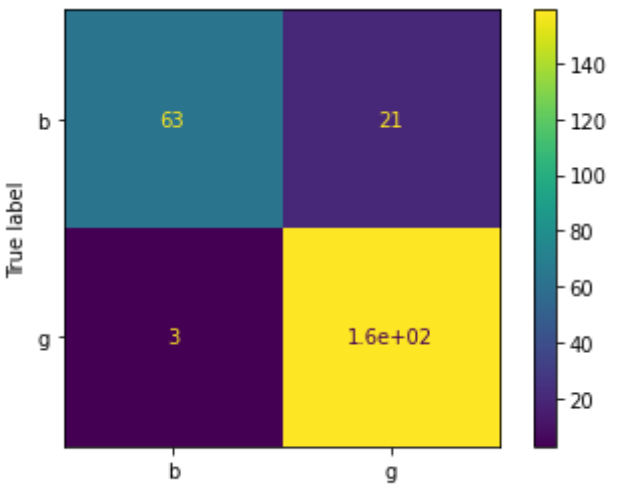


In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)
```

```
y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[ 63  21]
 [  3 159]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.95      0.75      0.84        84
           g       0.88      0.98      0.93       162

    accuracy                           0.90       246
   macro avg       0.92      0.87      0.88       246
weighted avg       0.91      0.90      0.90       246

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9024390243902439
```



In [ ]:

```
##########################################################################################################
```

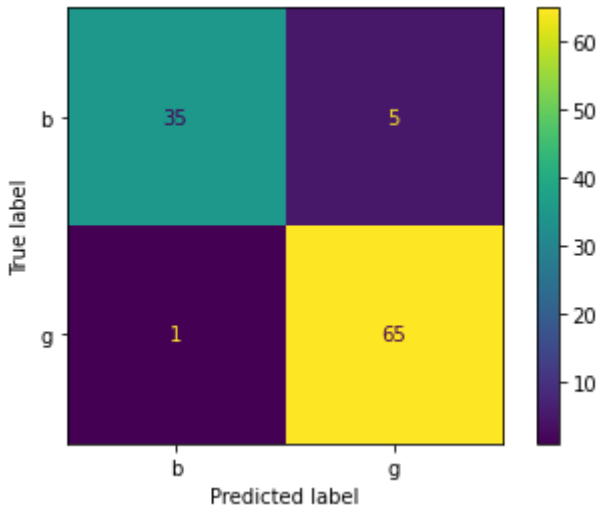
In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)
```

```python
# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

parameter_space = {
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

###############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
```

```
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[35  5]
 [ 1 65]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.97      0.88      0.92        40
           g       0.93      0.98      0.96        66

    accuracy                           0.94       106
   macro avg       0.95      0.93      0.94       106
weighted avg       0.95      0.94      0.94       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9433962264150944
```



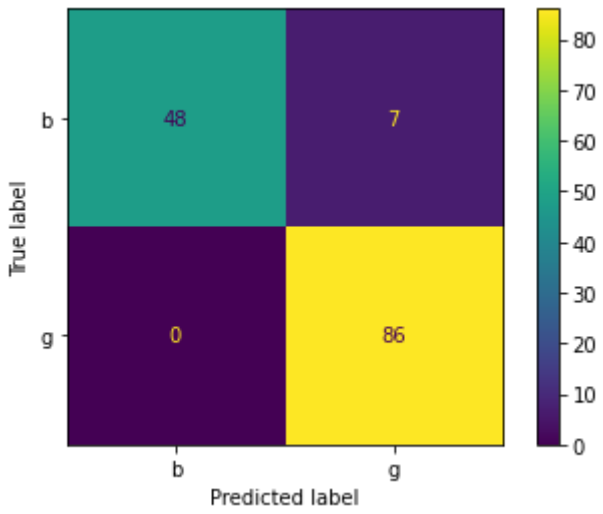
In [ ]:

```python
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

parameter_space = {
```

```
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

################################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[48  7]
 [ 0 86]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.87      0.93        55
           g       0.92      1.00      0.96        86

    accuracy                           0.95       141
   macro avg       0.96      0.94      0.95       141
weighted avg       0.95      0.95      0.95       141

--------------------------------------------------
```

```
--------------------------------------------------
Accuracy:
0.950354609929078
```

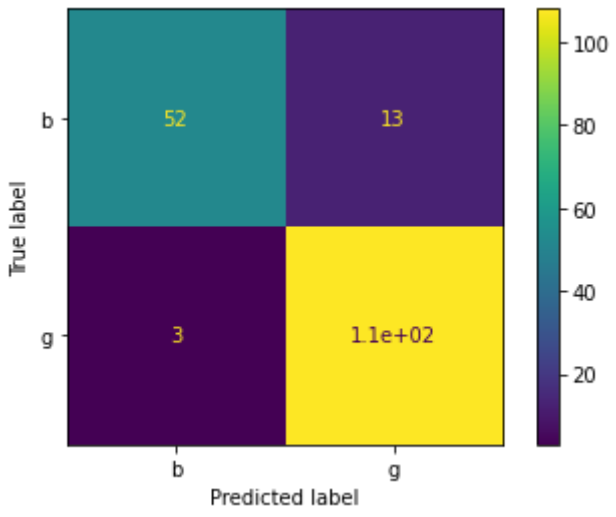


In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)
col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())


###############################################################################
# Creating a set of important sample features

parameter_space = {
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

###############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
```

```
print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[ 52  13]
 [  3 108]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.95      0.80      0.87        65
           g       0.89      0.97      0.93       111

    accuracy                           0.91       176
   macro avg       0.92      0.89      0.90       176
weighted avg       0.91      0.91      0.91       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9090909090909091
```



In [ ]:

```
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[40-60 split]
```

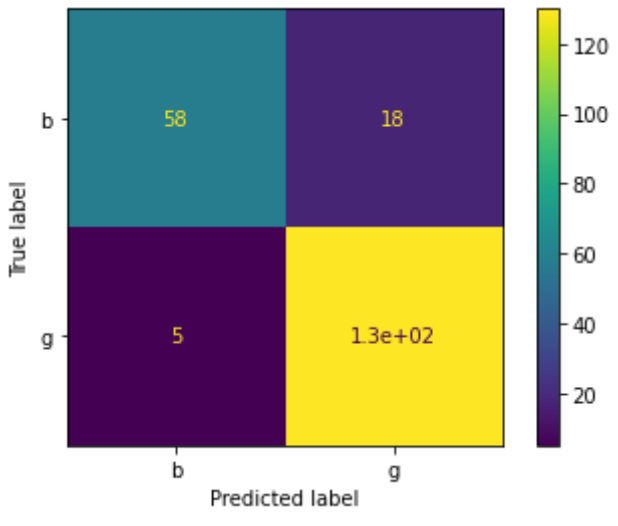
```
import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)
```

```
###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

parameter_space = {
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

###############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)
```

```
y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------------")
print("-------------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:
```

```
{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
Confusion Matrix:
[[ 58  18]
 [  5 130]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.92      0.76      0.83        76
           g       0.88      0.96      0.92       135

    accuracy                           0.89       211
   macro avg       0.90      0.86      0.88       211
weighted avg       0.89      0.89      0.89       211

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.8909952606635071
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
```



In [ ]:

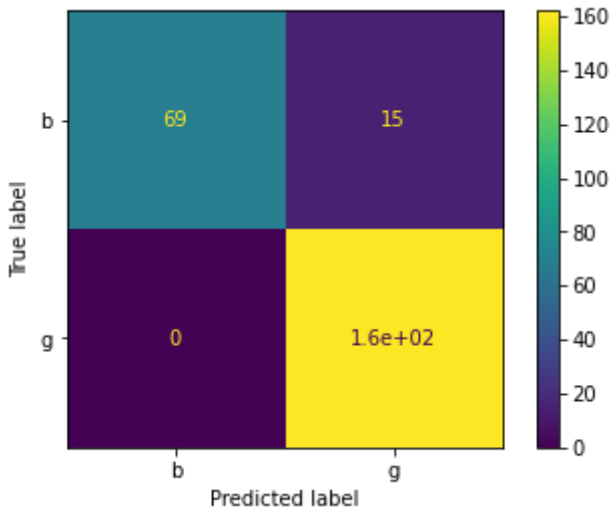
```python
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
```

```
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

parameter_space = {
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

###############################################################################

from sklearn.model_selection import GridSearchCV
# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
```

```
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
Confusion Matrix:
[[ 69  15]
 [  0 162]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.82      0.90        84
           g       0.92      1.00      0.96       162

    accuracy                           0.94       246
   macro avg       0.96      0.91      0.93       246
weighted avg       0.94      0.94      0.94       246

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9390243902439024
```



In [ ]:

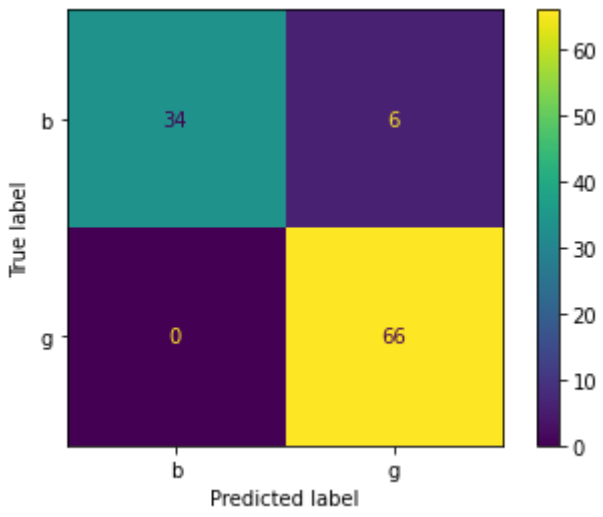
```
##########################################################################################################
```

In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
```

```
print(classification_report(y_test, y_pred))


print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[34  6]
 [ 0 66]]
-----------------------------------------------------
-----------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.85      0.92        40
           g       0.92      1.00      0.96        66

    accuracy                           0.94       106
   macro avg       0.96      0.93      0.94       106
weighted avg       0.95      0.94      0.94       106

-----------------------------------------------------
-----------------------------------------------------
Accuracy:
0.9433962264150944
```

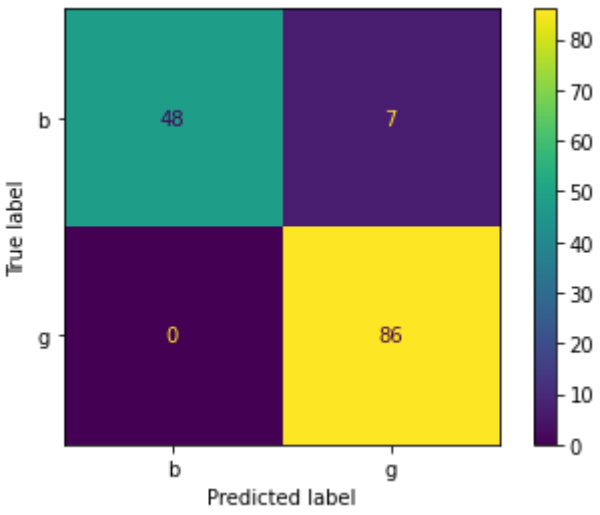


In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))
```

```
print("-----------------------------------------------------")
print("-----------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[48  7]
 [ 0 86]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.87      0.93        55
           g       0.92      1.00      0.96        86

    accuracy                           0.95       141
   macro avg       0.96      0.94      0.95       141
weighted avg       0.95      0.95      0.95       141

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.950354609929078
```

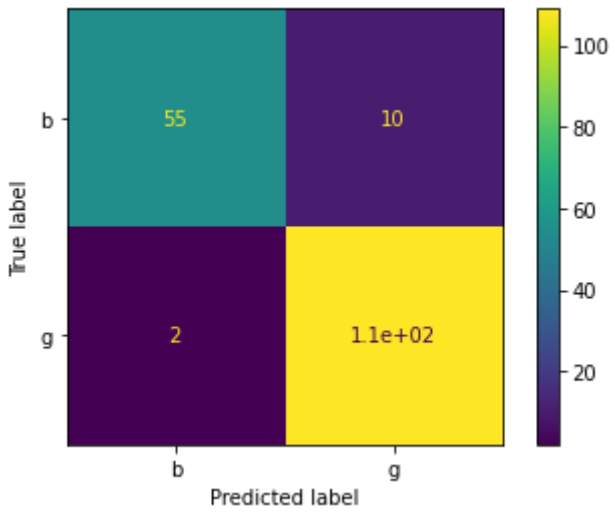


In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)
```

```
y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 55  10]
 [  2 109]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.96      0.85      0.90        65
           g       0.92      0.98      0.95       111

    accuracy                           0.93       176
   macro avg       0.94      0.91      0.92       176
weighted avg       0.93      0.93      0.93       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9318181818181818
```

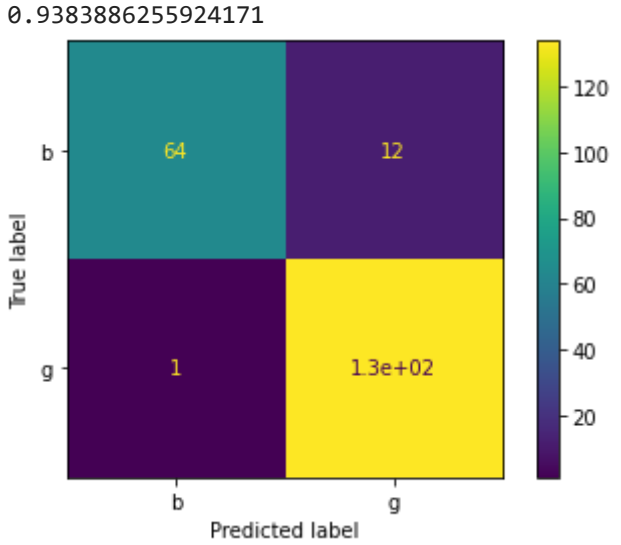


In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[40-60 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

```
# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 64  12]
 [  1 134]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.98      0.84      0.91        76
           g       0.92      0.99      0.95       135

    accuracy                           0.94       211
   macro avg       0.95      0.92      0.93       211
weighted avg       0.94      0.94      0.94       211

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9383886255924171
```

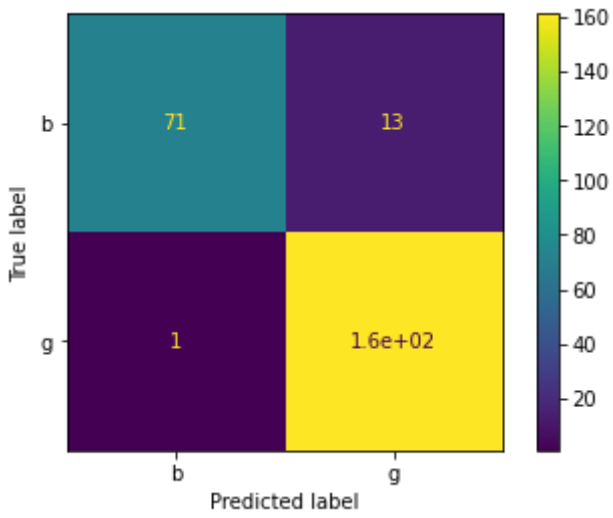


In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
```

```
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)

# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------------")
print("-------------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```

```
Confusion Matrix:
[[ 71  13]
 [  1 161]]
-------------------------------------------------------
-------------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.99      0.85      0.91        84
           g       0.93      0.99      0.96       162

    accuracy                           0.94       246
   macro avg       0.96      0.92      0.93       246
weighted avg       0.95      0.94      0.94       246

-------------------------------------------------------
-------------------------------------------------------
Accuracy:
0.943089430894309
```



In [ ]:
```
##########################################################################################################
```

In [ ]:
```
# IONOSPHERE DATASET
# SVM(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name
```

```
X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()

########################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

########################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

########################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
```

```
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
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[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
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[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
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[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
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[CV] C=100, gamma=1, kernel=poly .....................................
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[CV] C=100, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.1, kernel=rbf ....................................
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[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
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[CV] C=100, gamma=0.001, kernel=poly .................................
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[CV] ............... C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] ............... C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[40  0]
 [ 3 63]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.93      1.00      0.96        40
           g       1.00      0.95      0.98        66

    accuracy                           0.97       106
   macro avg       0.97      0.98      0.97       106
weighted avg       0.97      0.97      0.97       106
```
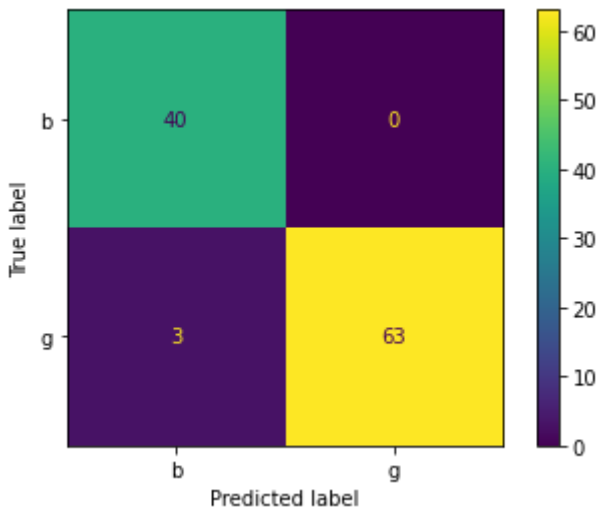

```
----------------------------------------------------
----------------------------------------------------
Accuracy:
0.9716981132075472
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    1.3s finished
```



In [ ]:

```python
# IONOSPHERE DATASET
# SVM(With Tuning)[60-40 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.6,test_size=0.4,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

################################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
```

```python
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
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[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
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[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
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[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
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[CV] C=0.1, gamma=0.1, kernel=sigmoid ...............................
[CV] ................ C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ...............................
[CV] ................ C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] ................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly .................................
[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
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[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly .................................
[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly .................................
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
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[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
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[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
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[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
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[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
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[CV] ................... C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=100, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] C=100, gamma=0.001, kernel=rbf ................................
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[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly ...............................
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[CV] C=100, gamma=0.001, kernel=sigmoid ............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[55  0]
 [ 6 80]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.90      1.00      0.95        55
           g       1.00      0.93      0.96        86

    accuracy                           0.96       141
   macro avg       0.95      0.97      0.96       141
weighted avg       0.96      0.96      0.96       141

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9574468085106383
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    1.1s finished
```

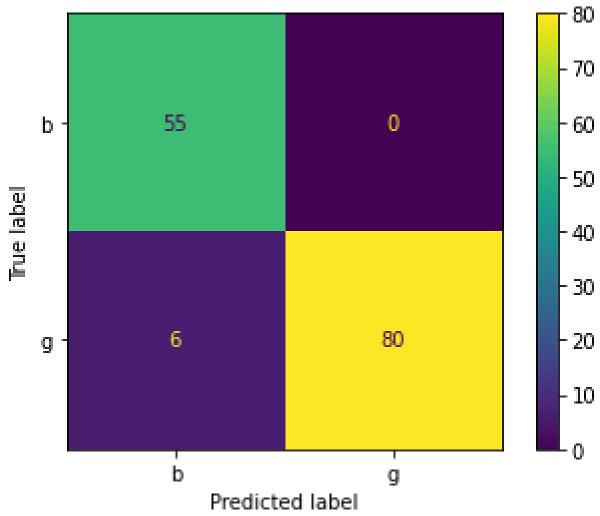

In [ ]:

```
# IONOSPHERE DATASET
# SVM(With Tuning)[50-50 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.5,test_size=0.5,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

```
# Classification
from sklearn.svm import SVC

classifier = SVC()

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

###############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("---------------------------------------------------")
print("---------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("---------------------------------------------------")
print("---------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
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[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
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[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
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[CV] C=0.1, gamma=1, kernel=poly .....................................
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[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
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[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
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[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
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[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
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[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] ................... C=0.1, gamma=0.01, kernel=poly, total=   0.0s
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[CV] ................ C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
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[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
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[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
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[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
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[CV] C=1, gamma=1, kernel=poly .......................................
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[CV] ..................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf ......................................
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[CV] ................... C=1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=0.1, kernel=sigmoid ..................................
[CV] ................... C=1, gamma=0.1, kernel=sigmoid, total=   0.0s
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[CV] ................... C=1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=0.01, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] .................. C=1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=poly ...................................
[CV] .................... C=1, gamma=0.001, kernel=poly, total=   0.0s
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[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[ 63   2]
 [  9 102]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.88      0.97      0.92        65
           g       0.98      0.92      0.95       111

    accuracy                           0.94       176
   macro avg       0.93      0.94      0.93       176
weighted avg       0.94      0.94      0.94       176

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9375
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    1.0s finished
```

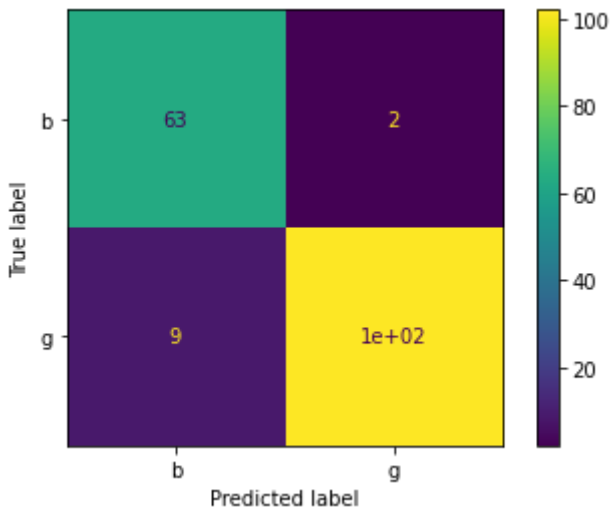

In [ ]:

```
# IONOSPHERE DATASET
# SVM(With Tuning)[40-60 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.4,test_size=0.6,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()

################################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

################################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

################################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")
```

```
print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf .....................................
[CV] ...................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf .....................................
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[CV] C=0.1, gamma=1, kernel=rbf .....................................
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[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
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[CV] C=100, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[ 71   5]
 [  8 127]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.90      0.93      0.92        76
           g       0.96      0.94      0.95       135

    accuracy                           0.94       211
   macro avg       0.93      0.94      0.93       211
weighted avg       0.94      0.94      0.94       211

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9383886255924171
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    0.9s finished
```

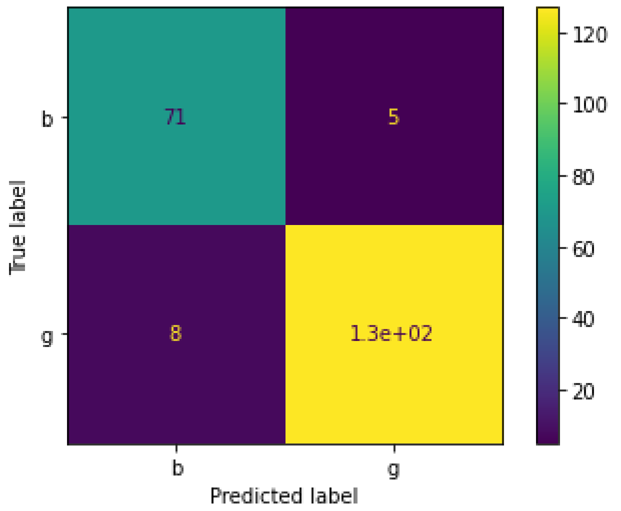

In [ ]:

```python
# IONOSPHERE DATASET
# SVM(With Tuning)[30-70 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.3,test_size=0.7,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()
```

```python
############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

############################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
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[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
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[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly .................................
[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
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[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly .................................
[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
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[CV] .................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
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[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
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[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid ..............................
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[CV] ............... C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
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[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=poly .......................................
[CV] ........................ C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=poly .......................................
[CV] ........................ C=1, gamma=1, kernel=poly, total=   0.0s
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[CV] ........................ C=1, gamma=1, kernel=poly, total=   0.0s
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[CV] ........................ C=1, gamma=1, kernel=poly, total=   0.0s
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[CV] ........................ C=1, gamma=1, kernel=poly, total=   0.0s
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[CV] ..................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ....................................
[CV] ..................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
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[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] C=100, gamma=0.1, kernel=poly ...................................
[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.1, kernel=poly ...................................
[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.1, kernel=poly ...................................
[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.1, kernel=poly ...................................
[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.1, kernel=poly ...................................
[CV] .................... C=100, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=100, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=100, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=100, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.1, kernel=sigmoid ................................
```
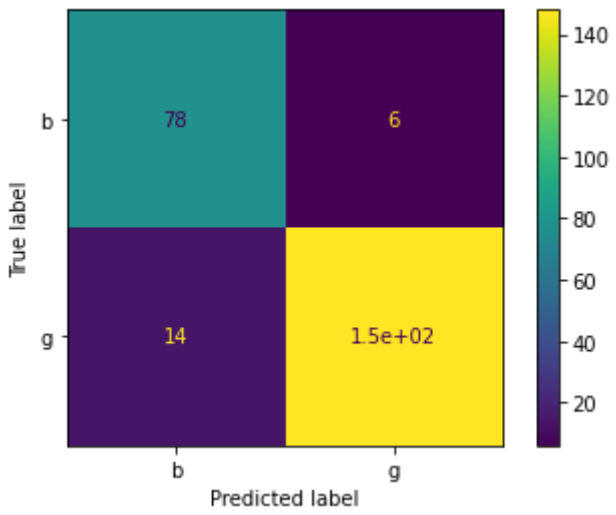
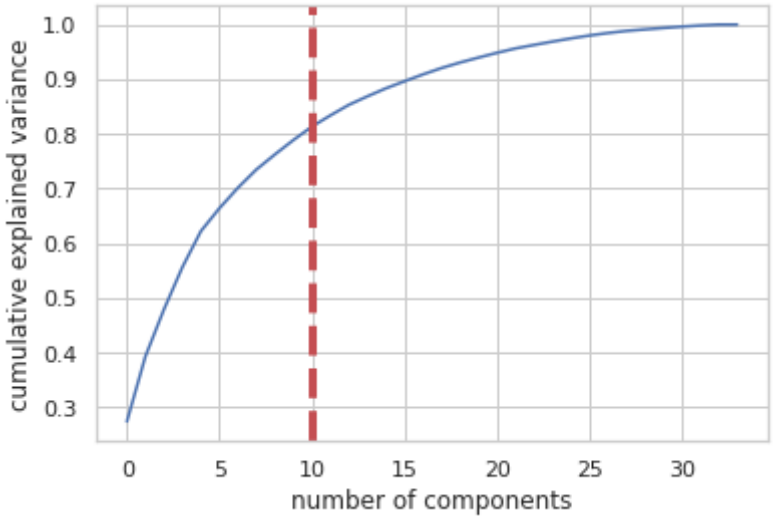

```
[CV] ................ C=100, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.1, kernel=sigmoid ................................
[CV] ................ C=100, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] ................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] ................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] ................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] ................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] ................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=poly ..................................
[CV] .................. C=100, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.01, kernel=poly ..................................
[CV] .................. C=100, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.01, kernel=poly ..................................
[CV] .................. C=100, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.01, kernel=poly ..................................
[CV] .................. C=100, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.01, kernel=poly ..................................
[CV] .................. C=100, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.01, kernel=sigmoid ...............................
[CV] ............... C=100, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.01, kernel=sigmoid ...............................
[CV] ............... C=100, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.01, kernel=sigmoid ...............................
[CV] ............... C=100, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.01, kernel=sigmoid ...............................
[CV] ............... C=100, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.01, kernel=sigmoid ...............................
[CV] ............... C=100, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] .................. C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly .................................
[CV] ................. C=100, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly .................................
[CV] ................. C=100, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly .................................
[CV] ................. C=100, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly .................................
[CV] ................. C=100, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.001, kernel=poly .................................
[CV] ................. C=100, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] .............. C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[ 78   6]
 [ 14 148]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.85      0.93      0.89        84
           g       0.96      0.91      0.94       162

    accuracy                           0.92       246
   macro avg       0.90      0.92      0.91       246
weighted avg       0.92      0.92      0.92       246

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9186991869918699
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    0.8s finished
```



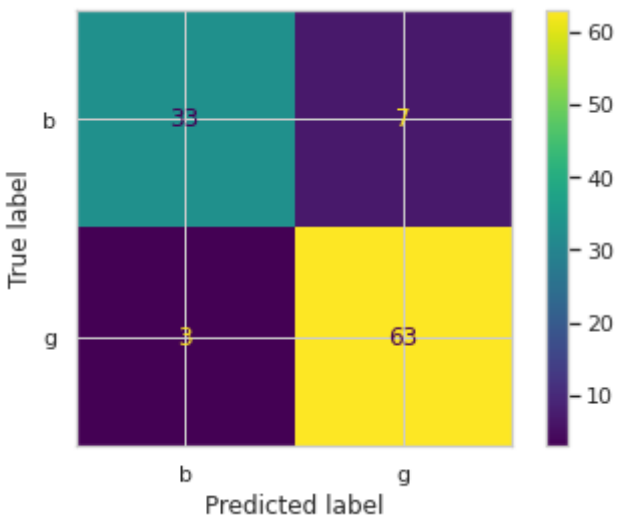
In [ ]:
```
##########################################################################################################################
```

In [ ]:
```
# IONOSPHERE DATASET
# Random Forest Classifier(Without Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.30,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 15 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)


# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators=20, random_state=0)
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")
```

```
print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```




```
None
Confusion Matrix:
[[33  7]
 [ 3 63]]
-----------------------------------------------------
-----------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.92      0.82      0.87        40
           g       0.90      0.95      0.93        66

    accuracy                           0.91       106
   macro avg       0.91      0.89      0.90       106
weighted avg       0.91      0.91      0.90       106

-----------------------------------------------------
-----------------------------------------------------
Accuracy:
0.9056603773584906
```

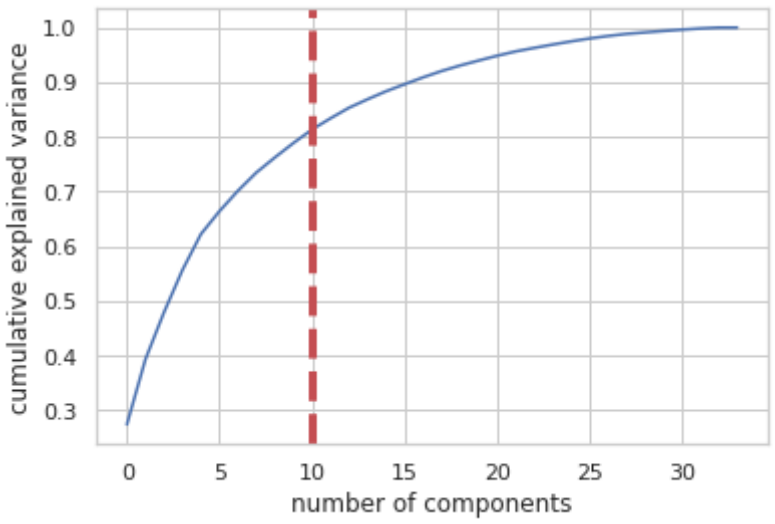


In [ ]:

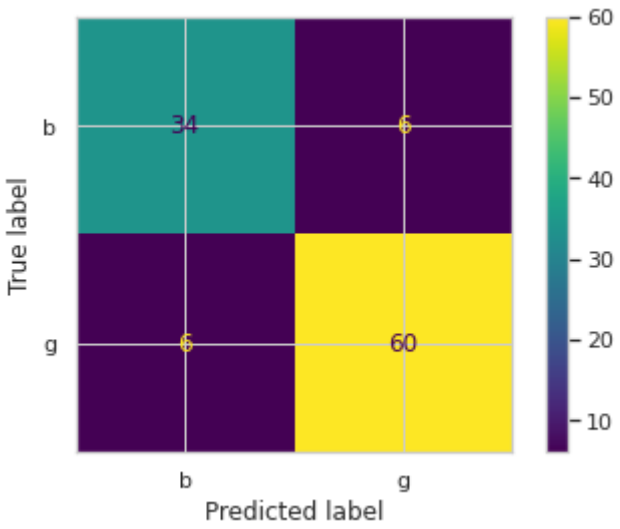
```
# IONOSPHERE DATASET
# Random Forest Classifier(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)
```

```python
# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 15 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)


# Classification
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier()

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

from sklearn.model_selection import RandomizedSearchCV
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]
# Number of features to consider at every split
max_features = ['auto', 'sqrt']
# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)
# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]
# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]
# Method of selecting samples for training each tree
bootstrap = [True, False]
# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
pprint(random_grid)

###############################################################################

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = RandomForestClassifier()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = classifier, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_
# Fit the random search model
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
```

```
print(classification_report(y_test, y_pred))


print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```



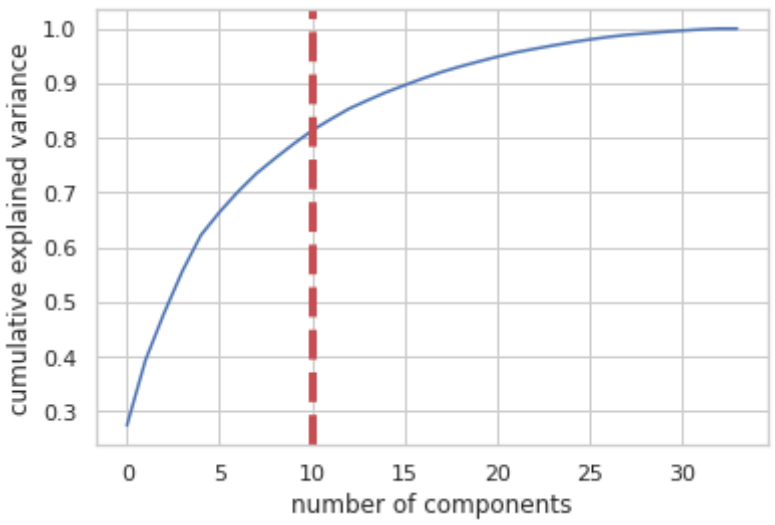

```
None
Parameters currently in use:

{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:   37.6s
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed:  2.5min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:  4.8min finished
Confusion Matrix:
[[34  6]
 [ 6 60]]
-----------------------------------------------------
-----------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.85      0.85      0.85        40
           g       0.91      0.91      0.91        66

    accuracy                           0.89       106
   macro avg       0.88      0.88      0.88       106
weighted avg       0.89      0.89      0.89       106

-----------------------------------------------------
-----------------------------------------------------
Accuracy:
0.8867924528301887
```



In [ ]:

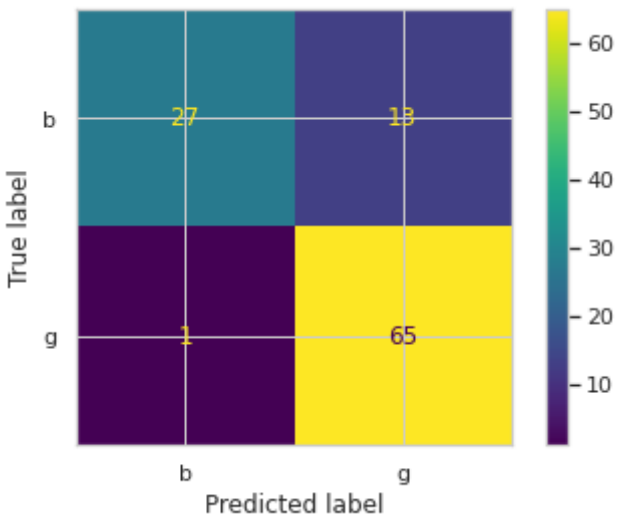
```
# IONOSPHERE DATASET
# Multi Layer Perceptron(Without Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 10 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)


# Classification using MLP
from sklearn.neural_network import MLPClassifier

classifier = MLPClassifier()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))
```

```
print("-----------------------------------------------------")
print("-----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```




```
None
Confusion Matrix:
[[27 13]
 [ 1 65]]
-----------------------------------------------------
-----------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.96      0.68      0.79        40
           g       0.83      0.98      0.90        66

    accuracy                           0.87       106
   macro avg       0.90      0.83      0.85       106
weighted avg       0.88      0.87      0.86       106

-----------------------------------------------------
-----------------------------------------------------
Accuracy:
0.8679245283018868
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (200) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
```



In [ ]:

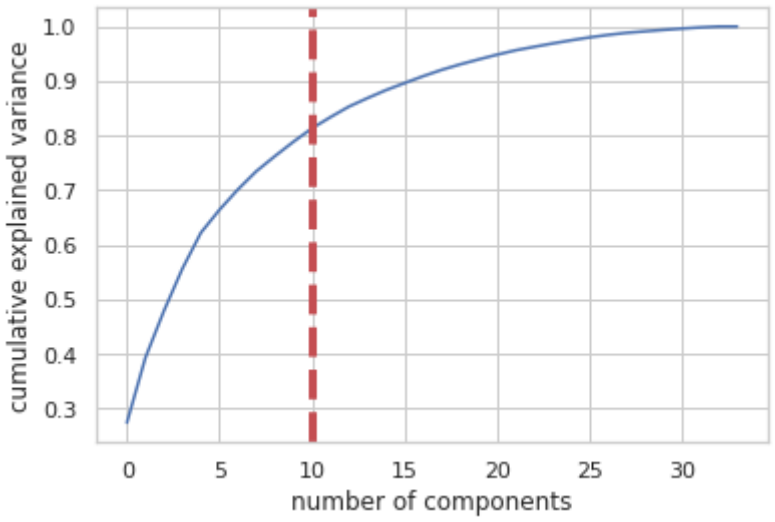
```
# IONOSPHERE DATASET
# Multi Layer Perceptron(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)
```

```
# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 10 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)
```

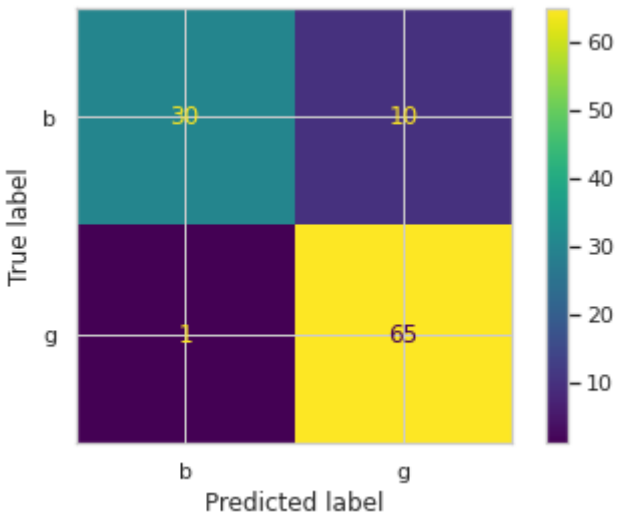
```
# Classification
from sklearn.neural_network import MLPClassifier
classifier = MLPClassifier(max_iter=100)

###############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

###############################################################################
# Creating a set of important sample features

parameter_space = {
    'hidden_layer_sizes': [(50,50,50), (50,100,50), (100,)],
    'activation': ['tanh', 'relu'],
    'solver': ['sgd', 'adam'],
    'alpha': [0.0001, 0.05],
    'learning_rate': ['constant','adaptive'],
}
pprint(parameter_space)

###############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = MLPClassifier(max_iter=100)
```

```
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(classifier, parameter_space, n_jobs=-1, cv=3)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("--------------------------------------------------")
print("--------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("--------------------------------------------------")
print("--------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
```

```
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```



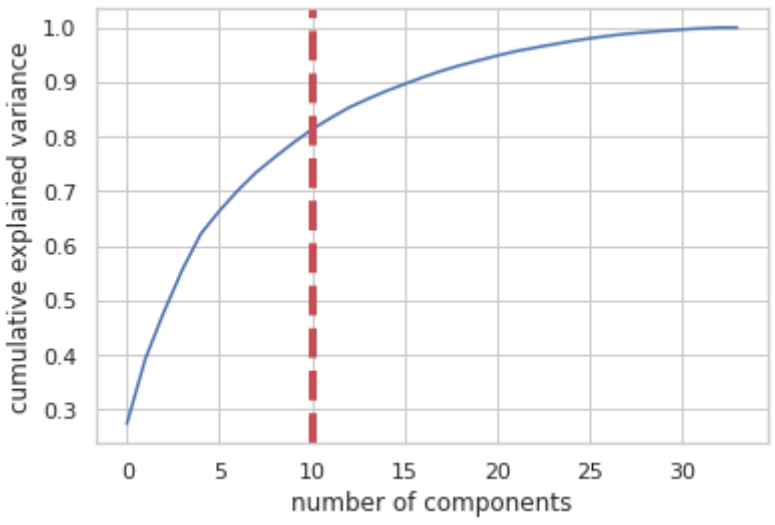

```
None
Parameters currently in use:

{'activation': 'relu',
 'alpha': 0.0001,
 'batch_size': 'auto',
 'beta_1': 0.9,
 'beta_2': 0.999,
 'early_stopping': False,
 'epsilon': 1e-08,
 'hidden_layer_sizes': (100,),
 'learning_rate': 'constant',
 'learning_rate_init': 0.001,
 'max_fun': 15000,
 'max_iter': 100,
 'momentum': 0.9,
 'n_iter_no_change': 10,
 'nesterovs_momentum': True,
 'power_t': 0.5,
 'random_state': None,
 'shuffle': True,
 'solver': 'adam',
 'tol': 0.0001,
 'validation_fraction': 0.1,
 'verbose': False,
 'warm_start': False}
{'activation': ['tanh', 'relu'],
 'alpha': [0.0001, 0.05],
 'hidden_layer_sizes': [(50, 50, 50), (50, 100, 50), (100,)],
 'learning_rate': ['constant', 'adaptive'],
 'solver': ['sgd', 'adam']}
Confusion Matrix:
[[30 10]
 [ 1 65]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.97      0.75      0.85        40
           g       0.87      0.98      0.92        66

    accuracy                           0.90       106
   macro avg       0.92      0.87      0.88       106
weighted avg       0.90      0.90      0.89       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.8962264150943396
/usr/local/lib/python3.7/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:571: ConvergenceWarning: Stochastic Optimi
zer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  % self.max_iter, ConvergenceWarning)
```



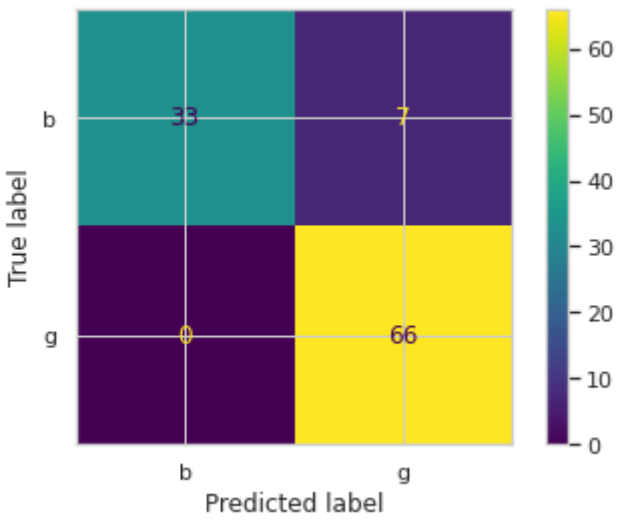
In [ ]:

```
# IONOSPHERE DATASET
# SVM(Without Tuning)[70-30 split]


import pandas as pd
```

```
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 10 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train,y_train)

y_pred = classifier.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("-------------------------------------------------------")
print("-------------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("-------------------------------------------------------")
print("-------------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))

import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(classifier, X_test, y_test)
plt.show()
```




```
None
Confusion Matrix:
[[33  7]
 [ 0 66]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       1.00      0.82      0.90        40
           g       0.90      1.00      0.95        66

    accuracy                           0.93       106
   macro avg       0.95      0.91      0.93       106
weighted avg       0.94      0.93      0.93       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9339622641509434
```



In [ ]:

```python
# IONOSPHERE DATASET
# SVM(With Tuning)[70-30 split]


import pandas as pd
import numpy as np

# Dataset Preparation
df = pd.read_csv("ionosphere.data",header=None)

col_name = ['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19'
           ,'20','21','22','23','24','25','26','27','28','29','30','31','32','33','34','Class']


df.columns = col_name


X = df.drop(['Class'], axis=1)
y = df['Class']

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size=0.7,test_size=0.3,random_state=10)


# Feature Scaling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)


# Finding the important parameters that contribute to most of the variance in the data.

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA

pca_test = PCA(n_components=34)
```

```
pca_test.fit(X_train)
sns.set(style='whitegrid')
plt.plot(np.cumsum(pca_test.explained_variance_ratio_))
plt.xlabel('number of components')
plt.ylabel('cumulative explained variance')
plt.axvline(linewidth=4, color='r', linestyle = '--', x=10, ymin=0, ymax=1)
display(plt.show())

# So we can see that we have 10 important parameters

pca = PCA(n_components=15)
pca.fit(X_train)
X_train = pca.transform(X_train)
X_test = pca.transform(X_test)


# Classification
from sklearn.svm import SVC

classifier = SVC()

##############################################################################
# Showing all the parameters

from pprint import pprint
# Look at parameters used by our current forest
print('Parameters currently in use:\n')
pprint(classifier.get_params())

##############################################################################
# Creating a set of important sample features

param_grid = {'C': [0.1,1, 10, 100], 'gamma': [1,0.1,0.01,0.001],'kernel': ['rbf', 'poly', 'sigmoid']}

pprint(param_grid)

##############################################################################

from sklearn.model_selection import GridSearchCV

# Use the random grid to search for best hyperparameters
# First create the base model to tune
classifier = SVC()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores

rf_random = GridSearchCV(SVC(), param_grid, refit=True, verbose=2)
rf_random.fit(X_train, y_train)

y_pred = rf_random.predict(X_test)

from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

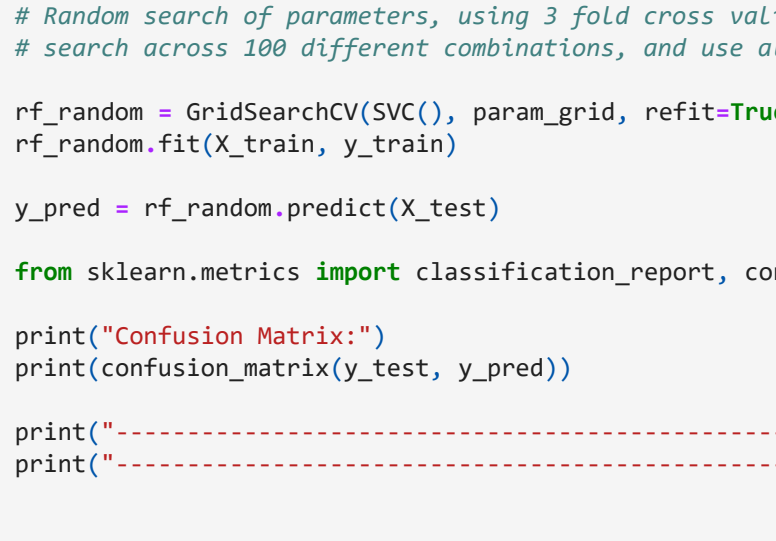
print("----------------------------------------------------")
print("----------------------------------------------------")


print("Performance Evaluation")
print(classification_report(y_test, y_pred))


print("----------------------------------------------------")
print("----------------------------------------------------")

print("Accuracy:")
print(accuracy_score(y_test, y_pred))


import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
plot_confusion_matrix(rf_random, X_test, y_test)
plt.show()
```



None

```
Parameters currently in use:

{'C': 1.0,
 'break_ties': False,
 'cache_size': 200,
 'class_weight': None,
 'coef0': 0.0,
 'decision_function_shape': 'ovr',
 'degree': 3,
 'gamma': 'scale',
 'kernel': 'rbf',
 'max_iter': -1,
 'probability': False,
 'random_state': None,
 'shrinking': True,
 'tol': 0.001,
 'verbose': False}
{'C': [0.1, 1, 10, 100],
 'gamma': [1, 0.1, 0.01, 0.001],
 'kernel': ['rbf', 'poly', 'sigmoid']}
Fitting 5 folds for each of 48 candidates, totalling 240 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=poly .....................................
[CV] ...................... C=0.1, gamma=1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=1, kernel=sigmoid ..................................
[CV] ................... C=0.1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=poly ...................................
[CV] .................... C=0.1, gamma=0.1, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=sigmoid ................................
[CV] ................. C=0.1, gamma=0.1, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly ..................................
[CV] ................... C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=poly ..................................
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```
[CV] .................. C=0.1, gamma=0.01, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.01, kernel=sigmoid ..............................
[CV] ............... C=0.1, gamma=0.01, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
[CV] .................. C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
[CV] .................. C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
[CV] .................. C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
[CV] .................. C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=rbf .................................
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[CV] .................. C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly ................................
[CV] ................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly ................................
[CV] ................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly ................................
[CV] ................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly ................................
[CV] ................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=poly ................................
[CV] ................. C=0.1, gamma=0.001, kernel=poly, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=0.1, gamma=0.001, kernel=sigmoid .............................
[CV] .............. C=0.1, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
[CV] ....................... C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
[CV] ....................... C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
[CV] ....................... C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
[CV] ....................... C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=poly ......................................
[CV] ....................... C=1, gamma=1, kernel=poly, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ...................................
[CV] .................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ...................................
[CV] .................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ...................................
[CV] .................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ...................................
[CV] .................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=1, kernel=sigmoid ...................................
[CV] .................... C=1, gamma=1, kernel=sigmoid, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] ..................... C=1, gamma=0.1, kernel=poly, total=   0.0s
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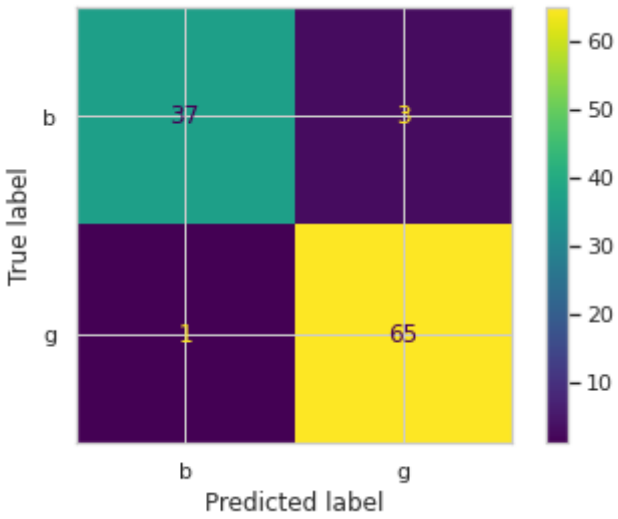
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
[CV] ............... C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid ..............................
```

```
[CV] ............... C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
[CV] C=100, gamma=0.001, kernel=sigmoid .............................
[CV] ............... C=100, gamma=0.001, kernel=sigmoid, total=   0.0s
Confusion Matrix:
[[37  3]
 [ 1 65]]
--------------------------------------------------
--------------------------------------------------
Performance Evaluation
              precision    recall  f1-score   support

           b       0.97      0.93      0.95        40
           g       0.96      0.98      0.97        66

    accuracy                           0.96       106
   macro avg       0.96      0.95      0.96       106
weighted avg       0.96      0.96      0.96       106

--------------------------------------------------
--------------------------------------------------
Accuracy:
0.9622641509433962
[Parallel(n_jobs=1)]: Done 240 out of 240 | elapsed:    0.9s finished
```



In [ ]: