Autism Classification Model

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Change Control Log:

Change #: 1
Change(s) Made: Found and imported dataset. Created model.
Date of Change: 3/26/2023

Change #: 2
Change(s) Made: Added cross-fold validation to investigate the suspiciously high accuracy.
Date of Change: 3/28/2023

In [1]:
```
# Libraries
from scipy.io import arff
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

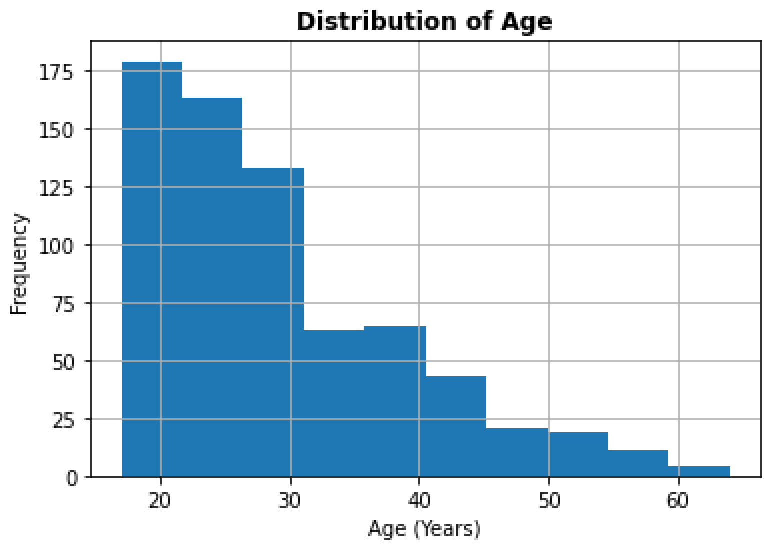
In [2]:
```
data = arff.loadarff("Autism-Adult-Data.arff")
df = pd.DataFrame(data[0])
```

In [3]:
```
df.columns
```

Out[3]:
```
Index(['A1_Score', 'A2_Score', 'A3_Score', 'A4_Score', 'A5_Score', 'A6_Score',
       'A7_Score', 'A8_Score', 'A9_Score', 'A10_Score', 'age', 'gender',
       'ethnicity', 'jundice', 'austim', 'contry_of_res', 'used_app_before',
       'result', 'age_desc', 'relation', 'Class/ASD'],
      dtype='object')
```

In [4]:
```
df_filtered = df[df['age'] <= 100]
df_filtered['age'].hist()
plt.xlabel('Age (Years)')
plt.ylabel('Frequency')
plt.title('Distribution of Age',
          fontweight ="bold")
```

Out[4]:
```
Text(0.5, 1.0, 'Distribution of Age')
```

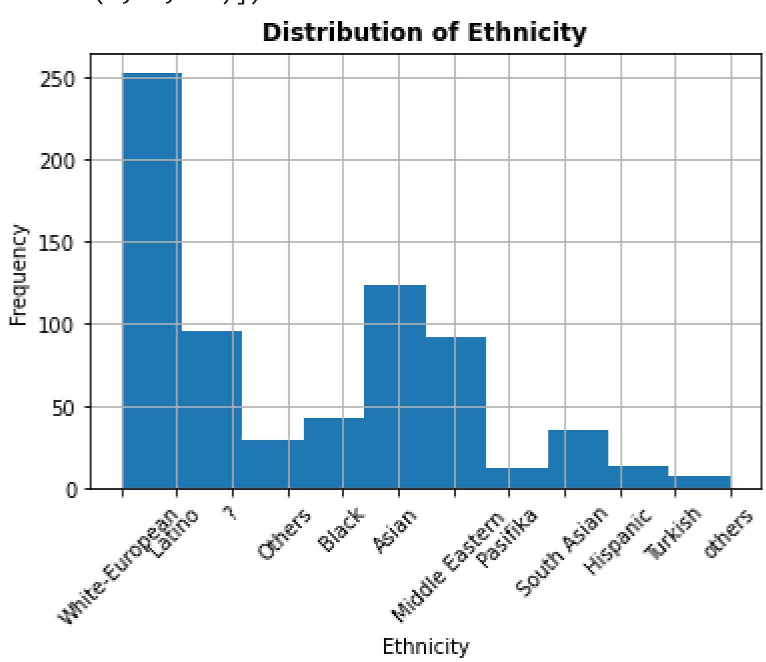


In [5]:

```
df['ethnicity'].hist()
plt.xlabel('Ethnicity')
plt.ylabel('Frequency')
plt.title('Distribution of Ethnicity',
          fontweight ="bold")
plt.xticks(rotation=45)
```

Out[5]:

```
([0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11],
 [Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, '')])
```

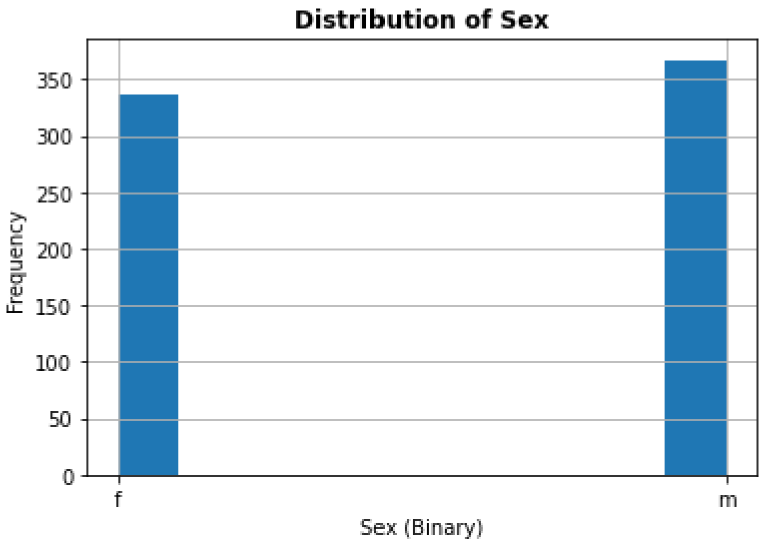


In [6]:

```
df['gender'].hist()
plt.xlabel('Sex (Binary)')
plt.ylabel('Frequency')
plt.title('Distribution of Sex',
          fontweight ="bold")
```

Out[6]:

```
Text(0.5, 1.0, 'Distribution of Sex')
```



In [7]:

```
df.shape
```

Out[7]:

```
(704, 21)
```

In [8]:

```
# make a dataframe with just the training and target features
df = df[['A1_Score', 'A2_Score', 'A3_Score', 'A4_Score', 'A5_Score', 'A6_Score',
       'A7_Score', 'A8_Score', 'A9_Score', 'A10_Score', 'Class/ASD']]
```

In [9]:

```
# Convert byte columns into strings
df_convert = pd.DataFrame()

for col in df.columns:
    df_convert[col] = df[col].str.decode("utf-8")
```

In [10]:

```
df = df_convert
df.head()
```

Out[10]:

	A1_Score	A2_Score	A3_Score	A4_Score	A5_Score	A6_Score	A7_Score	A8_Score	A9_Score	A10_Sc
0	1	1	1	1	0	0	1	1	0	
1	1	1	0	1	0	0	0	1	0	
2	1	1	0	1	1	0	1	1	1	
3	1	1	0	1	0	0	1	1	0	
4	1	0	0	0	0	0	0	1	0	

In [11]:

```
df.dtypes
```

Out[11]:

```
A1_Score     object
A2_Score     object
A3_Score     object
A4_Score     object
A5_Score     object
A6_Score     object
A7_Score     object
A8_Score     object
A9_Score     object
A10_Score    object
Class/ASD    object
dtype: object
```

In [12]:

```
df['A1_Score'] = df['A1_Score'].astype('int')
```

In [13]:

```
for col in df.columns:
    if col != 'Class/ASD':
        df[col] = df[col].astype('int')

df['Class/ASD'] = df['Class/ASD'].astype('str')

df.dtypes
```

Out[13]:

```
A1_Score      int32
A2_Score      int32
A3_Score      int32
A4_Score      int32
A5_Score      int32
A6_Score      int32
A7_Score      int32
A8_Score      int32
A9_Score      int32
A10_Score     int32
Class/ASD    object
dtype: object
```

In [14]:

```
df['Class/ASD'].replace('YES', 1, inplace = True)
df['Class/ASD'].replace('NO', 0, inplace = True)
df.dtypes
```

Out[14]:

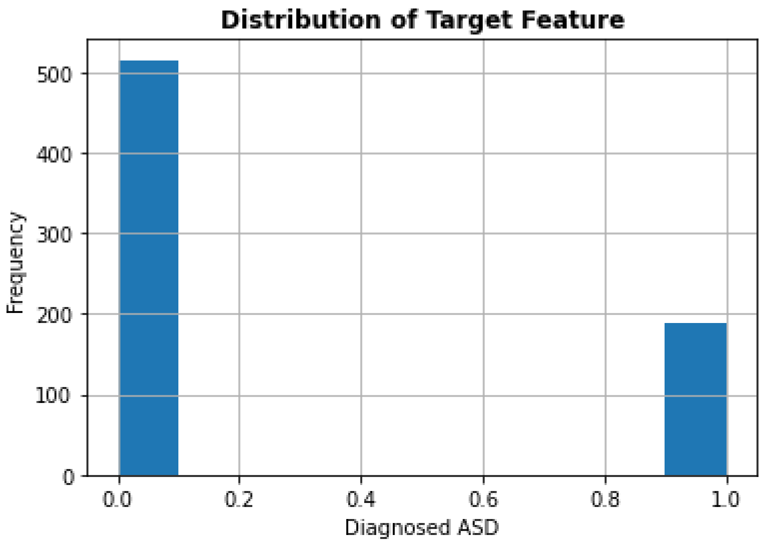
```
A1_Score     int32
A2_Score     int32
A3_Score     int32
A4_Score     int32
A5_Score     int32
A6_Score     int32
A7_Score     int32
A8_Score     int32
A9_Score     int32
A10_Score    int32
Class/ASD    int64
dtype: object
```

In [15]:

```
df['Class/ASD'].hist()
plt.xlabel('Diagnosed ASD')
plt.ylabel('Frequency')
plt.title('Distribution of Target Feature',
          fontweight ="bold")
```

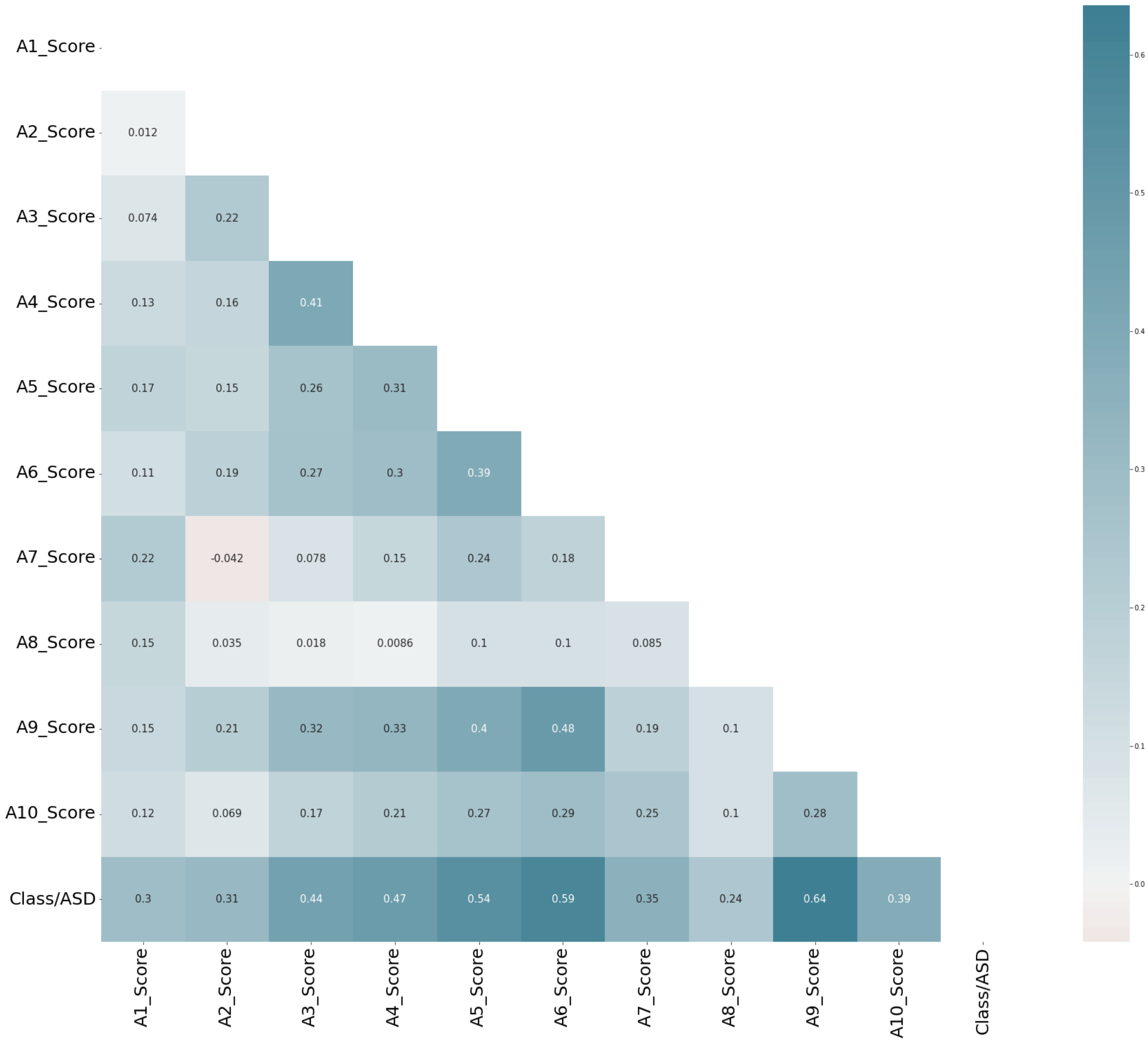
Out[15]:

```
Text(0.5, 1.0, 'Distribution of Target Feature')
```



In [16]:

```
# Define figure sizes and axis label sizes/ticks
plt.figure(figsize = (30,25))
plt.xticks(fontsize = 25)
plt.yticks(fontsize = 25)
# Use a mask on the upper triangle for readability (triu - upper triangle vs tril - low
mask = np.triu(np.ones_like(df_convert.corr(), dtype=bool))
# Create heatmap
sns.heatmap(df_convert.corr(method = 'pearson'),
            cmap=sns.diverging_palette(20, 220, n=200),
            center = 0,
            mask = mask,
            annot= True,
            annot_kws = {"size": 15}
           )
plt.show()
```



'In fact, a Pearson correlation coefficient estimated for two binary variables will return the phi coefficient." https://en.m.wikipedia.org/wiki/Phi_coefficient

https://scikit-learn.org/stable/modules/generated/sklearn.metrics.matthews_corrcoef.html

The Model

In [17]:

```
# Import train_test_split function
from sklearn.model_selection import train_test_split
```

In [18]:

```
training_features = df.drop(['Class/ASD'], axis =1)
target_feature = df['Class/ASD']
```

In [19]:

```
# Split dataset into training set and test set
X_train, X_test, y_train, y_test = train_test_split(training_features, target_feature,
```

In [20]:

```
#Import svm model
from sklearn import svm
```

In [21]:
```
#Create a svm Classifier
clf = svm.SVC(kernel='rbf')
```

In [22]:
```
#Train the model using the training sets
clf.fit(X_train, y_train)
```

Out[22]:

```
▾ SVC
SVC()
```

In [23]:
```
#Predict the response for test dataset
y_pred = clf.predict(X_test)
```

In [24]:
```
#Import scikit-learn metrics module for accuracy calculation
from sklearn import metrics
```

In [25]:
```
# Model Accuracy: how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(y_test, y_pred))
```

```
Accuracy: 0.9858490566037735
```

In [26]:
```
from sklearn import datasets
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import roc_curve, roc_auc_score
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
```

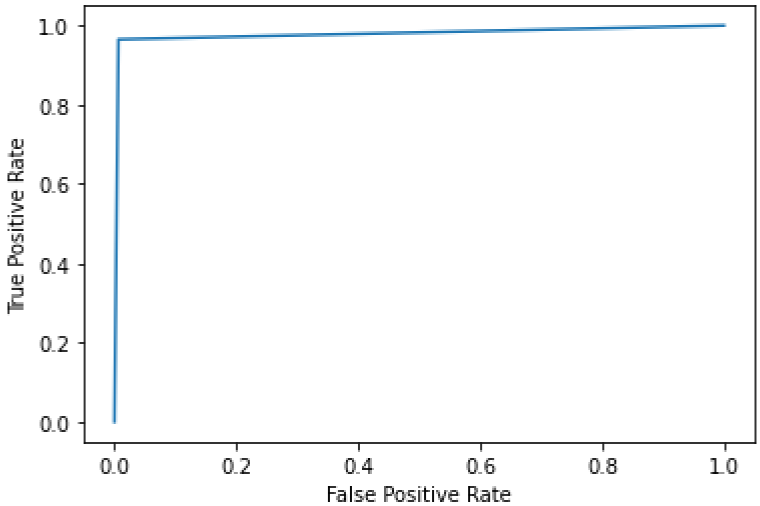
In [27]:
```
import matplotlib.pyplot as plt

def plot_roc_curve(true_y, y_prob):
    """
    plots the roc curve based of the probabilities
    """

    fpr, tpr, thresholds = roc_curve(true_y, y_prob)
    plt.plot(fpr, tpr)
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
```

In [28]:
```
plot_roc_curve(y_test, y_pred)
print(f'model 1 AUC score: {roc_auc_score(y_test, y_pred)}')
```

```
model 1 AUC score: 0.9792303338992642
```



https://www.datacamp.com/tutorial/svm-classification-scikit-learn-python

In [29]:

```
from sklearn.model_selection import GridSearchCV

# defining parameter range
param_grid = {'C': [0.1, 1, 10, 100, 1000],
              'gamma': [1, 0.1, 0.01, 0.001, 0.0001],
              'kernel': ['rbf']}

grid = GridSearchCV(clf, param_grid, refit = True, verbose = 3)

# fitting the model for grid search
grid.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 25 candidates, totalling 125 fits
[CV 1/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.828 total time=   0.0s
[CV 2/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.869 total time=   0.0s
[CV 3/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.878 total time=   0.0s
[CV 4/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.878 total time=   0.0s
[CV 5/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.857 total time=   0.0s
[CV 1/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.939 total time=   0.0s
[CV 2/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.909 total time=   0.0s
[CV 3/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.969 total time=   0.0s
[CV 4/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.969 total time=   0.0s
[CV 5/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.898 total time=   0.0s
[CV 1/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.727 total time=   0.0s
[CV 2/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.727 total time=   0.0s
[CV 3/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.735 total time=   0.0s
[CV 4/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 2/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 3/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 4/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END ...C=0.1, gamma=0.0001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 2/5] END ...C=0.1, gamma=0.0001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 3/5] END ...C=0.1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 4/5] END ...C=0.1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END ...C=0.1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END ..........C=1, gamma=1, kernel=rbf;, score=0.939 total time=   0.0s
[CV 2/5] END ..........C=1, gamma=1, kernel=rbf;, score=0.949 total time=   0.0s
```

```
[CV 3/5] END .........C=1, gamma=1, kernel=rbf;, score=0.969 total time=   0.0s
[CV 4/5] END .........C=1, gamma=1, kernel=rbf;, score=0.969 total time=   0.0s
[CV 5/5] END .........C=1, gamma=1, kernel=rbf;, score=0.959 total time=   0.0s
[CV 1/5] END .......C=1, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END .......C=1, gamma=0.1, kernel=rbf;, score=0.980 total time=   0.0s
[CV 3/5] END .......C=1, gamma=0.1, kernel=rbf;, score=0.990 total time=   0.0s
[CV 4/5] END .......C=1, gamma=0.1, kernel=rbf;, score=0.990 total time=   0.0s
[CV 5/5] END .......C=1, gamma=0.1, kernel=rbf;, score=0.959 total time=   0.0s
[CV 1/5] END ......C=1, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.919 total time=   0.0s
[CV 3/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.969 total time=   0.0s
[CV 4/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.959 total time=   0.0s
[CV 5/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.949 total time=   0.0s
[CV 1/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 2/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 3/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 4/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END ....C=1, gamma=0.0001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 2/5] END ....C=1, gamma=0.0001, kernel=rbf;, score=0.727 total time=   0.0s
[CV 3/5] END ....C=1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 4/5] END ....C=1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END ....C=1, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END ........C=10, gamma=1, kernel=rbf;, score=0.919 total time=   0.0s
[CV 2/5] END ........C=10, gamma=1, kernel=rbf;, score=0.949 total time=   0.0s
[CV 3/5] END ........C=10, gamma=1, kernel=rbf;, score=0.980 total time=   0.0s
[CV 4/5] END ........C=10, gamma=1, kernel=rbf;, score=0.969 total time=   0.0s
[CV 5/5] END ........C=10, gamma=1, kernel=rbf;, score=0.959 total time=   0.0s
[CV 1/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 3/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 5/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 1/5] END .....C=10, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.960 total time=   0.0s
[CV 3/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.990 total time=   0.0s
[CV 4/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.980 total time=   0.0s
[CV 5/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.959 total time=   0.0s
[CV 1/5] END ....C=10, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ....C=10, gamma=0.001, kernel=rbf;, score=0.929 total time=   0.0s
[CV 3/5] END ....C=10, gamma=0.001, kernel=rbf;, score=0.959 total time=   0.0s
[CV 4/5] END ....C=10, gamma=0.001, kernel=rbf;, score=0.959 total time=   0.0s
[CV 5/5] END ....C=10, gamma=0.001, kernel=rbf;, score=0.939 total time=   0.0s
[CV 1/5] END ...C=10, gamma=0.0001, kernel=rbf;, score=0.727 total time=   0.0s
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[CV 4/5] END ...C=10, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 5/5] END ...C=10, gamma=0.0001, kernel=rbf;, score=0.735 total time=   0.0s
[CV 1/5] END .......C=100, gamma=1, kernel=rbf;, score=0.919 total time=   0.0s
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[CV 3/5] END .....C=100, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END .....C=100, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 5/5] END .....C=100, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 1/5] END ....C=100, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ....C=100, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
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```
[CV 3/5] END .....C=100, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END .....C=100, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
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[CV 1/5] END ....C=100, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
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[CV 5/5] END ...C=100, gamma=0.0001, kernel=rbf;, score=0.939 total time=   0.0s
[CV 1/5] END ......C=1000, gamma=1, kernel=rbf;, score=0.919 total time=   0.0s
[CV 2/5] END ......C=1000, gamma=1, kernel=rbf;, score=0.949 total time=   0.0s
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[CV 3/5] END .....C=1000, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END .....C=1000, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 5/5] END .....C=1000, gamma=0.1, kernel=rbf;, score=1.000 total time=   0.0s
[CV 1/5] END ....C=1000, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ....C=1000, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 3/5] END ....C=1000, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END ....C=1000, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 5/5] END ....C=1000, gamma=0.01, kernel=rbf;, score=1.000 total time=   0.0s
[CV 1/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 3/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 4/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 5/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 1/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=1.000 total time=   0.0s
[CV 2/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.960 total time=   0.0s
[CV 3/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.990 total time=   0.0s
[CV 4/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.980 total time=   0.0s
[CV 5/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.959 total time=   0.0s
```

Out[29]:

```
▸ GridSearchCV
▸ estimator: SVC
  ▸ SVC
```

In [30]:

```python
# print best parameter after tuning
print(grid.best_params_)

# print how our model looks after hyper-parameter tuning
print(grid.best_estimator_)
```

```
{'C': 10, 'gamma': 0.1, 'kernel': 'rbf'}
SVC(C=10, gamma=0.1)
```

In [31]:

```python
grid_predictions = grid.predict(X_test)

print("Accuracy:",metrics.accuracy_score(y_test, grid_predictions))
```

Accuracy: 1.0

In [32]:
```
clf_best =  svm.SVC(C=2, kernel='rbf', gamma=0.1)
```

In [33]:
```
from sklearn.model_selection import cross_val_score
scores = cross_val_score(clf_best, training_features, target_feature, cv=5)
scores
```

Out[33]:
```
array([1.        , 0.9858156 , 0.9929078 , 1.        , 0.99285714])
```

In [34]:
```
scores.mean()
```

Out[34]:
```
0.9943161094224923
```

In [35]:
```
plot_roc_curve(y_test, grid_predictions)
print(f'model 1 AUC score: {roc_auc_score(y_test, grid_predictions)}')
```

model 1 AUC score: 1.0