iris-assignment-2

August 22, 2023

0.0.1 Iris Dataset classification using SVM, MLP and Random Forest classifier

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

[ ]:
```
from sklearn.datasets import load_iris
iris = load_iris()
df = pd.DataFrame(iris.data, columns = iris.feature_names)
df.head()
```

[ ]:
```
X = df.iloc[:][:]
y = iris["target"]
dict_svm = {}
dict_mlp = {}
dict_rfr = {}
RocAucSvm = {}
RocAucMlp = {}
RocAucRfr = {}
print(X, y)
```

0.0.2 Used for ploting confusion matrix

[ ]:
```
def plot(y_test, y_pred):
  from sklearn.metrics import confusion_matrix
  import seaborn as sns

  print("Confusion Matrix : ")
  cf_matrix = confusion_matrix(y_test, y_pred)
  group_counts = ["{0:0.0f}".format(value) for value in
                  cf_matrix.flatten()]
  group_percentages = ["{0:.2%}".format(value) for value in
                       cf_matrix.flatten()/np.sum(cf_matrix)]
  labels = [f"{v1}\n{v2}" for v1, v2 in
            zip(group_counts,group_percentages)]
  labels = np.asarray(labels).reshape(3,3)
  plt.figure(figsize=(6, 4))
```

```
  sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', xticklabels = iris.
 ↪target_names, yticklabels=iris.target_names)
  plt.xlabel('Predicted')
  plt.ylabel('Actual')
  plt.title('Confusion Matrix')
  plt.show()
  print("*********************************************")
```

[ ]:
```
def reports(y_test, y_pred):
  from sklearn.metrics import classification_report
  plot(y_test, y_pred)
  print("*********************************************")
  print("Classification Evaluation : ")
  print(classification_report(y_test, y_pred, zero_division = 0))
```

0.0.3 SVM CLASSIFIER

[ ]:
```
def SVMClassifier(split, kernalValue = 'rbf', degreeValue = 3, gammaValue =␣
 ↪'scale', maxIter = -1):
  from sklearn.model_selection import train_test_split
  from sklearn.svm import SVC
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  scaler.fit(X)
  X_train, X_test, y_train, y_test = train_test_split(X,y, test_size = split,␣
 ↪random_state=44)
  classifier = SVC(kernel = kernalValue, degree = degreeValue, gamma =␣
 ↪gammaValue, max_iter = maxIter)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_svm:
    if dict_svm[str(split)][0] < accuracy:
      dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_svm[str(split)][0]:
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
SVMClassifier(0.3)
```

```
SVMClassifier(0.3, 'linear')
SVMClassifier(0.3, 'poly')
SVMClassifier(0.3, 'sigmoid', 3, 0.022)
```

[ ]:
```
#Train - Test split 60-40
SVMClassifier(0.4, 'rbf', 3, 'auto')
SVMClassifier(0.4, 'linear')
SVMClassifier(0.4, 'poly')
SVMClassifier(0.4, 'sigmoid', 3, 0.023 ) #wrost performance
```

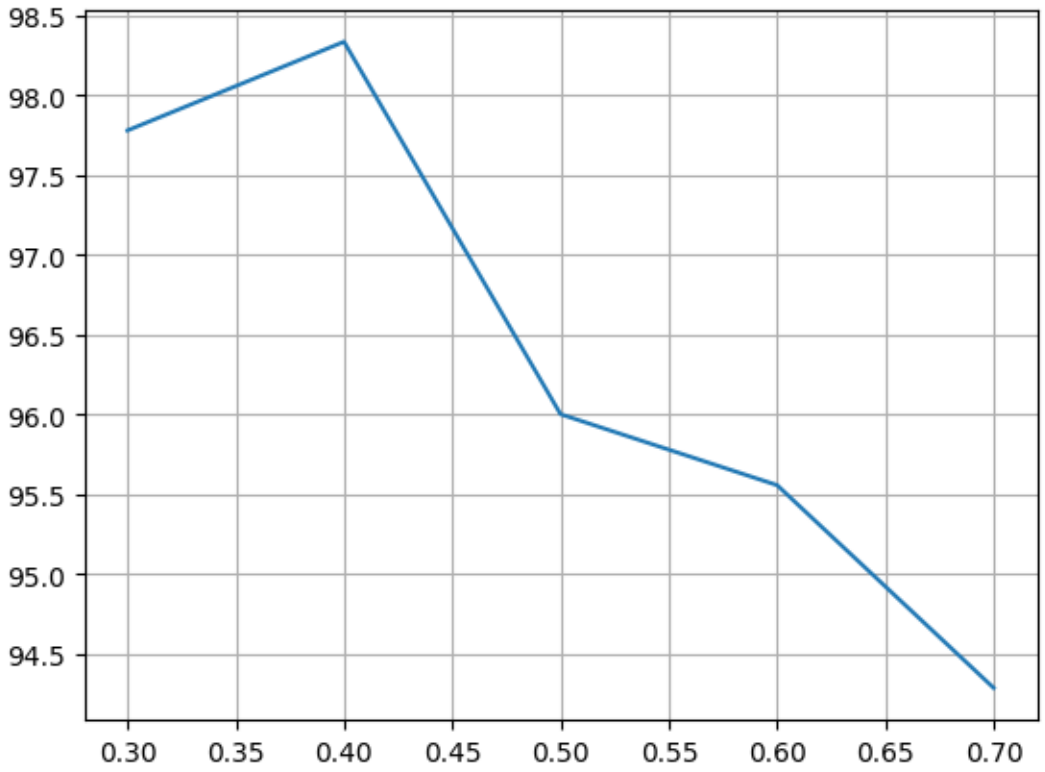
[ ]:
```
#Train - Test split 50-50
SVMClassifier(0.5, 'rbf', 3, 'auto')
SVMClassifier(0.5, 'linear')
SVMClassifier(0.5, 'poly')
SVMClassifier(0.5, 'sigmoid', 3, 0.022) #wrost performance
```

[ ]:
```
#Train - Test split 40-60
SVMClassifier(0.6, 'rbf', 3, 'auto')
SVMClassifier(0.6, 'linear')
SVMClassifier(0.6, 'poly')
SVMClassifier(0.6, 'sigmoid', 3, 0.015 ) #wrost performance
```

[ ]:
```
#Train - Test split 30-70
SVMClassifier(0.7, 'rbf', 3, 'auto')
SVMClassifier(0.7, 'linear')
SVMClassifier(0.7, 'poly')
SVMClassifier(0.7, 'sigmoid', 3, 2 ) #wrost performance
```

0.0.4 split vs accuracy graph

[37]:
```
keys = dict_svm.keys()
y_points = []
for key in keys:
  y_points.append(dict_svm[key][0]*100)
x_points = [float(key) for key in dict_svm.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.5 MLP Classifier

```
[ ]: def MLPClassifier(split, hiddenLayerSize = [100, ], activationValue = 'relu',␣
      ↪solverValue = 'adam'):
       from sklearn.model_selection import train_test_split
       from sklearn.neural_network import MLPClassifier
       from sklearn.metrics import accuracy_score
       X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
      ↪random_state=44)
       classifier = MLPClassifier(hidden_layer_sizes = hiddenLayerSize, activation =␣
      ↪activationValue, solver = solverValue, random_state = 1)
       classifier.fit(X_train, y_train)
       y_pred = classifier.predict(X_test)
       accuracy = accuracy_score(y_test, y_pred)

       if str(split) in dict_mlp:
         if dict_mlp[str(split)][0] < accuracy:
           dict_mlp[str(split)] = [accuracy, y_test, y_pred]
         if str(split) == '0.3' and accuracy > dict_mlp[str(split)][0]:
           RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}
       else:
         dict_mlp[str(split)] = [accuracy, y_test, y_pred]
```

```
    if str(split) == '0.3':
      RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
MLPClassifier(0.3, [30, ])
```

[ ]:
```
#Train - Test split 60-40
MLPClassifier(0.4, [35, ])
```

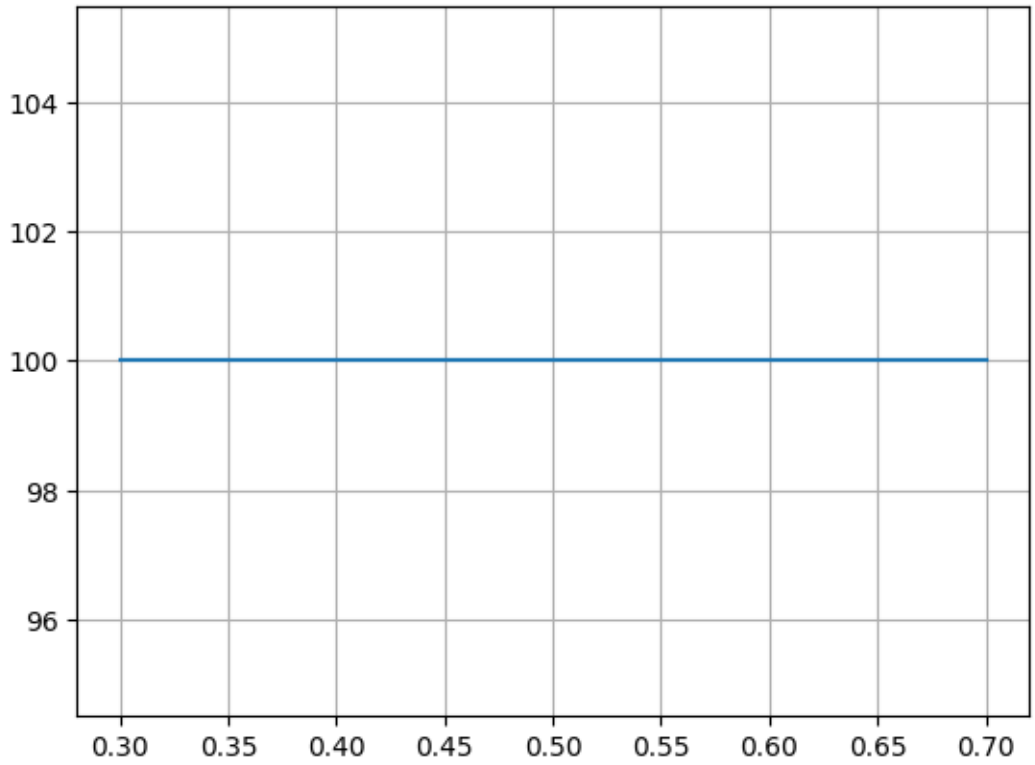
[ ]:
```
#Train - Test split 50-50
MLPClassifier(0.5, [35, ])
```

[ ]:
```
#Train - Test split 40-60
MLPClassifier(0.6, [45, 8])
```

[ ]:
```
#Train - Test split 30-70
MLPClassifier(0.7, [50, 10])
```

0.0.6 split vs accuracy graph

[36]:
```
keys = dict_mlp.keys()
y_points = []
for key in keys:
  y_points.append(dict_mlp[key][0]*100)
x_points = [float(key) for key in dict_mlp.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.7 Random Forest Classifier

[ ]:
```
def randomForest(split, estimator = 100, criterionValue = 'gini', ):
  from sklearn.model_selection import train_test_split
  from sklearn.ensemble import RandomForestClassifier
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  scaler.fit(X)
  X_train, X_test, y_train, y_test = train_test_split(X,y, test_size = split,␣
 ↪random_state=44)
  classifier = RandomForestClassifier(n_estimators = estimator, criterion =␣
 ↪criterionValue)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_rfr:
    if dict_rfr[str(split)][0] < accuracy:
      dict_rfr[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_rfr[str(split)][0]:
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}
```

```
  else:
    dict_rfr[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
randomForest(0.3)
```

[ ]:
```
randomForest(0.4)
```

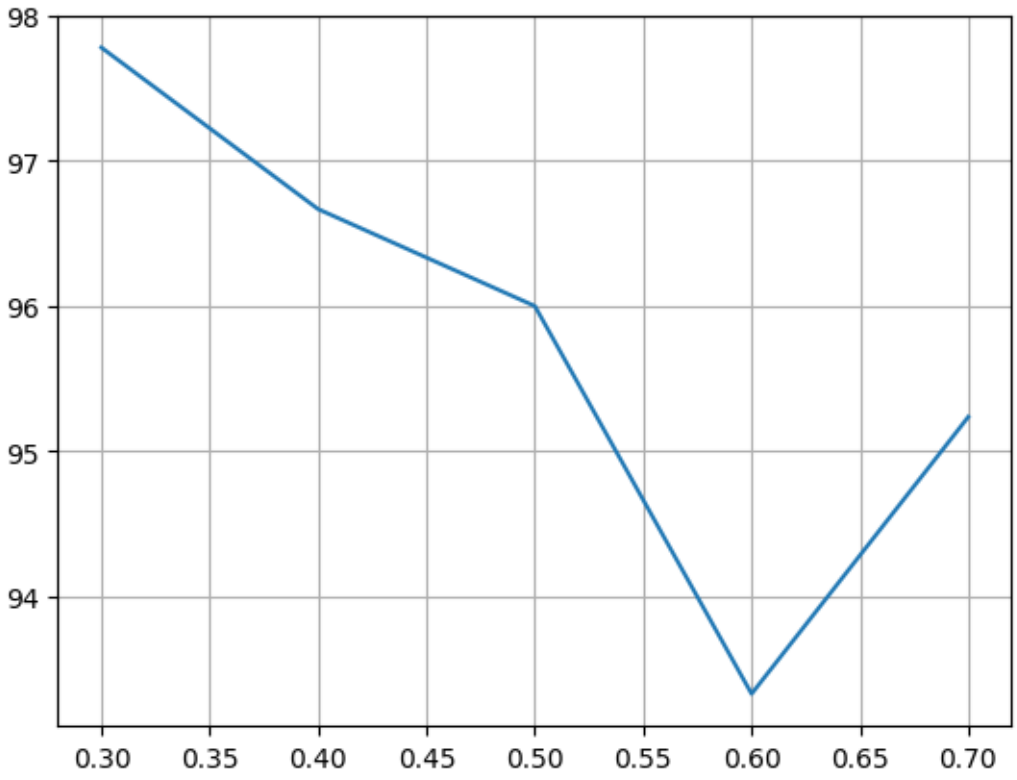
[ ]:
```
randomForest(0.5)
```

[ ]:
```
randomForest(0.6, 100, 'entropy')
```

[ ]:
```
randomForest(0.7, 120)
```

0.0.8 split vs accuracy graph

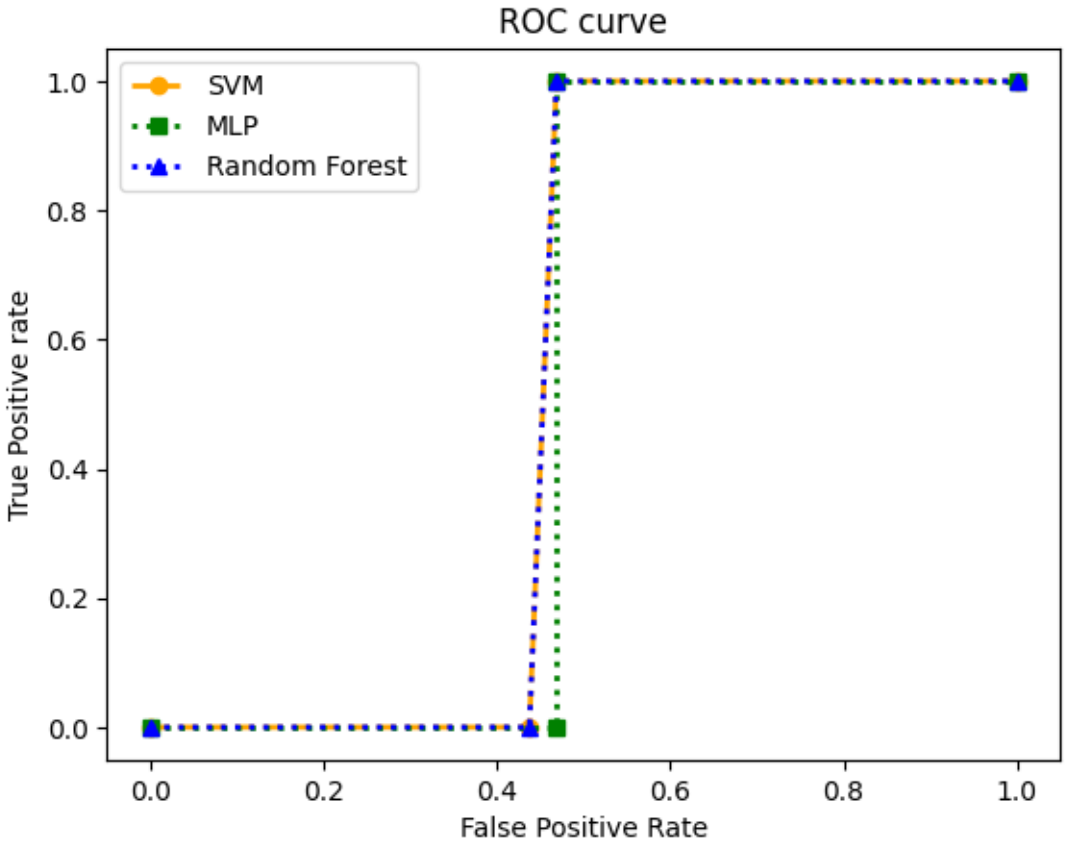
[35]:
```
keys = dict_rfr.keys()
y_points = []
for key in keys:
  y_points.append(dict_rfr[key][0]*100)
x_points = [float(key) for key in dict_rfr.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.9 ROC curve and ROC_AUC score for all the classifier having maximum accuracy when train test split 70-30.

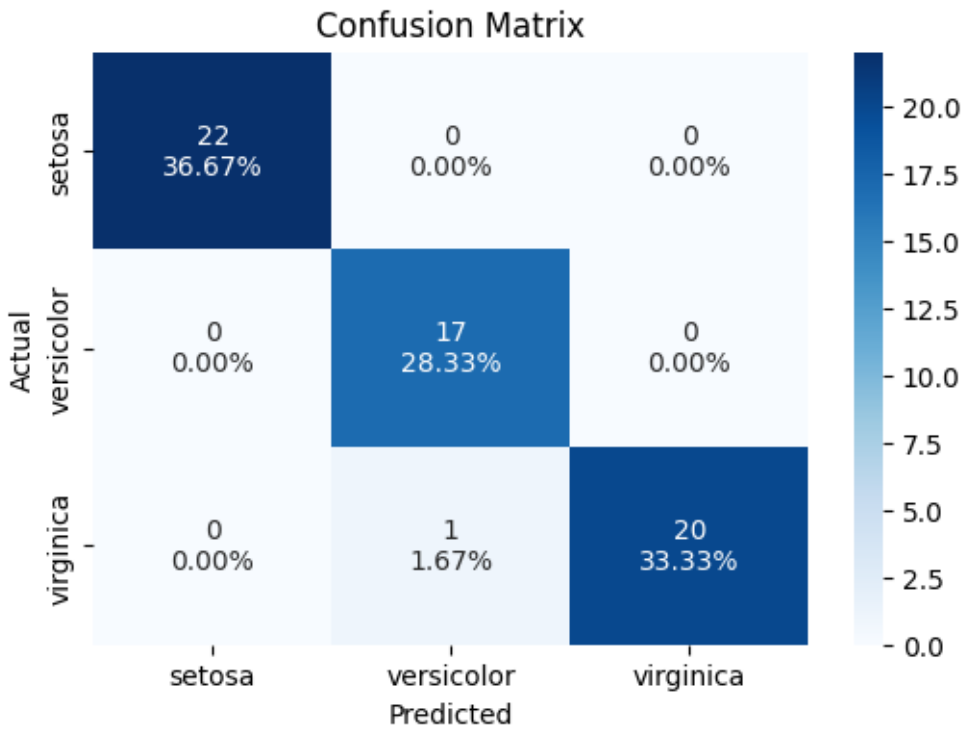
[34]:
```
from sklearn import metrics
def auc_roc():
    fpr1, tpr1, _1 = metrics.roc_curve(RocAucSvm['max']['y_test'],␣
 ↪RocAucSvm['max']['y_pred'], pos_label=1)
    fpr2, tpr2, _2 = metrics.roc_curve(RocAucMlp['max']['y_test'],␣
 ↪RocAucMlp['max']['y_pred'], pos_label=1)
    fpr3, tpr3, _3 = metrics.roc_curve(RocAucRfr['max']['y_test'],␣
 ↪RocAucRfr['max']['y_pred'], pos_label=1)
    plt.plot(fpr1, tpr1, linestyle='--', linewidth=2, color='orange',␣
 ↪marker='o', markersize=6, label='SVM')
    plt.plot(fpr2, tpr2, linestyle='dotted', linewidth=2, color='green',␣
 ↪marker='s', markersize=6, label='MLP')
    plt.plot(fpr3, tpr3, linestyle=':', linewidth=2, color='blue', marker='^',␣
 ↪markersize=6, label='Random Forest')
    plt.title('ROC curve')
    # x label
    plt.xlabel('False Positive Rate')
    # y label
```

```
    plt.ylabel('True Positive rate')

    plt.legend(loc='best')
    plt.savefig('ROC',dpi=300)
    plt.show()
auc_roc()
```



[33]:
```
#Best result for svm classifier
maxi=0
y_test = []
y_pred = []
for key in dict_svm:
  if maxi < 100*dict_svm[key][0]:
    maxi = 100*dict_svm[key][0]
    y_test = dict_svm[key][1]
    y_pred = dict_svm[key][2]
reports(y_test, y_pred)
```

```
Confusion Matrix :
```

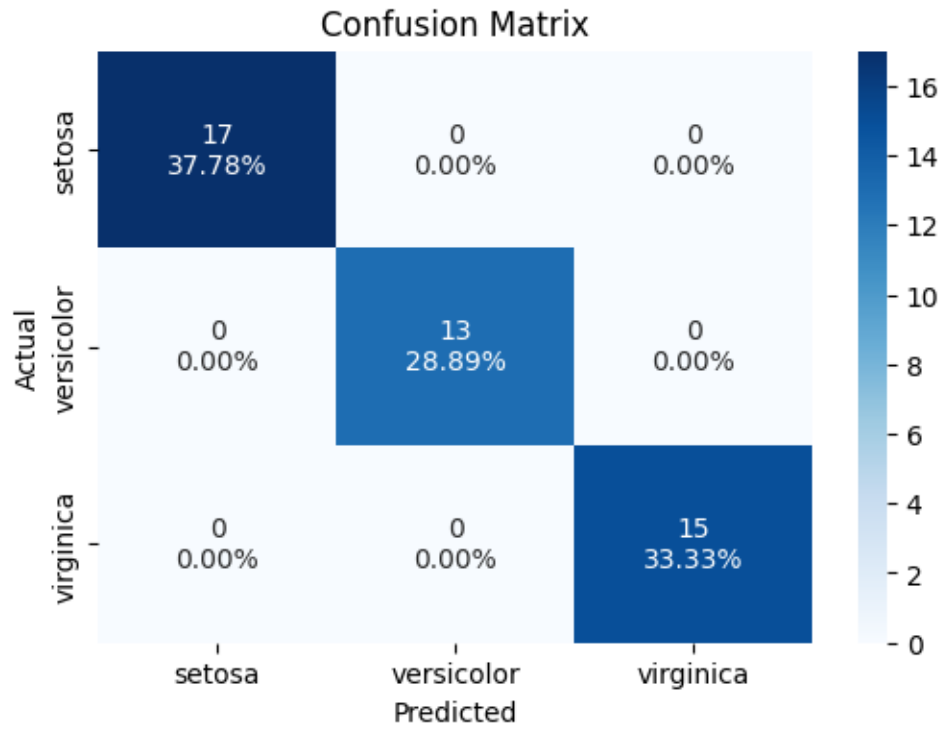



```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        22
           1       0.94      1.00      0.97        17
           2       1.00      0.95      0.98        21

    accuracy                           0.98        60
   macro avg       0.98      0.98      0.98        60
weighted avg       0.98      0.98      0.98        60
```

[32]:
```
#Best result for mlp classifier
maxi=0
y_test = []
y_pred = []
for key in dict_mlp:
  if maxi < 100*dict_mlp[key][0]:
    maxi = 100*dict_mlp[key][0]
    y_test = dict_mlp[key][1]
    y_pred = dict_mlp[key][2]
```

```
reports(y_test, y_pred)
```

```
Confusion Matrix :
```

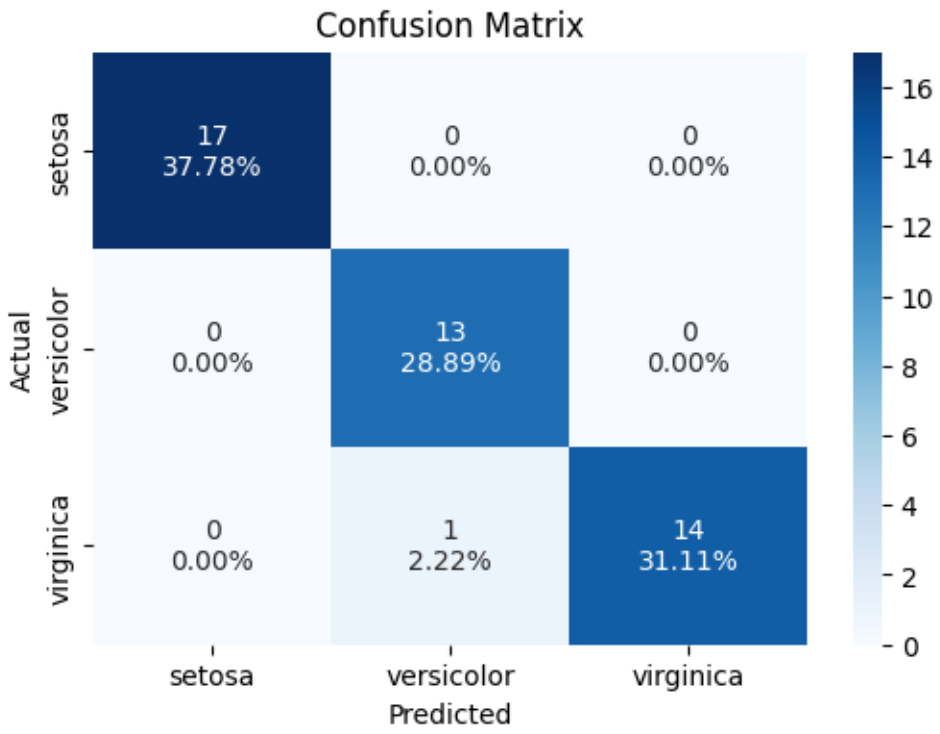



```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        17
           1       1.00      1.00      1.00        13
           2       1.00      1.00      1.00        15

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45
```

[31]:
```
#Best result for random forest classifier
maxi=0
y_test = []
y_pred = []
for key in dict_rfr:
```

```
  if maxi < 100*dict_rfr[key][0]:
    maxi = 100*dict_rfr[key][0]
    y_test = dict_rfr[key][1]
    y_pred = dict_rfr[key][2]
reports(y_test, y_pred)
```

Confusion Matrix :




```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        17
           1       0.93      1.00      0.96        13
           2       1.00      0.93      0.97        15

    accuracy                           0.98        45
   macro avg       0.98      0.98      0.98        45
weighted avg       0.98      0.98      0.98        45
```

ncer-wisconsin-diagnostic-data-set

August 22, 2023

0.0.1 Breast Cancer Wisconsin (Diagnostic) Dataset classification using SVM, MLP and Random Forest classifier

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

[ ]:
```
url = 'https://raw.githubusercontent.com/Aqeel-0/phone.html/master/data.csv'
df = pd.read_csv(url)
df.head()
```

0.0.2 Pre Preprocessing

[ ]:
```
from sklearn.preprocessing import LabelEncoder
X = df.drop(['id', 'diagnosis', 'Unnamed: 32'], axis=1)
X.info()
le = LabelEncoder()
encoded = le.fit_transform(df['diagnosis'])
df.drop("diagnosis", axis=1, inplace=True)
df["diagnosis"] = encoded
y = df["diagnosis"]
y.info()
dict_svm = {}
dict_mlp = {}
dict_rfr = {}
RocAucSvm = {}
RocAucMlp = {}
RocAucRfr = {}
```

0.0.3 Used for ploting confusion matrix

[ ]:
```
def plot(y_test, y_pred):
  from sklearn.metrics import confusion_matrix
  import seaborn as sns
  from sklearn.metrics import roc_curve
  from sklearn.metrics import auc
```

```
  print("Confusion Matrix : ")
  cf_matrix = confusion_matrix(y_test, y_pred)
  group_names = ['True Pos','False Pos','False Neg','True neg']
  group_counts = ["{0:0.0f}".format(value) for value in
                  cf_matrix.flatten()]
  group_percentages = ["{0:.2%}".format(value) for value in
                       cf_matrix.flatten()/np.sum(cf_matrix)]
  labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
            zip(group_names,group_counts,group_percentages)]
  labels = np.asarray(labels).reshape(2,2)
  plt.figure(figsize=(6, 4))
  sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues',␣
 ↪xticklabels=['Benign', 'Malignant'], yticklabels=['Benign', 'Malignant'])
  plt.xlabel('Predicted')
  plt.ylabel('Actual')
  plt.title('Confusion Matrix')
  plt.show()
  print("*********************************************")
```

[ ]:
```
def reports(y_test, y_pred):
  from sklearn.metrics import classification_report
  plot(y_test, y_pred)
  print("*********************************************")
  print("Classification Evaluation : ")
  print(classification_report(y_test, y_pred, zero_division = 0))
```

0.0.4 SVMClassifier

[ ]:
```
def SVMClassifier(split, kernalValue = 'rbf', degreeValue = 3, gammaValue =␣
 ↪'scale', maxIter = -1):
  from sklearn.model_selection import train_test_split
  from sklearn.svm import SVC
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
 ↪random_state=44)
  scaler.fit_transform(X_train)
  scaler.transform(X_test)
  classifier = SVC(kernel = kernalValue, degree = degreeValue, gamma =␣
 ↪gammaValue, max_iter = maxIter)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
```

```
  if str(split) in dict_svm:
    if dict_svm[str(split)][0] < accuracy:
      dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_svm[str(split)][0]:
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
SVMClassifier(0.3, 'rbf', 3)
SVMClassifier(0.3, 'linear', 3,)
SVMClassifier(0.3, 'poly', 2, )
SVMClassifier(0.3, 'sigmoid', 3, 0.01)
```

[ ]:
```
#Train - Test split 60-40
SVMClassifier(0.4, 'rbf', 3,)
SVMClassifier(0.4, 'linear', 3,)
SVMClassifier(0.4, 'poly', 5, )
SVMClassifier(0.4, 'sigmoid', 3, 0.1)
```

[ ]:
```
#Train - Test split 50-50
SVMClassifier(0.5, 'rbf', 3,)
SVMClassifier(0.5, 'linear', 3, )
SVMClassifier(0.5, 'poly', 4, )
SVMClassifier(0.5, 'sigmoid', 3, 0.3 ) #wrost performance
```

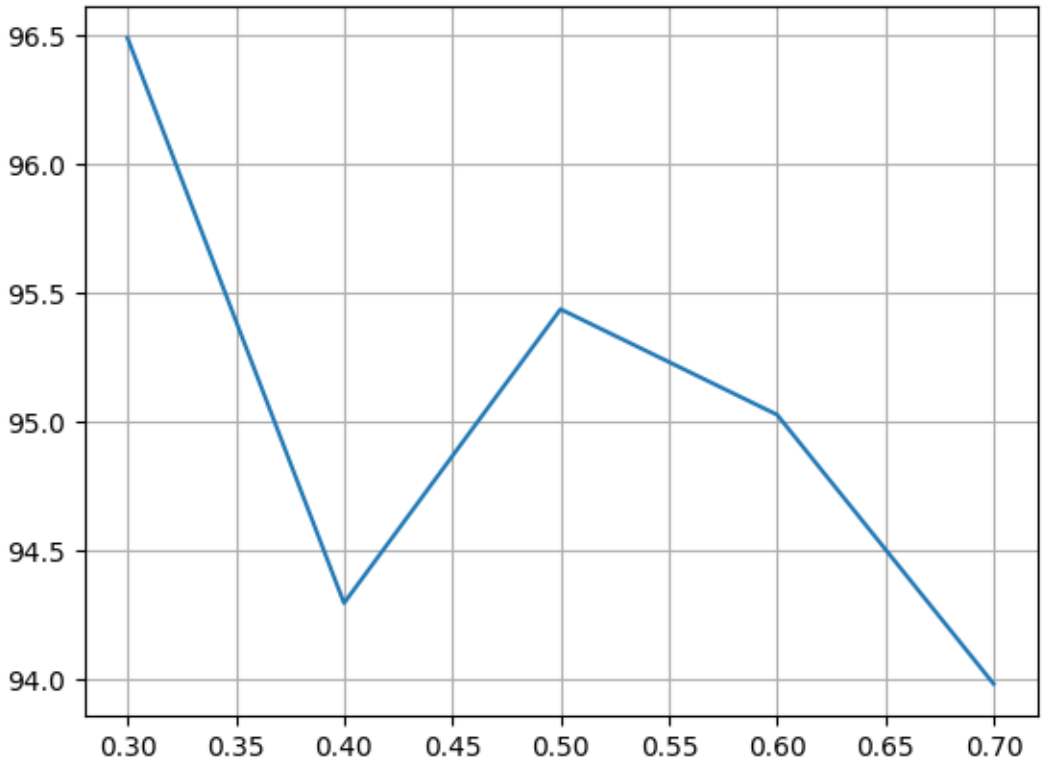
[ ]:
```
#Train - Test split 40-60
SVMClassifier(0.6, 'rbf', 3,)
SVMClassifier(0.6, 'linear', 3, )
SVMClassifier(0.6, 'poly', 2, 0.14)
SVMClassifier(0.6, 'sigmoid', 3, 0.2) #wrost performance
```

[ ]:
```
#Train - Test split 30-70
SVMClassifier(0.7, 'rbf', 3,)
SVMClassifier(0.7, 'linear')
SVMClassifier(0.7, 'poly', 2,)
SVMClassifier(0.7, 'sigmoid', 3, 0.2 ) #wrost performance
```

0.0.5 split vs accuracy graph

[64]:
```
keys = dict_svm.keys()
y_points = []
for key in keys:
  y_points.append(dict_svm[key][0]*100)
```

```
x_points = [float(key) for key in dict_svm.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.6 MLP Classifier

[ ]:
```
def MLPClassifier(split, hiddenLayerSize = [100, ], activationValue = 'relu',␣
↪solverValue = 'adam'):
 from sklearn.model_selection import train_test_split
 from sklearn.neural_network import MLPClassifier
 from sklearn.metrics import accuracy_score
 from sklearn.preprocessing import StandardScaler
 scaler = StandardScaler()
 X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
↪random_state=44)
 scaler.fit_transform(X_train)
 scaler.transform(X_test)
 classifier = MLPClassifier(hidden_layer_sizes = hiddenLayerSize, activation =␣
↪activationValue, solver = solverValue, random_state = 1)
 classifier.fit(X_train, y_train)
```

```
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
  if str(split) in dict_mlp:
    if dict_mlp[str(split)][0] < accuracy:
      dict_mlp[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_mlp[str(split)][0]:
      RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_mlp[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
MLPClassifier(0.3, [100, 60,])
```

[ ]:
```
#Train - Test split 60-40
MLPClassifier(0.4, [100, 66,])
```

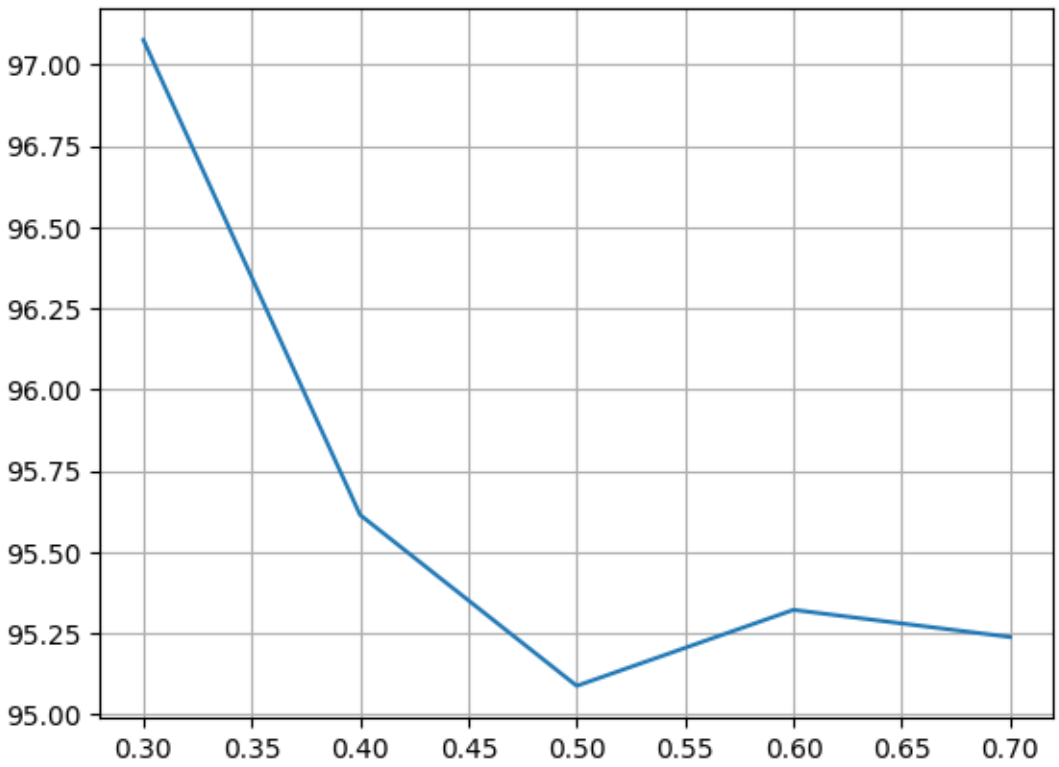
[ ]:
```
#Train - Test split 50-50
MLPClassifier(0.5, [150, 32])
```

[ ]:
```
#Train - Test split 40-60
MLPClassifier(0.6, [150, 50])
```

[ ]:
```
#Train - Test split 30-70
MLPClassifier(0.7, [100, 80])
```

0.0.7 split vs accuracy graph

[65]:
```
keys = dict_mlp.keys()
y_points = []
for key in keys:
  y_points.append(dict_mlp[key][0]*100)
x_points = [float(key) for key in dict_mlp.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.8 Random Forest Classifier

[ ]:
```
def randomForest(split, estimator = 100, criterionValue = 'gini', ):
  from sklearn.model_selection import train_test_split
  from sklearn.ensemble import RandomForestClassifier
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
↪random_state=44)
  scaler.fit_transform(X_train)
  scaler.transform(X_test)
  classifier = RandomForestClassifier(n_estimators = estimator, criterion =␣
↪criterionValue)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_rfr:
    if dict_rfr[str(split)][0] < accuracy:
      dict_rfr[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_rfr[str(split)][0]:
```

```
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_rfr[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
randomForest(0.3)
```

[ ]:
```
randomForest(0.4, 100,)
```

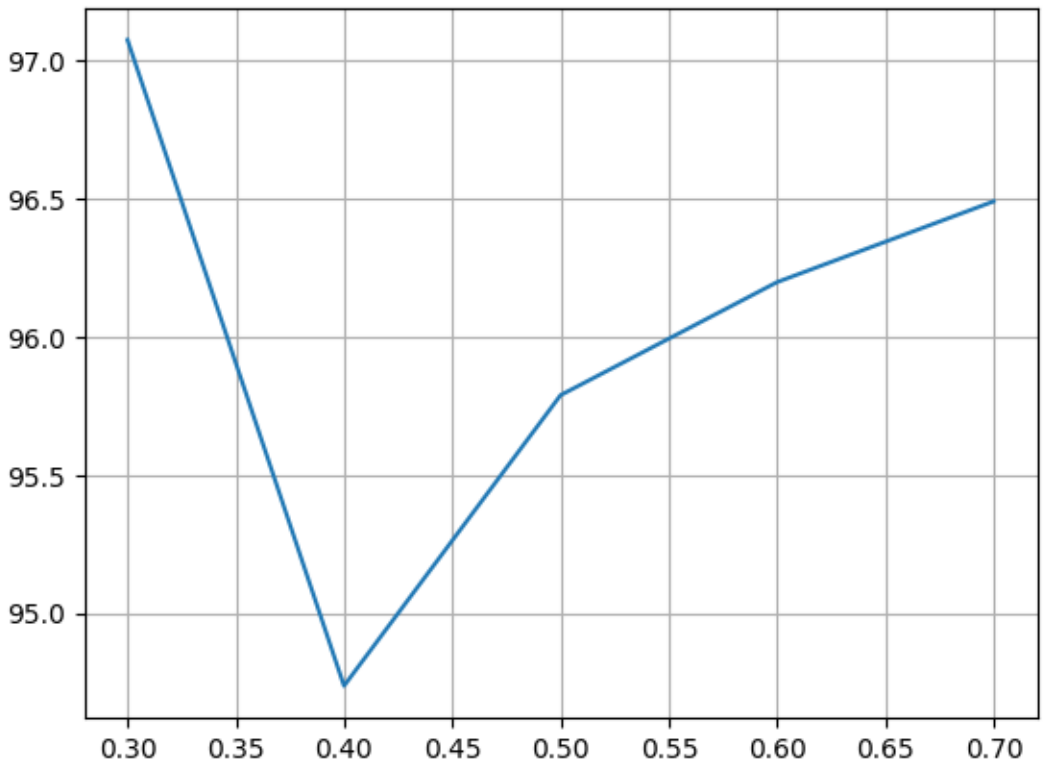
[ ]:
```
randomForest(0.5)
```

[ ]:
```
randomForest(0.6, 100, 'entropy')
```

[ ]:
```
randomForest(0.7, 120)
```

0.0.9 split vs accuracy graph

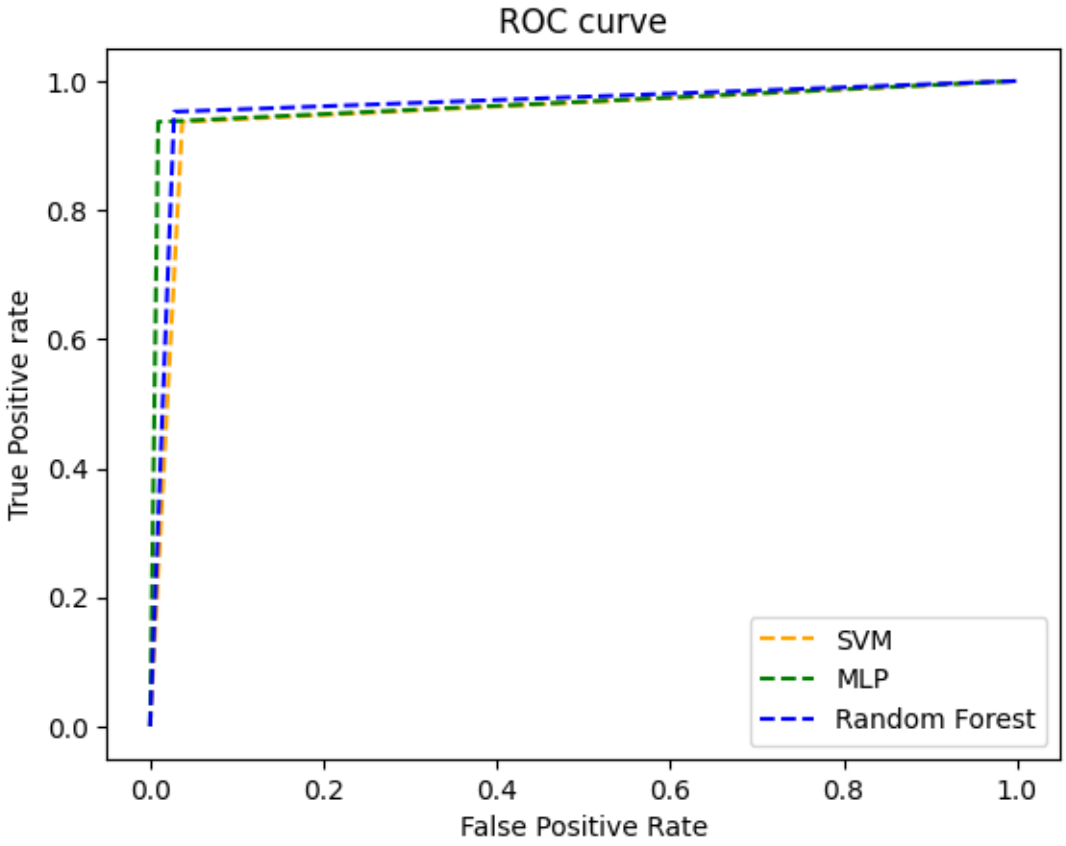
[66]:
```
keys = dict_rfr.keys()
y_points = []
for key in keys:
  y_points.append(dict_rfr[key][0]*100)
x_points = [float(key) for key in dict_rfr.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.10 ROC curve and ROC_AUC score for all the classifier having maximum accuracy when train test split 70-30.

[67]:
```
from sklearn import metrics
def auc_roc():
    fpr1, tpr1, _1 = metrics.roc_curve(RocAucSvm['max']['y_test'],␣
 ↪RocAucSvm['max']['y_pred'], pos_label=1)
    fpr2, tpr2, _2 = metrics.roc_curve(RocAucMlp['max']['y_test'],␣
 ↪RocAucMlp['max']['y_pred'], pos_label=1)
    fpr3, tpr3, _3 = metrics.roc_curve(RocAucRfr['max']['y_test'],␣
 ↪RocAucRfr['max']['y_pred'], pos_label=1)
    plt.plot(fpr1, tpr1, linestyle='--',color='orange', label='SVM')
    plt.plot(fpr2, tpr2, linestyle='--',color='green', label='MLP')
    plt.plot(fpr3, tpr3, linestyle='--', color='blue', label= 'Random Forest')
    plt.title('ROC curve')
    # x label
    plt.xlabel('False Positive Rate')
    # y label
    plt.ylabel('True Positive rate')

    plt.legend(loc='best')
```

```
    plt.savefig('ROC',dpi=300)
    plt.show()
auc_roc()
```



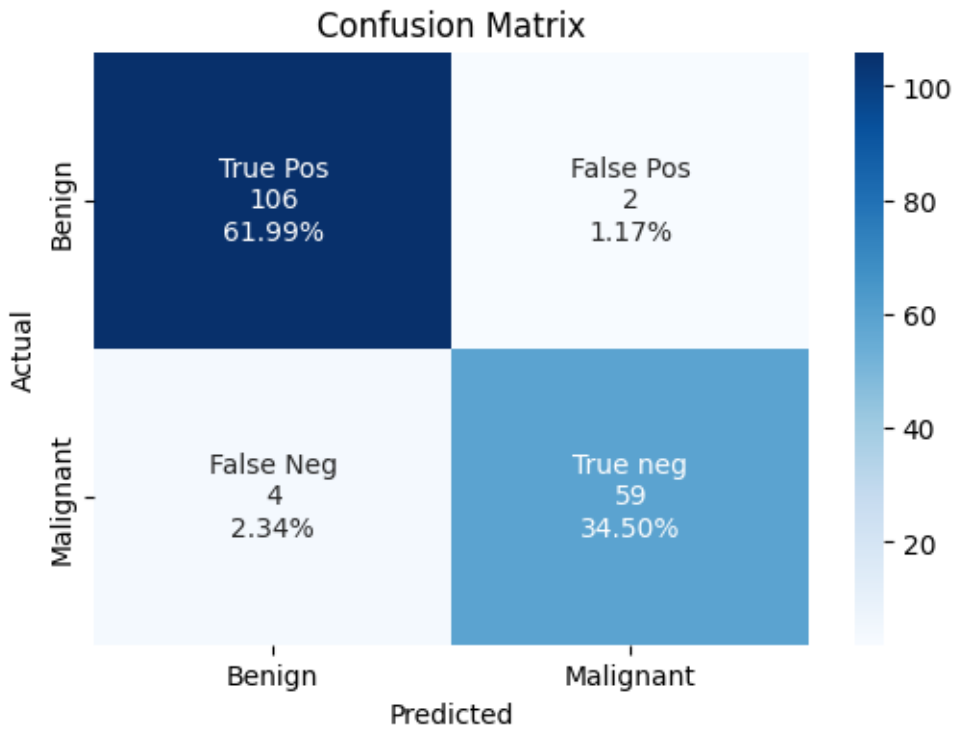
0.0.11 Using PCA

[ ]:
```
# from sklearn.datasets import load_breast_cancer
# dataset = load_breast_cancer()
# X = pd.DataFrame(data=dataset.data, columns=dataset.feature_names)
# y = dataset.target
# print(X)


# Standardizing the data (breast cancer dataset is already standardized)
##      from sklearn.preprocessing import StandardScaler
##      scaler = StandardScaler()
##      X_std = scaler.fit_transform(X)
##      print(X_std)
```

```
# Performing PCA
from sklearn.decomposition import PCA
from sklearn.metrics import accuracy_score
number_of_components = 10  # Number of components to retain (your choice)
pca = PCA(n_components=number_of_components)
transformed_data = pca.fit_transform(X)
print(transformed_data.shape)


## choose train-test split or hyperparameters accordingly
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = 0.3,␣
 ↪random_state=42)
rfc = RandomForestClassifier()
rfc.fit(X_train,y_train)
y_pred = rfc.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
if dict_rfr[str(0.3)][0] < accuracy:
      dict_rfr[str(0.3)] = [accuracy, y_test, y_pred]
print(classification_report(y_test,y_pred))
```

[68]:
```
#Best result for svm classifier
maxi=0
y_test = []
y_pred = []
for key in dict_svm:
  if maxi < 100*dict_svm[key][0]:
    maxi = 100*dict_svm[key][0]
    y_test = dict_svm[key][1]
    y_pred = dict_svm[key][2]
reports(y_test, y_pred)
```

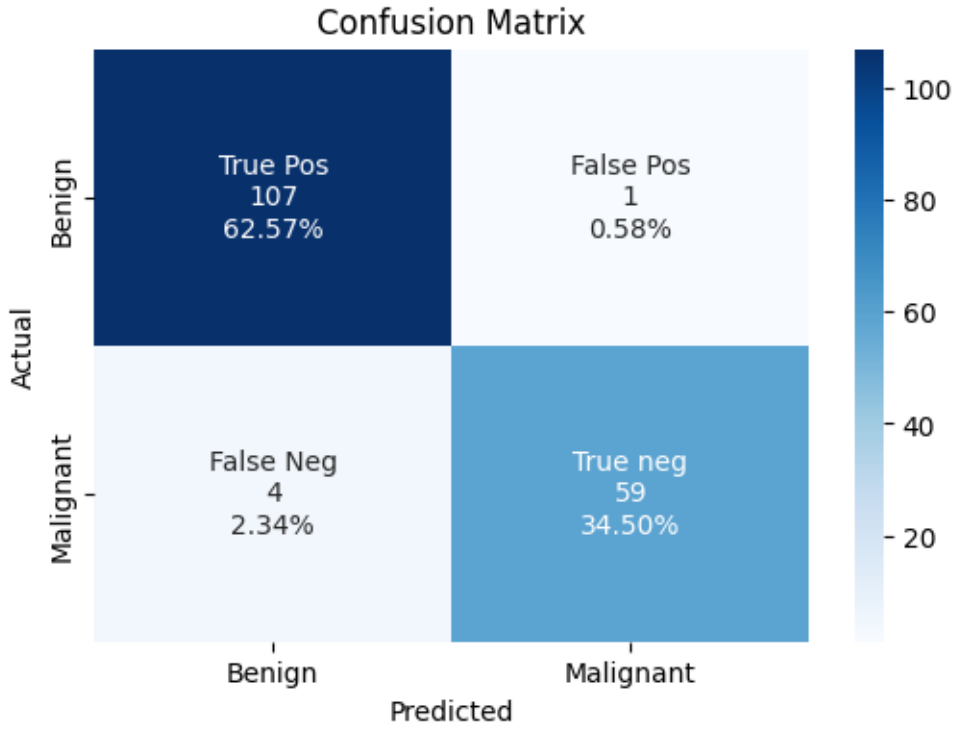
```
Confusion Matrix :
```




```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       0.96      0.98      0.97       108
           1       0.97      0.94      0.95        63

    accuracy                           0.96       171
   macro avg       0.97      0.96      0.96       171
weighted avg       0.96      0.96      0.96       171
```

[69]:
```
#Best result for mlp classifier
maxi=0
y_test = []
y_pred = []
for key in dict_mlp:
  if maxi < 100*dict_mlp[key][0]:
    maxi = 100*dict_mlp[key][0]
    y_test = dict_mlp[key][1]
    y_pred = dict_mlp[key][2]
reports(y_test, y_pred)
```

```
Confusion Matrix :
```

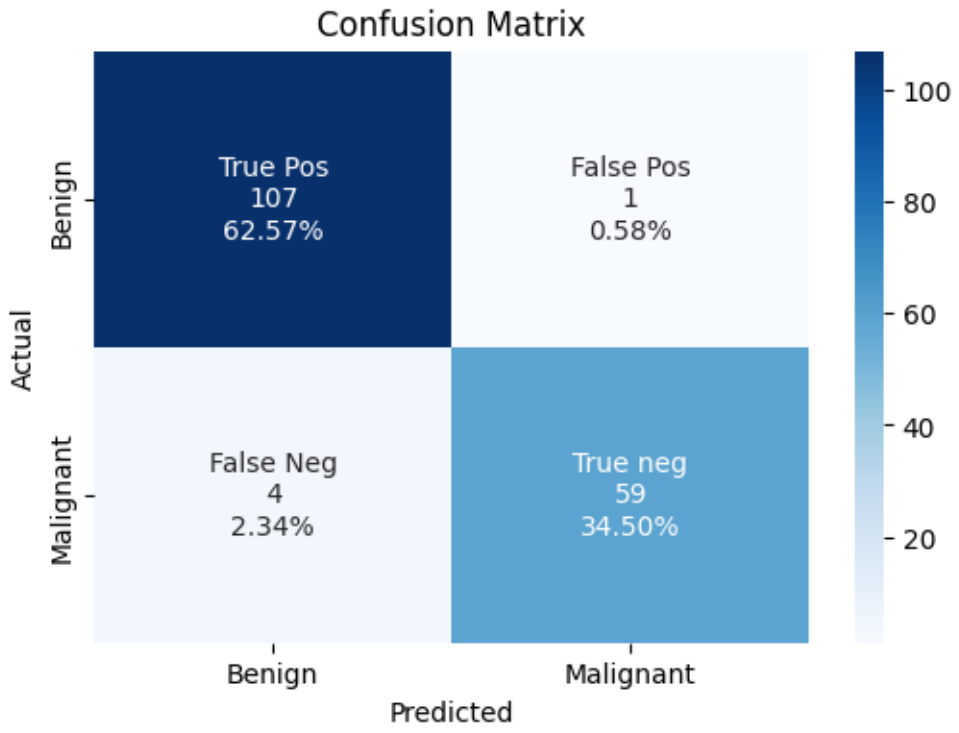



```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       0.96      0.99      0.98       108
           1       0.98      0.94      0.96        63

    accuracy                           0.97       171
   macro avg       0.97      0.96      0.97       171
weighted avg       0.97      0.97      0.97       171
```

[70]:
```
#Best result for random forest classifier
maxi=0
y_test = []
y_pred = []
for key in dict_rfr:
  if maxi < 100*dict_rfr[key][0]:
    maxi = 100*dict_rfr[key][0]
    y_test = dict_rfr[key][1]
    y_pred = dict_rfr[key][2]
```

```
reports(y_test, y_pred)
```

```
Confusion Matrix :
```




```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       0.96      0.99      0.98       108
           1       0.98      0.94      0.96        63

    accuracy                           0.97       171
   macro avg       0.97      0.96      0.97       171
weighted avg       0.97      0.97      0.97       171
```

ionosphere-assignment-2

August 22, 2023

0.0.1 IONOSPHERE Dataset classification using SVM, MLP and Random Forest classifier

[ ]:

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

[ ]:
```
url = 'https://raw.githubusercontent.com/Aqeel-0/phone.html/master/
↪ionosphere_data.csv'
df = pd.read_csv(url)
df.head()
#column_names = list(df.columns.values)
```

0.0.2 Pre Preprocessing

[ ]:
```
from sklearn.preprocessing import LabelEncoder
X = df.iloc[:, 0:-1]
y = df.iloc[: , -1]
le = LabelEncoder()
encoded = le.fit_transform(df['column_ai'])
df.drop("column_ai", axis=1, inplace=True)
df["column_ai"] = encoded
y = df["column_ai"]
dict_svm = {}
dict_mlp = {}
dict_rfr = {}
RocAucSvm = {}
RocAucMlp = {}
RocAucRfr = {}
y.info(), X.info()
y.value_counts()
```

0.0.3 Used for ploting confusion matrix

[ ]:
```
def plot(y_test, y_pred):
  from sklearn.metrics import confusion_matrix
  import seaborn as sns

  print("Confusion Matrix : ")
  cf_matrix = confusion_matrix(y_test, y_pred)
  group_names = ['True Pos','False Pos','False Neg','True neg']
  group_counts = ["{0:0.0f}".format(value) for value in
                  cf_matrix.flatten()]
  group_percentages = ["{0:.2%}".format(value) for value in
                       cf_matrix.flatten()/np.sum(cf_matrix)]
  labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
            zip(group_names,group_counts,group_percentages)]
  labels = np.asarray(labels).reshape(2,2)
  plt.figure(figsize=(6, 4))
  sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues',␣
 ↪xticklabels=['Good', 'Bad'], yticklabels=['Good', 'Bad'])
  plt.xlabel('Predicted')
  plt.ylabel('Actual')
  plt.title('Confusion Matrix')
  plt.show()
  print("***********************************************")
```

[ ]:
```
def reports(y_test, y_pred):
  from sklearn.metrics import classification_report, confusion_matrix
  plot(y_test, y_pred)
  print("***********************************************")
  print("Classification Evaluation : ")
  print(classification_report(y_test, y_pred, zero_division = 0))
```

0.0.4 SVM CLASSIFIER

[ ]:
```
def SVMClassifier(split, kernalValue = 'rbf', degreeValue = 3, gammaValue =␣
 ↪'scale', maxIter = -1):
  from sklearn.model_selection import train_test_split
  from sklearn.svm import SVC
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
 ↪random_state=44)
  scaler.fit_transform(X_train)
  scaler.transform(X_test)
  classifier = SVC(kernel = kernalValue, degree = degreeValue, gamma =␣
 ↪gammaValue, max_iter = maxIter)
```

```
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_svm:
    if dict_svm[str(split)][0] < accuracy:
      dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_svm[str(split)][0]:
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_svm[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucSvm['max'] = {'y_test': y_test, 'y_pred': y_pred}
  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
SVMClassifier(0.3, 'rbf', 3, 0.42)
SVMClassifier(0.3, 'linear', 3, 0.1)
SVMClassifier(0.3, 'poly', 5, )
SVMClassifier(0.3, 'sigmoid',3, 0.01)
```

[ ]:
```
#Train - Test split 60-40
SVMClassifier(0.4, 'rbf', 3, 0.31)
SVMClassifier(0.4, 'linear', 3, 0.01)
SVMClassifier(0.4, 'poly', 5, )
SVMClassifier(0.4, 'sigmoid', 3, 0.01)
```

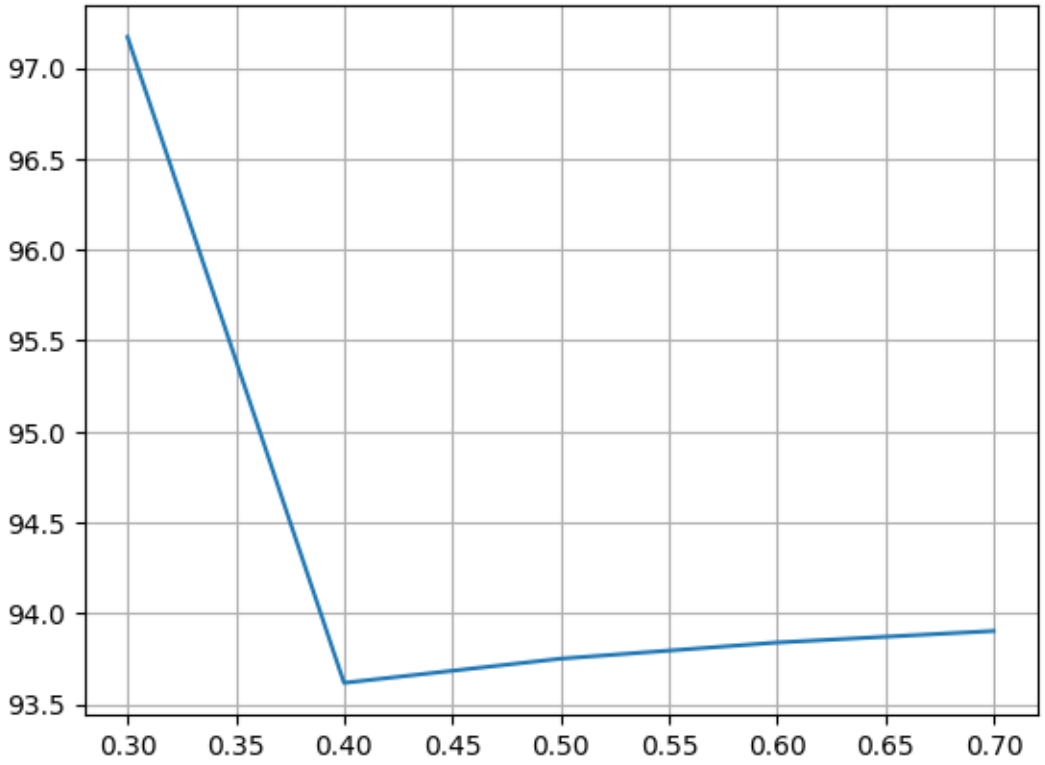
[ ]:
```
#Train - Test split 50-50
SVMClassifier(0.5, 'rbf', 3, 0.18)
SVMClassifier(0.5, 'linear', 3, )
SVMClassifier(0.5, 'poly', 4, )
SVMClassifier(0.5, 'sigmoid', 3, 0.09 ) #wrost performance
```

[ ]:
```
#Train - Test split 40-60
SVMClassifier(0.6, 'rbf', 3, 0.51)
SVMClassifier(0.6, 'linear', 3, )
SVMClassifier(0.6, 'poly', 2, 0.14)
SVMClassifier(0.6, 'sigmoid', 3,) #wrost performance
```

[ ]:
```
#Train - Test split 30-70
SVMClassifier(0.7, 'rbf', 3, 0.64)
SVMClassifier(0.7, 'linear')
SVMClassifier(0.7, 'poly', 2,)
SVMClassifier(0.7, 'sigmoid' ) #wrost performance
```

0.0.5 split vs accuracy graph

[83]:
```
keys = dict_svm.keys()
y_points = []
for key in keys:
  y_points.append(dict_svm[key][0]*100)
x_points = [float(key) for key in dict_svm.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.6 MLP Classifier

[ ]:
```
def MLPClassifier(split, hiddenLayerSize = [100, ], activationValue = 'relu',␣
 ↪solverValue = 'adam'):
  from sklearn.model_selection import train_test_split
  from sklearn.neural_network import MLPClassifier
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
```

```
  X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
↪random_state=44)
  scaler.fit_transform(X_train)
  scaler.transform(X_test)
  classifier = MLPClassifier(hidden_layer_sizes = hiddenLayerSize, activation =␣
↪activationValue, solver = solverValue, random_state = 1)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_mlp:
    if dict_mlp[str(split)][0] < accuracy:
      dict_mlp[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3' and accuracy > dict_mlp[str(split)][0]:
      RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_mlp[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucMlp['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
#Train - Test split 70-30
MLPClassifier(0.3, [80, 20])
```

[ ]:
```
#Train - Test split 60-40
MLPClassifier(0.4, [80, 15])
```

[ ]:
```
#Train - Test split 50-50
MLPClassifier(0.5, [80, 15])
```

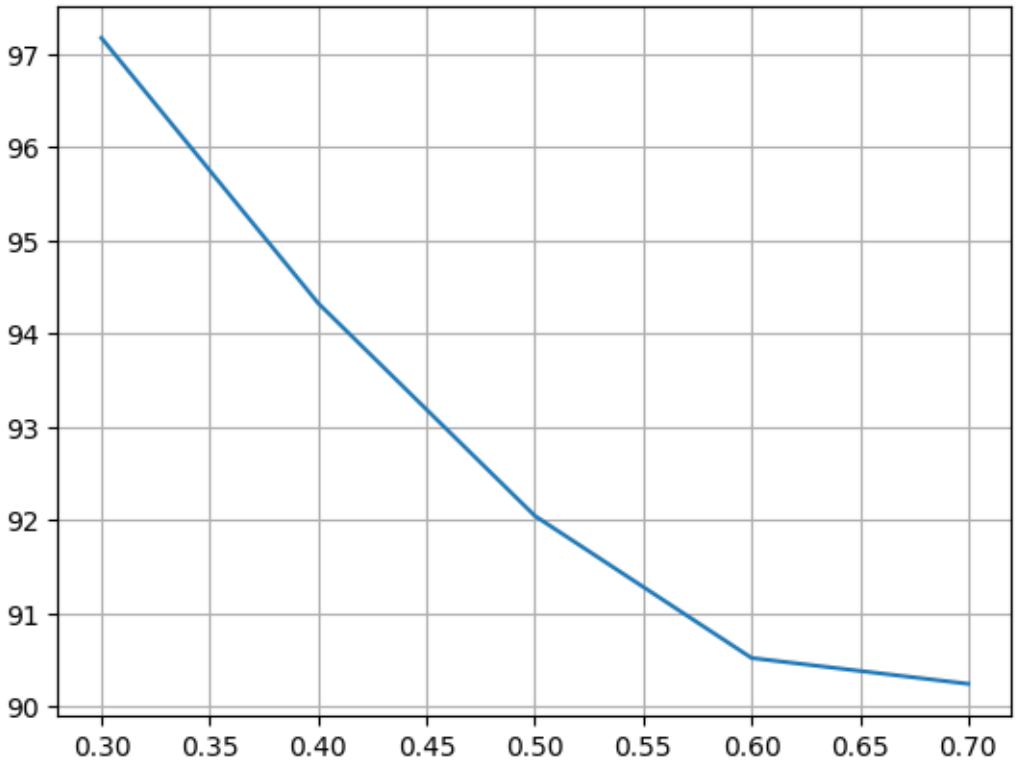
[ ]:
```
#Train - Test split 40-60
MLPClassifier(0.6, [80, 46])
```

[ ]:
```
#Train - Test split 30-70
MLPClassifier(0.7, [50, 22])
```

0.0.7 split vs accuracy graph

[82]:
```
keys = dict_mlp.keys()
y_points = []
for key in keys:
  y_points.append(dict_mlp[key][0]*100)
x_points = [float(key) for key in dict_mlp.keys()]

plt.plot(x_points, y_points)
```

```
plt.grid(True)
plt.show()
```



[ ]:
```
def randomForest(split, estimator = 100, criterionValue = 'gini', ):
  from sklearn.model_selection import train_test_split
  from sklearn.ensemble import RandomForestClassifier
  from sklearn.metrics import accuracy_score
  from sklearn.preprocessing import StandardScaler
  scaler = StandardScaler()
  X_train, X_test, y_train, y_test = train_test_split(X,y,test_size = split,␣
 ↪random_state=44)
  scaler.fit_transform(X_train)
  scaler.transform(X_test)
  classifier = RandomForestClassifier(n_estimators = estimator, criterion =␣
 ↪criterionValue)
  classifier.fit(X_train, y_train)
  y_pred = classifier.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)

  if str(split) in dict_rfr:
    if dict_rfr[str(split)][0] < accuracy:
      dict_rfr[str(split)] = [accuracy, y_test, y_pred]
```

```
    if str(split) == '0.3' and accuracy > dict_rfr[str(split)][0]:
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}
  else:
    dict_rfr[str(split)] = [accuracy, y_test, y_pred]
    if str(split) == '0.3':
      RocAucRfr['max'] = {'y_test': y_test, 'y_pred': y_pred}

  reports(y_test, y_pred)
```

[ ]:
```
randomForest(0.3, 170)
randomForest(0.3, 205, 'entropy')
```

[ ]:
```
randomForest(0.4, 70)
randomForest(0.4, 80, 'entropy')
```

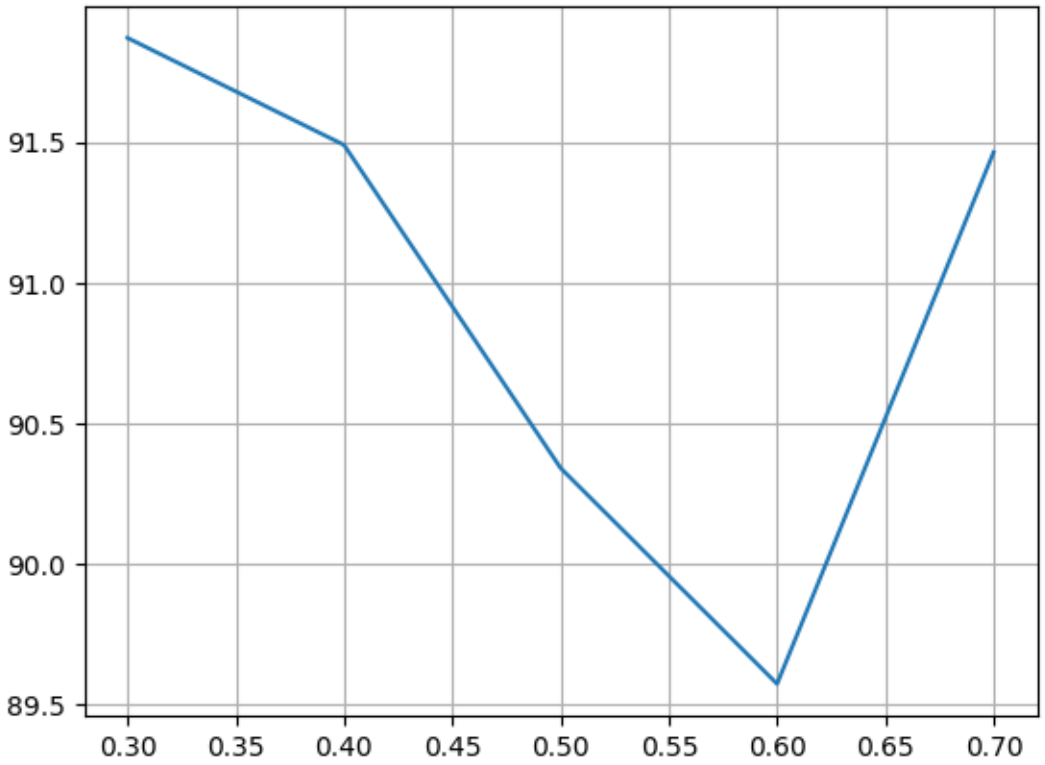
[ ]:
```
randomForest(0.5, 66)
randomForest(0.5, 140, 'entropy')
```

[ ]:
```
randomForest(0.6, )
randomForest(0.6, 100, 'entropy')
```

[ ]:
```
randomForest(0.7, 120)
randomForest(0.4, 80, 'entropy')
```

0.0.8 split vs accuracy graph

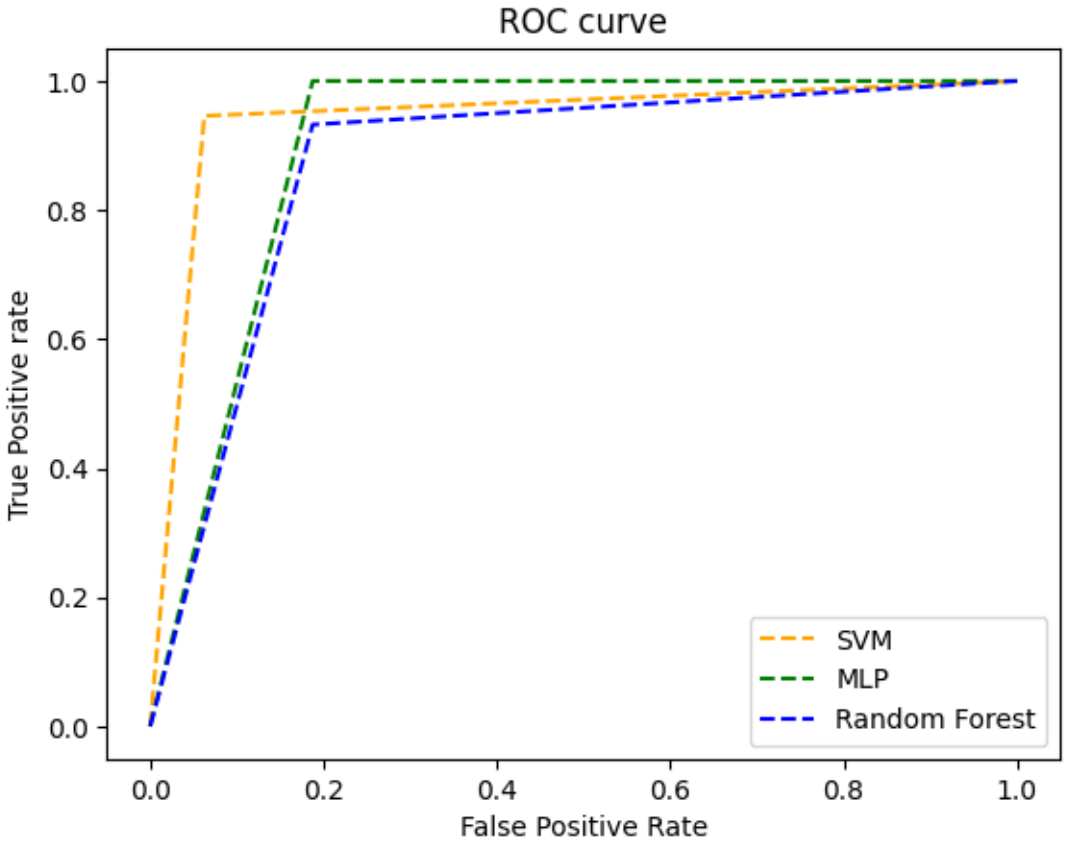
[81]:
```
keys = dict_rfr.keys()
y_points = []
for key in keys:
  y_points.append(dict_rfr[key][0]*100)
x_points = [float(key) for key in dict_rfr.keys()]

plt.plot(x_points, y_points)
plt.grid(True)
plt.show()
```



0.0.9 ROC curve and ROC_AUC score for all the classifier having maximum accuracy when train test split 70-30.

[80]:
```
from sklearn import metrics
def auc_roc():
    fpr1, tpr1, _1 = metrics.roc_curve(RocAucSvm['max']['y_test'],␣
 ↪RocAucSvm['max']['y_pred'], pos_label=1)
    fpr2, tpr2, _2 = metrics.roc_curve(RocAucMlp['max']['y_test'],␣
 ↪RocAucMlp['max']['y_pred'], pos_label=1)
    fpr3, tpr3, _3 = metrics.roc_curve(RocAucRfr['max']['y_test'],␣
 ↪RocAucRfr['max']['y_pred'], pos_label=1)
    plt.plot(fpr1, tpr1, linestyle='--',color='orange', label='SVM')
    plt.plot(fpr2, tpr2, linestyle='--',color='green', label='MLP')
    plt.plot(fpr3, tpr3, linestyle='--', color='blue', label= 'Random Forest')
    plt.title('ROC curve')
    # x label
    plt.xlabel('False Positive Rate')
    # y label
    plt.ylabel('True Positive rate')

    plt.legend(loc='best')
```

```
    plt.savefig('ROC',dpi=300)
    plt.show()
auc_roc()
```



0.0.10 Using PCA on Random Forest Classifiers

[ ]:
```
# Standardizing the data (ionosphere dataset is already standardized)
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score
scaler = StandardScaler()
X_std = scaler.fit_transform(X)
print(X_std)


# Performing PCA
from sklearn.decomposition import PCA

number_of_components = 10  # Number of components to retain (your choice)
pca = PCA(n_components=number_of_components)
```

```
transformed_data = pca.fit_transform(X)
print(transformed_data.shape)

## choose train-test split or hyperparameters accordingly
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
import seaborn as sns

X_train, X_test, y_train, y_test = train_test_split(transformed_data, y,␣
 ↪test_size=0.7, random_state=42)
rfc = RandomForestClassifier(n_estimators=100, criterion='gini')  # most␣
 ↪suitable hyperparameters
rfc.fit(X_train, y_train)
y_pred = rfc.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
if dict_rfr[str(0.3)][0] < accuracy:
      dict_rfr[str(0.3)] = [accuracy, y_test, y_pred]
print('-------------------------------------------------------------------------------')
print(
  'Classification report of Random Forest Classifier after PCA (' +␣
 ↪str(number_of_components) + ' components taken):  ')
print('-------------------------------------------------------------------------------')
print(classification_report(y_test, y_pred))

print("Confusion Matrix for the same: ")
cf_matrix = confusion_matrix(y_test, y_pred)
group_names = ['True Pos', 'False Pos', 'False Neg', 'True neg']
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten() / np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names, group_counts, group_percentages)]
labels = np.asarray(labels).reshape(2, 2)
plt.figure(figsize=(6, 4))
print(sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues',␣
 ↪xticklabels=['Benign', 'Malignant'],
                  yticklabels=['Benign', 'Malignant']))
```

0.0.11 Using PCA on Support Vector Machines

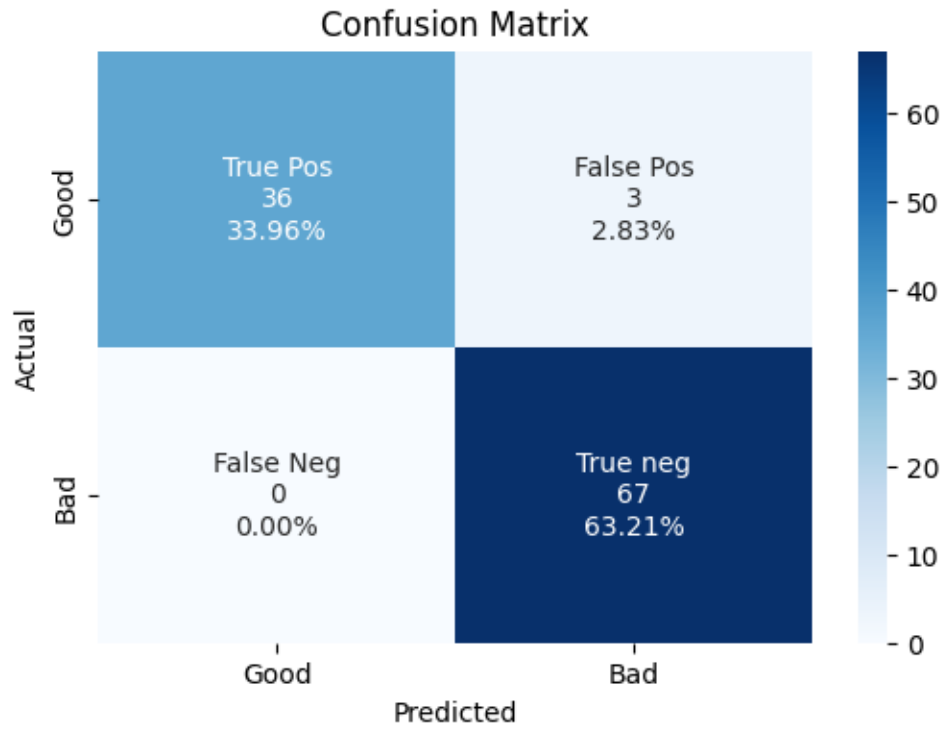
[ ]:
```
# Performing PCA
from sklearn.decomposition import PCA
from sklearn.metrics import accuracy_score
number_of_components = 12  # Number of components to retain (your choice)
pca = PCA(n_components=number_of_components)
transformed_data = pca.fit_transform(X)
print(transformed_data.shape)

## choose train-test split or hyperparameters accordingly
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
import seaborn as sns

X_train, X_test, y_train, y_test = train_test_split(transformed_data, y,␣
 ↪test_size=0.3, random_state=42)
rfc = SVC(gamma='scale', kernel='rbf', degree=3)  # most suitable␣
 ↪hyperparameters
rfc.fit(X_train, y_train)
y_pred = rfc.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
if dict_svm[str(0.3)][0] < accuracy:
      dict_svm[str(0.3)] = [accuracy, y_test, y_pred]
print('-------------------------------------------------------------------------------')
print(
  'Classification report of Support Vector Machines Classifier after PCA (' +␣
 ↪str(number_of_components) + ' components taken):  ')
print('-------------------------------------------------------------------------------')
print(classification_report(y_test, y_pred))

print("Confusion Matrix for the same: ")
cf_matrix = confusion_matrix(y_test, y_pred)
group_names = ['True Pos', 'False Pos', 'False Neg', 'True neg']
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten() / np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names, group_counts, group_percentages)]
labels = np.asarray(labels).reshape(2, 2)
plt.figure(figsize=(6, 4))
print(sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues',␣
 ↪xticklabels=['Benign', 'Malignant'],
                  yticklabels=['Benign', 'Malignant']))
```

0.0.12 Using PCA on Multi Layer Perceptron

[ ]:
```
# Performing PCA
from sklearn.decomposition import PCA
from sklearn.metrics import accuracy_score
number_of_components = 12  # Number of components to retain (your choice)
pca = PCA(n_components=number_of_components)
transformed_data = pca.fit_transform(X)
print(transformed_data.shape)

## choose train-test split or hyperparameters accordingly
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
import seaborn as sns

X_train, X_test, y_train, y_test = train_test_split(transformed_data, y,␣
 ↪test_size=0.3, random_state=42)
rfc = SVC(gamma='scale', kernel='rbf', degree=3)  # most suitable␣
 ↪hyperparameters
rfc.fit(X_train, y_train)
y_pred = rfc.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
if dict_mlp[str(0.3)][0] < accuracy:
      dict_mlp[str(0.3)] = [accuracy, y_test, y_pred]
print('-----------------------------------------------------------------------------')
print(
  'Classification report of Multi Layer Perceptron Classifier after PCA (' +␣
 ↪str(number_of_components) + ' components taken):  ')
print('-----------------------------------------------------------------------------')
print(classification_report(y_test, y_pred))

print("Confusion Matrix for the same: ")
cf_matrix = confusion_matrix(y_test, y_pred)
group_names = ['True Pos', 'False Pos', 'False Neg', 'True neg']
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten() / np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names, group_counts, group_percentages)]
labels = np.asarray(labels).reshape(2, 2)
plt.figure(figsize=(6, 4))
print(sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues',␣
 ↪xticklabels=['Benign', 'Malignant'],
                  yticklabels=['Benign', 'Malignant']))
```

[79]:
```
#Best result for svm classifier
maxi=0
y_test = []
y_pred = []
for key in dict_svm:
  if maxi < 100*dict_svm[key][0]:
    maxi = 100*dict_svm[key][0]
    y_test = dict_svm[key][1]
    y_pred = dict_svm[key][2]
reports(y_test, y_pred)
```

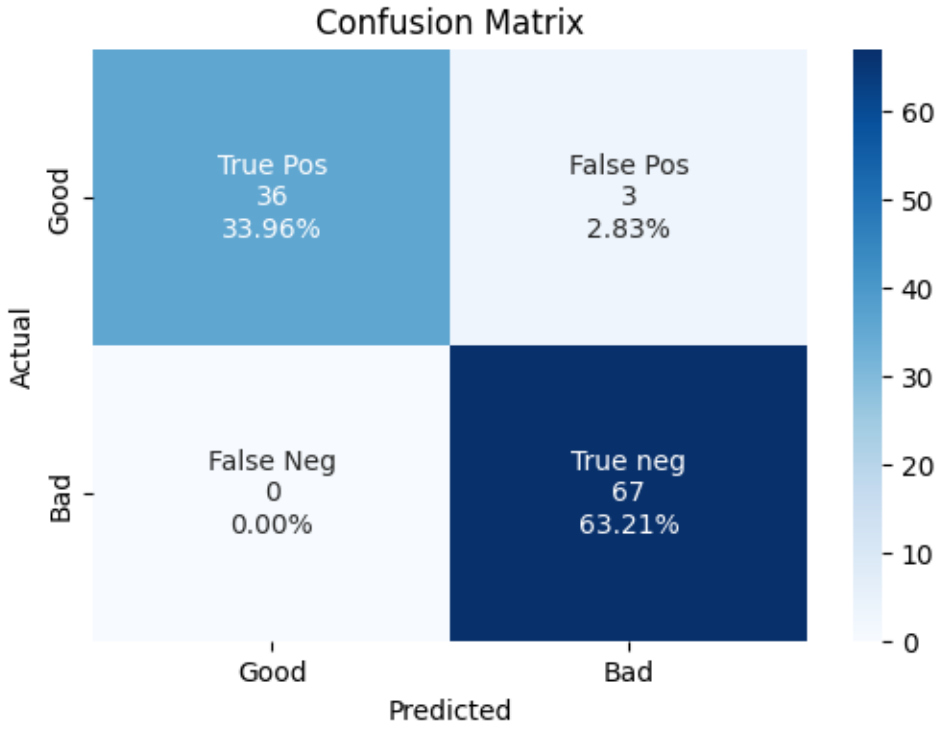
```
Confusion Matrix :
```




```
*********************************************
*********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       1.00      0.92      0.96        39
           1       0.96      1.00      0.98        67

    accuracy                           0.97       106
   macro avg       0.98      0.96      0.97       106
weighted avg       0.97      0.97      0.97       106
```

[78]:
```
#Best result for mlp classifier
maxi=0
y_test = []
y_pred = []
for key in dict_mlp:
  if maxi < 100*dict_mlp[key][0]:
    maxi = 100*dict_mlp[key][0]
    y_test = dict_mlp[key][1]
    y_pred = dict_mlp[key][2]
reports(y_test, y_pred)
```

```
Confusion Matrix :
```

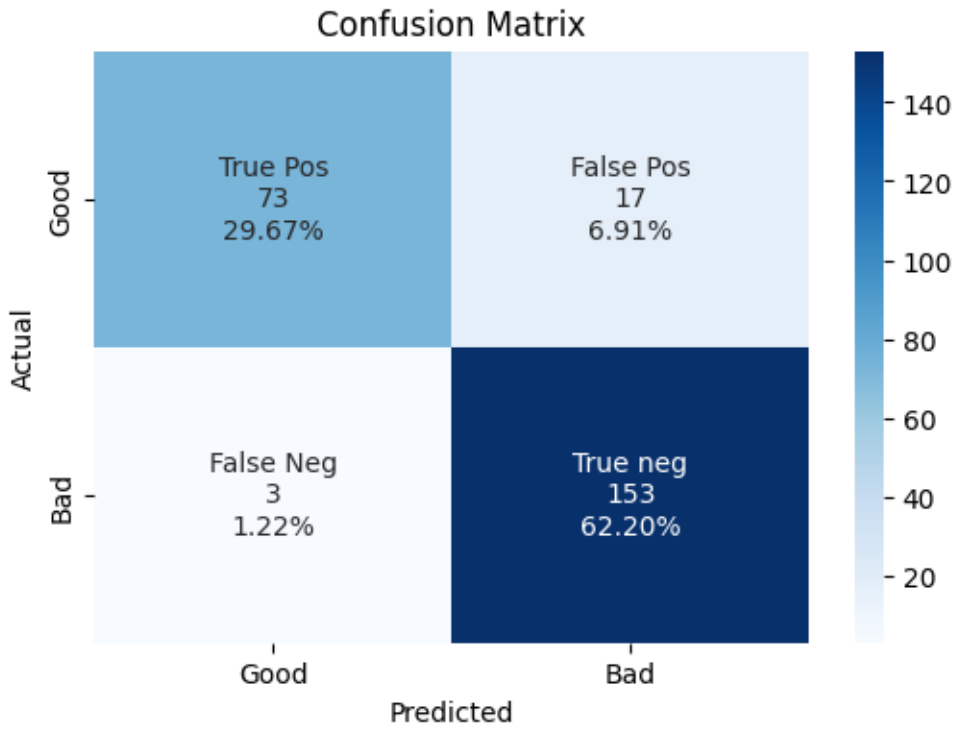



```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       1.00      0.92      0.96        39
           1       0.96      1.00      0.98        67

    accuracy                           0.97       106
```

```
   macro avg       0.98      0.96      0.97       106
weighted avg       0.97      0.97      0.97       106
```

[77]:
```
#Best result for random forest classifier
maxi=0
y_test = []
y_pred = []
for key in dict_rfr:
  if maxi < 100*dict_rfr[key][0]:
    maxi = 100*dict_rfr[key][0]
    y_test = dict_rfr[key][1]
    y_pred = dict_rfr[key][2]
reports(y_test, y_pred)
```

```
Confusion Matrix :
```




```
**********************************************
**********************************************
Classification Evaluation :
              precision    recall  f1-score   support

           0       0.96      0.81      0.88        90
           1       0.90      0.98      0.94       156
```

```
              precision    recall  f1-score   support

    accuracy                         0.92       246
   macro avg       0.93      0.90      0.91       246
weighted avg       0.92      0.92      0.92       246
```